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OLİMPİK STİL HALTERDE ELİT VE SUB-ELİT KADIN HALTERCİLERİN Q-AÇILARI

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Özet

Bu araştırmanın amacı, elit ve sub-elit kadın halter sporcularının quadriseps femoris kas açısını (Q açısı) belirlemek ve ayrıca, Q açısının bazı fiziksel parametreler, spor seviyeleri ve halter performansları ile ilişkisini incelemektir. Araştırmaya uluslararası Olimpik halter şampiyonalarına katılan elit halterciler (EH), (n=18) ve ulusal-uluslararası halter turnuvalarında halter şampiyonalarına katılan sub-elit sağlıklı kadın halterciler (n=18) katılmıştır. Q açıları, sporcular sırtüstü yatar pozisyonunda hareketsizken bir gonyometre ile ölçüldü. Ayrıca, uyluk uzunluğu (UU), uyluk çevresi (UÇ), pelvik genişlik (PG) ve diz ekstansiyon-fleksiyon kas kuvvetleri ölçüldü. İstatistiksel analiz; t-Test, eşleştirilmiş örneklem t-Testi ve Pearson korelasyon analizleri ile SPSS programıyla yapıldı. $p< .05$ anlamlı olarak kabul edildi. EH ve sub-EH'lerin demografik ve antropometrik değerleri arasında yaş haricinde fark gözlenmedi ($p>.05$). Sub-EH'lerin sağ-sol Q açısı değerlerinin (sırasıyla 16,67±2,43^o ve 18,28±2,70^o) EH'lerden (sırasıyla 14,56±2,68^o± ve 14,94±2,21^o), $p<.05$, $p<.001$, sırasıyla) daha büyük olduğu belirlendi. Sub-EH'lerin sağ-sol Q açıları arasında da farklılıklar tespit edildi ($p<.05$). Sub-EH'lerde sağ Q açısının vücut kitle indeksi, sağ UU, sol UÇ, PG, halter performansları ve spor geçmişi ile pozitif ve anlamlı olarak ilişkili olduğu görüldü ($p<.05$). Bu araştırmada, elit halter seviyesine bağlı olarak halter performansı artarken, Q açısının azaldığı gözlendi.

Anahtar Kelimeler: Gonyometre, Olimpik Stil Halter, Quadriseps Açısı, AnteriorSuperiorİliak Çıkıntı (ASİÇ)

Q-ANGLES OF ELITE AND SUB-ELITE FEMALE WEIGHTLIFTERS İN OLYMPIC STYLE WEIGHTLIFTING

Abstract

The aim of this study is to determine the quadriceps femoris muscle angle (Q-angle) of elite and sub-elite female weightlifters, and also to examine the relationship of Q-angle with some physical parameters, training experience and weightlifting performances.Elite weightlifters (EWL) participating in international Olympic style weightlifting championships (n=18) and sub-elite healthy female weightlifters participating in weightlifting championships in National-International Weightlifting Tournaments participated in the research (n=18). The Q-angles were determined with a goniometer in the supine position at rest. Also, thigh length (TL), thigh girth (TG), pelvic width (PW) and knee extension-flexion muscle strength were measured. Statistical analysis was conducted with SPSS program. $p< .05$ was accepted significantly.No difference was observed between the demographic and anthropometric values of the EWLs and sub-EWLs (except for age; $p>.05$). It was determined that the right-left Q-angle values of the sub-EWLs (16.67±2.43^o and 18.28±2.70^o, respectively) were greater than the EWLs (14.56±2.68^o± and 14.94±2.21^o, respectively, $p<.05$, $p<.001$, respectively). Differences were detected between the right-left Q-angles of sub-EWLs ($p<.05$). In sub-EWLs, it was observed that the right Q-angle was positively correlated with weightlifting performances and training experience ($p<.05$).In this study, it was observed that while weightlifting performance increased depending on the elite weightlifting level, the Q-angle decreased.

Key Words: Goniometry, Olympic style weightlifting, Quadriceps angle, Anterior Superior Iliac Spine (ASIS)

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INTRODUCTION

The patella-femoral angle measurement is a method that is frequently used in the kinesiological evaluation of the knee joint and lower extremity, and it is also called the Q-angle or the angle of the quadriceps femoris muscle (O'brien, 2001).The Q angle is an angle between the line extending from the anterior superior iliac spine (ASIS) to the midpoint of the patella and the line extending from the midpoint of the patella to the tuberositas tibia and provides information about pelvic position, hip rotation, tibial torsion and patella and foot position (Sarkar et al., 2009). As a result of many studies performed, it is seen that although the norm values for the Q angle have been reported and accepted by the clinicians, there is still no consensus on the reference values. Values greater than 15 degrees for male and 20 degrees for female are considered abnormal(Woodland and Francis, 1992; Herrington and Nester, 2004). It is thought that when the Q-angle exceeds the limit of 15-20 degrees, it causes a malfunction in the knee extensor mechanism and causes patellofemoral pain with the tendency of the patella to slide towards the lateral(Byl et al., 2000). In the other hand, It has been suggested that an abnormally increased Q-angle value may cause changes in neuromuscular control, excessive stress on the joint due to the change in the knee joint's plane of motion and a decrease in performance in the athletes (Bloomfield et al., 2007; Hewett et al., 2005). Also, an abnormally low Q-angle has been found to be associated with a variety of ailments (Wilson and Kitsell, 2002).

The Q-angle determines the force exerted by the quadriceps muscle on the tuberositas tibia through the patellar tendon, and it is thought that the effect of the transmitted muscle force will increase as the angle gets smaller (Sarkar et al., 2009). For this reason, it is stated that the Q-angle may change depending on the contraction state of the quadriceps muscle, and similarly, the contraction state of the quadriceps muscle can change the Q angle (Biedert and Warnke, 2001).It has been stated that there is a relationship between the Q-angle, which is an indicator of the lower extremity biomechanical alignment, and the knee joint muscle strength, and that the quadriceps muscle strength decreases as the Q-angle increases(Byl et al., 2000; Mohanty et al., 2019). Messieret al. (1991) was reported that individuals with high Q-angle have lower quadriceps muscle strength, On the other hand, Hahn and Foldspang(1997)was reported that Q-angle decreased after quadriceps strengthening training. It has been reported that the Q-angle is affected by many factors such as the sport branch, training experience, gender and dominance status (Hahn and Foldspang (1997) and there is a relationship between the Q-angle and some physical characteristics and sportive performance(Hahn and Foldspang, 1997;Yücel 1995;Kishali et al., 2004).

With this work; it was aimed to investigate the Q-angles of elite and sub-elite female weightlifters. In addition, it is aimed to investigate the relationship of the determined Q-angles withweightlifting performance, some physical characteristics and training experience.

METHODS

Research Model

In this study, the relational survey method, one of the quantitative research methods, was used.

Universe-Sample (Research Group)

Our research was planned to investigate the Q-angles of elite and sub-elite female weightlifters. Our study was carried out on two groups consisting of female weightlifters participating in Olympic style weightlifting championships at the international level (elite weightlifter (EWL); n= 18; 5.5% participated in Olympic Games; 94.5% participated in both World Weightlifting Championship and participated in European Weightlifting Championship) and female weightlifting athletes participating in weightlifting championships in national-International Weightlifting Tournaments (Sub-EWL; n= 18; 66.7% participated in International Weightlifting Tournaments; 33.3% participated in ranking in the first three athletes in Turkish Weightlifting Championships). The groups of our research consisted of the athletes of the Turkish Olympic Preparation Center located in Konya and the athletes of the women's Turkish Weightlifting National Team camp opened in the same city. The EWL group has been selected from the athletes who have been doing regular and active weightlifting sports (at least 6 days a week) for the last 3 years in the Turkish Weightlifting National Teams. The Sub-EWL group was selected from athletes who have been regularly and actively engaged in weightlifting (at least 5 days a week) for 4 years. Before measurements, each participant was asked whether he had an injury or an operation on lower extremity and physical treatment of the groups was conducted by anmedicinespecialist (B.I).For both groups; exclusion criteria were being younger than 18 years of age, playing sports for less than three years, ongoing pain in the lower extremities, an orthopedic problem, any surgical condition in the lower extremities, and an acute or chronic sports injury.In addition, due to the possibility of affecting the muscle strength in the dominant extremity and therefore the Q-angle, left-sided dominance was determined as an exclusion criterion.Only right-sided dominant athletes were included in the study.In determining the dominant foot, individuals were asked about the side they used most in daily life or sportive activities and it was recorded.Athletes participating in the study were given general information about the study.A signed consent form was obtained from all athletes who agreed to participate in the study. Our research was carried out in accordance with the principles of the 2008 Helsinki Declaration and approval was obtained from the Clinical Research Ethics Committee of KaramanoğluMehmetbey University Faculty of Medicine (Date: 29.06.2022, Decision No: 06-2022/5).

Data Collection Tools

Experimental Protocol

Q-angle and lower extremity measurements

The right and left knee Q-angles of the athletes were measured when the knee and hip were in full extension in supine position without shoes. Before measurements, the borders of the patella, the tibial tuberosity and the anterior superior iliac spine were located by careful palpation. The goniometer (Base line goniometer, Netherlands) was placed on the center of the patella; the longer arm was directed to the anterior superior iliac spine and the shorter arm to the tibial tuberosity. The athletes were instructed to keep the quadriceps muscles as relaxed as possible. Right and left Q-angle measurements were recorded in degrees(Weiss et al.,2013; Caiaetal., 2016; Mohamed etal., 2012). When the athletes were in supine position, thigh length and girth, pelvic width was measured by a measurement tape (with 1 mm interval). Thigh length (TL): The distance between trochanter major and patella (from the center) was measured. Thigh girth (TG): The athletes were asked to stand and open their legs as far as the length of their shoulders. The measurement was made from the largest part closest to the groin (at m. quadriceps extension). Pelvic width (PW): The pelvic width was measured as the distance between the anterior superior iliac spines in supine position (Mohamed et al., 2012; Baltzopoulos et al., 2009; Norton et al., 2018). At the time of the Q-angle and anthropometric measurements, all subjects completed a questionnaire on baseline characteristics including age, training experience (TE, years). Anthropometric measurements were taken on day/days when the athletes did not train. In addition, the height (cm), body weight (kg) and body mass index (BMI, kg/m2) of the athletes were determined on the same day. Height and weight measurements: The height of the athletes have been measured with stadiotmeter (SECA, Germany) which has 0.01 m. degree of accuracy, the weight of the athletes have been measured with electronic bascule (Tanita MC-580, Japon) which has 0.1 kg degree of accuracy. BMI was calculated by dividing the body weight by the square of the height measurement (Norton et al., 2018). All measurements were taken by the same investigator (K.E).

The determination of athletic performance and knee extension-flexion muscle strength of athletes in Olympic style weightlifting

Single repetitional maximal (1RM) snatch and clean-and-jerk records for the gained by the athletes in World weightlifting championships, European weightlifting championships, International tournaments and weightlifting championships in Turkey were taken from the official web sites of World Weightlifting Federation (https://www.iwf.net/new_bw/results_by_events/), European Weightlifting Federation(http://result.ewfed.com/)and Turkish Weightlifting Federation(https://halter.gov.tr/sonuclar/).

The initial position of the athletes examined in the knee extension (Knee Ext) was as follows: the athletes examined sat on the couch with the leg bent over the knee at the ankle joint at 90 degrees, the back was straight, and feet did not touch the ground (athletes were asked to keep their hands in the air and pelvic movement was not allowed). At the moment when the athletes examined was extending the knee, the tester provided resistance by placing the hand held dynamometer (Lafayette manual muscle tester, Lafayette instruments©, USA, Model-01165) at the distal part of the knee. The athletes had to overcome the resistance force provided by the tester by extending the knee at the maximum capacity within 3 seconds (measurements performed thrice with the rest of 15 seconds, recorded by taking the average of three measurements).

The initial position of the athletes examined in the knee flexion (Knee Flex) was as follows: the athletes examined sat on the couch with the leg bent over the knee at the ankle joint at 90 degrees, the back was straight, and feet did not touch the ground (athletes were asked to keep their hands in the air and pelvic movement was not allowed). At the moment when the athletes examined was flexing the knee, the tester provided resistance by placing the hand held dynamometer (Lafayette manual muscle tester, Lafayette instruments©, A.B.D. Model-01165) at the rear part of the knee. At the moment of knee flexion the tester had to stabilize the back and the leg of the athletes examined. The person had to overcome the resistance force provided by the testerby flexing the knee at the maximum capacity within 3 seconds (measurements performed thrice with the rest of 15 seconds,recorded by taking the average of three measurements) (Dunn and Iversen, 2003). The knee extension-flexion muscle strengths of the athletes were measured by the same researcher (K.E) on a day when the athletes did not train.

Data Analysis

Before proceeding to the basic analysis, descriptive statistics of demographic variables were examined. To test the normality assumption, skewness-kurtosis values, histograms and Q-Q plots were examined.According to the results obtained, it was determined that all research variables showed normal distribution.A series of Independent Groups t-Tests were conducted to examine some of the anthropometric and demographic values of the EWL and Sub-EWLs.Paired Sample t-Test was performed to compare right-left lower extremity anthropometric measurements and right-left Q-angles of EWL and Sub-EWLs.In addition, the relationships between right-left Q-angles and other variables of the study were analyzed by Pearson Correlation analysis.Statistically significant level was accepted as $p < .05$ for all analyzes and analyzes were performed with SPSS 25(IBM Corp. Released 2017, IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.) program.

RESULTS

Demographic characteristics and some anthropometric values of EWL and Sub-EWLs are presented in Table 1.As a result of a series of t-Tests for Independent Groups, it was determined that there was only a significant difference in age values between the groups ($t(34) = 3.86$, $p < .001$). No significant difference was found between the other parameter measurement values of the groups ($p > .05$). Paired Sample t-Test was performed to compare Right-Left TL and Right-Left TG of EWL and Sub-EWL groups. According to the results obtained, no significant difference was found between the Right-Left TL and Right-Left TG measurement values of the groups($p > .05$), (Table 1).

Table 1. Comparison of demographic and physical characteristics of athletes.

Variables	Groups	n	Mean	SD	*t*	*P*	95% Confidence Range	
							Lower Value	Upper Value
Age (years)	EWL	18	20.28	2.19	3.86	**.000***	.97	3.14
	Sub-EWL	18	18.22	.55				
Height (cm)	EWL	18	1.61	.08	.04	.963	-.05	.05
	Sub-EWL	18	1.61	.06				
Weight (kg)	EWL	18	65.80	17.05	.10	.918	-11.46	12.69
	Sub EWL	18	65.18	18.58				
BMI (kg/m²)	EWL	18	25.21	4.86	.11	.913	-3.35	3.74
	Sub -EWL	18	25.02	5.57				
Right TL (cm)	EWL	18	42.89	2.45	1.22	.229	-.61	2.48
	Sub -EWL	18	41.96	2.11				
Left TL (cm)	EWL	18	42.81	2.40	1.10	.276	-.69	2.33
	Sub -EWL	18	41.98	2.04				
Right TG (cm)	EWL	18	60.91	6.20	1.44	.158	-1.23	7.25
	Sub -EWL	18	57.90	6.30				
Left TG(cm)	EWL	18	60.73	6.08	1.40	.168	-1.28	7.05
	Sub -EWL	18	57.84	6.21				
PW (cm)	EWL	18	30.08	3.52	-.61	.545	-3.39	1.82
	Sub -EWL	18	29.29	4.14				

EWL: Elite Athletes in Olympic Style Weightlifting, BMI: Body Muscle Index (kg/m^2), TL: Thigh Length (cm), TG: Thigh Girth (cm), PW: Pelvic Width (cm), *p<.05.

A series of Independent Samples t-Tests were conducted to compare the EWL and Sub-EWL groups in terms of Right-Left Q-angle, Right-Left Knee Ext, Right-Left Knee Flex, 1RM snatch, 1RM clean-jerk and training experience.In the test results, it was observed that there were statistical differences between Right-Left Q-angle, Right-Left Knee Ext, Right-Left Knee Flex, 1RM snatch, 1RM clean-jerk and training experience values of EWL and Sub-EWLs (respectively; $t(34) = -2.47$, $p<.05$; $t(34) = -4.05$, $p<.001$; $t(34) = 4.54$, $p< .001$; $t(34) = 4.77$, $p< .001$; $t(34) = 4.67$, $p< .001$, $t(34) = 4.09$, $p< .001$; $t(34) = 4.53$, $p< .001$; $t(34) = 2.44$, $p< .05$), (Table 2).

Paired Sample t-Test was performed to compare the Q-angles and right-left knee extension-flexion muscle strength of the EWL and Sub-EWL groups. According to the results obtained, it was observed that only the Left Q-angle of Sub-EWLgroup was higher than the Right Q-angle ($t(17)= -2.60$, $p< .05$).No significant difference was detected between the measurement values of other parameters ($p>.05$).

Table 2. Q-angles, right-left knee extension-flexion muscle strength, weightlifting performance and training years of the athlete groups in the study.

Variables	Groups	n	Mean	SD	*t*	*P*	95% Confidence Range	
							Lower Value	Upper Value
Right Q-angle (^{0})	EWL	18	14.56	2.68	-2.47	**.018***	-3.84	-.38
	Sub-EWL	18	16.67	2.43				
Left Q-angle (^{0})	EWL	18	14.94	2.21	-4.05	**.000***	-5.00	-1.66
	Sub-EWL	18	18.28	2.70				
Right Knee Ext (kg)	EWL	18	32.46	7.27	4.54	**.000***	5.30	13.87
	Sub EWL	18	22.87	5.23				
Left Knee Ext (kg)	EWL	18	32.02	6.04	4.77	**.000***	5.22	12.96
	Sub -EWL	18	22.93	5.36				
Right Knee Flex (kg)	EWL	18	24.88	5.18	4.67	**.000***	4.13	10.47
	Sub -EWL	18	17.58	4.12				
Left Knee Flex (kg)	EWL	18	24.37	4.93	3.94	**.000***	3.09	9.67
	Sub -EWL	18	17.99	4.78				
1RM snatch (kg)	EWL	18	88.22	12.01	4.09	**.000***	7.50	22.28
	Sub -EWL	18	73.33	9.68				
1RM clean and jerk(kg)	EWL	18	111.61	15.13	4.53	**.000***	11.09	29.13
	Sub -EWL	18	91.50	11.21				
TE (years)	EWL	18	7.47	3.31	2.44	**.020***	.37	4.02
	Sub –EWL	18	5.28	1.87				

EWL: Elite Athletes in Olympic Style Weightlifting, (^{0}): Degrees, Ext: Extension, Flex: Flexion, 1RM: Single Repetitional Maximal (kg), TE: Training Experience (years), *p<.05.

The demographic values of the EWL and Sub-EWL groups, some anthropometric measurement values, and the correlation of Right-Left Q-angles are presented in Table 3.A positive correlation was observed between Right Q-angle and Left Q-angle in both EWL and Sub-EWL groups (respectively; p<.001, p<.05).Also, in Sub-EWLs, the right Q-angle; weight, BMI, right TL, left TG and PW were positively and significantly correlated (p<.05).It was determined that Q-angles were not in any correlation with other parameters in the EWL group (p> .05).

Table 3. The correlations between Q-angle values and demographic characteristics and anthropometric values of EWL and Sub-EWL groups.

Variable	EWL		Sub-EWL	
	Right Q-angle (⁰)	**Left Q-angle (⁰)**	**Right Q-angle (⁰)**	**Left Q-angle (⁰)**
Right Q-angle(°)	1	**.849*****	1	**.474***
Left Q-angle (°)	**.849*****	1	**.474***	1
Age (years)	.342	.137	-.059	-.004
Height (m)	-.181	-.116	.392	.083
Weight (kg)	-.131	-.054	**.491***	.188
BMI (kg/m²)	-.107	-.029	**.489***	.205
Right TL (cm)	.091	-.045	.322	.293
Left TL(cm)	.136	-.003	.305	.280
Right TG (cm)	.121	-.076	**.512***	.285
Left TG (cm)	-.113	-.100	**.506***	.281
PW (cm)	.065	-058	**.572***	.183

EWL: Elite Athletes in Olympic Style Weightlifting, (⁰): Degrees, BMI: Body Muscle Index (kg/m²), TL: Thigh length (cm), TG: Thigh girth (cm), PW: Pelvic Width (cm),*p<.05, ***p<.001.

The correlation of Right-Left-Knee Ext, Right-Left Knee Flex, 1 RM snatch, 1 RM clean and jerk values and Right-Left Q-angles of EWL and Sub-EWL groups are presented in Table 4.It was observed that sub-EWLs were positively and significantly correlated with 1RM snatch, 1RM clean and jerk, and TE with Right Q-angle (p<.05).It was determined that Q-angles were not in any correlation with other parameters in the EWL group (p> .05).

Table 4. The correlations between Q-angle values and knee extension-flexion muscle strength, athletic performance and other variables of EWL and Sub-EWL groups.

Variable	EWL		Sub-EWL	
	Right Q-angle (°)	**Left Q-angle (°)**	**Right Q-angle (°)**	**Left Q-angle (°)**
Right Q-angle(°)	1	**.849*****	1	**.474***
Left Q-angle (°)	**.849*****	1	**.474***	1
Right Knee Ext (kg)	-.108	-.160	.233	.079
Left Knee Ext (kg)	-.203	-.220	.292	.174
Right Knee Flex (kg)	-.331	-.237	-.157	-.044
Left Knee Flex (kg)	-.348	-.294	-.062	-.045
1RM snatch (kg)	-.072	-.082	**.531***	.023
1RM clean and jerk (kg)	-.068	-.011	**.640****	.067
TE (years)	.393	.185	**.617****	-.63

EWL: Elite Athletes in Olympic Style Weightlifting, (⁰): Degrees, 1RM: Single Repetitional Maximal (kg), TE: Training Ex*p*erience (years), *p<.05, **p<.01, ***p<.001.

DISCUSSION and CONCLUSION

Q-angle is an important biomechanical marker because it is associated with muscle strength and plays a role in the etiological background of knee injuries (O'brien, 2001; Messier et al., 1991). It is considered normal that the Q-angle, which is expected to be at different intervals in male and female, is between 8-14º in male and 11-20º in female (Herrington and Nester, 2004).In cases where the Q-angle is above the normal limits, the patella will tend to displace laterally. It has been suggested that an abnormally increased Q-angle value may cause changes in neuromuscular control, excessive stress on the joint due to the change in the knee joint's plane of motion and a decrease in performance in the athlete(Bloomfield et al., 2007; Hewett et al., 2005). In the literature review, it has been reported that the Q-angle is affected by many factors such as the sport branch, age of the athlete, gender, some physical parameters and dominance status, and in some sources, the Q-angle is not affected by these factors. It was observed that the Q-angle values of the EWL and Sub-EWL athletes included in our study were within the normative values specified in the literature.However, some findings were different from literature values.We think that this observed difference may be due to factors such as sampling, sports branch, year of doing sports, measuring method and measuring equipment.

It has been reported that in healthy individuals who do not have knee joint problems and are engaged in different sports branches (Q-angle 14 ± 00^0 in female football players, 14 ± 0.00^0 in athletics athletes, 14.75 ± 1.41^0 in basketball players, 13.90 ± 1.73^0 in volleyball players, 14.50 ± 0.00^0 in swimmers, 14.33 ± 0.57^0 in gymnasts, 14.90 ± 1.00^0 in handball players, 15.5 ± 0.00^0 in karate players), factors such as age, sports, years of doing sports and the number of training sessions per week do not affect the size of the Q-angle(except for gender, lower extremity length and femur length), and there is no difference between the right-left extremity Q-angle values of the participants (Yücel, 1995). Horton and Hall, (1989) reported that healthy female individuals without any knee problems detected the Q-angle as 15.8±45 degrees, and that there was no correlation between the Q-angle and the length and hip width of the femur. On the other hand, Kishali et al. (2004) reported that there was no relationship between right-left Q-angle and femur length, tibia length, thigh and calf circumference of female soccer (right 16.04 ± 1.34^0, left 15.44 ± 1.47^0)and taekwondo (right 17.06 ± 1.08^o, left 16.57 ± 1.09^o) athletes.In the EWLs in our study, it was determined that right-left Q-angles were not in any correlation with age, height, weight, BMI, right-left TL, right-left TG, PW, right-left knee ext.and right-left knee flex.

In the study in which the Q-angles of amateur sportsmen and sedentary women were determined, it was reported that the Q-angle values of amateur sportswomen(12.28±2.38°) were lower than the Q-angle values of sedentary women(14.91±3.93°).In addition, the authors stated that there was a weak correlation between the length of the femur and the state of doing sports and the Q-angle, and a negative and weak correlation between the width of the pelvis and the Q-angle (Eliöz et al., 2015). In the study in which the relationships between the Q-angles of the athletes in different sports branches (badminton 14.67±3.21°, rugby 21.50±7.14°, volleyball 26.54±7.01°, basketball 19.15±7.29° and futsal 24.67±5.00°)were determined by the year of doing sports, the femur length and pelvic width values, the authors reported that they determined the relationship between the sports age and pelvic with values of the Q angle (Yilmaz et al., 2017).The right Q-angle was determined as 14.18±3.13 degrees, and the left Q-angle was 13.22±2.27 degrees in female athletes engaged in different sports branches and they reported that the obtained Q-angles were related to parameters such as training experience, age, some physical and anthropometric parameters (Hazar et al.,2016).

In our study, it was determined that Sub-EWLs were positively and significantly correlated with right Q-angle weight, BMI, right-left TG, PW, 1 RM snatch, 1 RM clean and jerk, and TE.

Kishali et al., (2004), in their study in which they determined the Q-angle of female soccer and taekwondo athletes, reported that the Q-angle on the dominant foot side was greater than the Q-angle on the non-dominant foot side. Hahn and Foldspang (1997), in their study investigating the Q-angles of athletes in different sports branches, reported that the right side Q-angles of the sportsmen groups were generally larger than the left side Q-angles and the detected asymmetric Q-angle difference might have occurred due to the use of the dominant foot.In our study, it was determined that the Q-angle of EWLs was smaller than the Q-angle of Sub-EWLs, the right Q-angle of Sub-EWLs was greater than the left Q-angle, but no difference was observed between the Q-angles of the EWL groups.

It is thought that the relationship between the Q-angle and muscle strength may change, and the differences between age, gender and sports branch and the differences between flexor and extensor muscle strength depending on these are thought to be effective (De SteCroixet al., 2004). In a study carried out by Bayraktar et al., (2004), it was reported that the decrease in Q- angle values was higher in active individuals engaged in physical activity than in sedentary individuals.These findings were associated with developmental differences by researchers without ignoring other biomechanical factors such as pelvis width and femur length, and they reported a decrease in Q-angle due to increased muscle tone and strength in the thigh muscle group (Bayraktar et al., 2004). It has been reported that Q-angle values have a strong distinguishing feature between runners without patella-femoral pain and injured group runners, and injured group runners have less lower extremity muscle strength and higher Q-angles (Messier et al., 1991). Byl et al., (1998) reported that the size of the Q-angle is related to the strength of the quadriceps muscle group and the magnitude of the Q-angle decreased with the increase of the quadriceps peak torque, although there was a weak correlation between the magnitude of the Q-angle and the peak torque of the quadriceps.They reported that the reduction in the Q-angle may be closely related to the contraction of the quadriceps pulling the patella superiorly and laterally.As stated by Hahn and Foldspang(1997), the high strenght and muscle tone applied by the quadriceps muscle group reduces the Q angle.Therefore, the smaller the Q-angle, the narrower the angle, the greater the effect of the transmitted muscle strength (Muratlı et al., 2000) On the other hand, Erdağı et al., in a study they conducted in 2022 on male elite and non-elite weightlifters, showed that the Q angles of elite weightlifters were statistically smaller than those of non-elite weightlifters. In addition, the authors noted that they did not find a relationship between muscle strength and Q-angle value (Erdağı et al., 2022). The findings we obtained as a result of the study also support this situation to a large extent. In our research, it was observed that right-left Knee Ext and Knee Flex, 1RM snatch and 1RM clean and jerk values of EWLs were greater than the values of Sub-EWLs. Moreover, in Sub-EWLs, there was a significant positive correlation between weightlifting performance and right Q-angles. In contrary, no correlation was found between the leg strength parameters and weightlifting performances of the EWL groups and their Q-angles. However, it has been observed that the right-left Q-angle of EWLs is smaller than the Q-angle of Sub-EWLs. In this reasons, we think that the Q-angle difference between the groups is closely related to leg strength and weightlifting performance.

The number of female weightlifting athletes who do sports at elite and sub-elite level is verylimited in Turkey due to the difficult nature of the weightlifting branch and the established negative beliefs. We included all female weightlifters engaged in elite and sub-elite sports in Turkey. Nevertheless, the narrow number of elite female weightlifters in Turkey was a limitation for the number of athletes included in our study.Many studies can be planned with more female elite weightlifters and athletes from different branches in the future.

RECOMMENDATIONS

As a result, our study revealed that the Q-angle values of female who do elite weightlifting sports are smaller than those of female who do sub-elite weightlifting sports.We think that frequent measurement of the Q angle by weightlifting trainers and sports physicians may be effective in preventing possible muscle asymmetry and sports injuries that may occur in weightlifters, and may contribute positively to weightlifting performance. Also, we think that the participation of more athletes for future Q-angle studies with female weightlifters will provide a different perspective to the literature on the subject.

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Conflict of Interest

The authors declare that they have no conflict of interest with any person, institute or institution.

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