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Research Article

Effect of Anthropometric Parameters on Quadriceps Femoris (Q) Angle: An Analytical Cross-Sectional Study from Iraq

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Abstract

Background: One important clinical indicator that shows how the muscle affects the patellofemoral joint is the quadriceps angle. This angle is formed between the quadriceps femoris and the patellar ligament. It is also thought to be a key factor in maintaining good posture and patellar movement. The angle is often used as a clinical sign to check on people who have problems with their knee joints. ***Objective***: The study is planned to measure the mean Q angle in Iraqi adult individuals with the goal of referring data to help improve the clinical diagnosis and evaluation of patients with knee joint malalignments. ***Methods***: The right and left Q angles of 200 participants were measured using a universal goniometer. The relationship between Q angles and different anthropometric parameters was tested using appropriate statistical tests. ***Results***: The mean right Q angles for males' measure 15.63° and for the females 17.58°. The mean left Q angles for males measured 14.18° and for the females were 16.14°. Both Q angles (right and left) were greater in females. The study revealed a strong negative correlation between height and QA, a moderate negative correlation between weight and QA, and a slight negative correlation between BMI and QA. ***Conclusions***: The study improves understanding of the usual range of the Q angle in a study group of seemingly healthy adults and attempts to establish a reference value for orthopedic surgeons, biomedical engineers, forensic specialists, and anthropologists.

Keywords: Anthropometry, Goniometer, Iraq, Q Angle.

تأثير المعلمات الأنثروبومترية على زاوية العضلة الفخذية: دراسة تحليلية مقطعية في العراق

الخلاصة

الخلفية: تعتبر هي زاوية العضلة الفخذية رباعية الرؤوس (QA) أحد المؤشرات السريرية الهامة التي توضح كيفية تأثير العضلة على مفصل الركبة. زاوية QA هي المتشكلة بين العضلة الفخذية رباعية الرؤوس والرباط الرضفي. ويُعتقد أيضًا أنها عامل رئيسي يساعد في الحفاظ على الحركة والوضعية الصحيحة لرضفة الركبة. وغالبًا ما تُستخدم كعلامة سريرية لفحص الأشخاص الذين يعانون من مشاكل في مفاصل الركبة. **الهدف**: قياس متوسط QA لدى مجموعة من الأفراد البالغين العراقيين للمساعدة في تحسين التشخيص والتقييم السريري للمرضى الذين يعانون من مشاكل في مفصل الركبة. **الطرق**: تم قياس زوايا QA اليمنى واليسرى لـ 200 مشارك باستخدام مقياس الزوايا العالمي واخضاعها لاختبارات احصائية مناسبة لاختبار علاقتها مع المعلمات القياسات البشرية المختلفة. **النتائج**: بلغ متوسط زوايتا QA للذكور 15.63° وللإناث 17.58°. بينما بلغت زواية QA اليسرى للذكور 14.18° وللإناث 16.14° درجة. وكانت اليمنى واليسرى أكبر عند الإناث. كشفت الدراسة عن وجود علاقة سلبية قوية بين الطول وال QA، وارتباط سلبي معتدل بين الوزن وال QA، وعلاقة سلبية طفيفة مع مؤشر كتلة الجسم. **الاستنتاجات**: تساعد النتائج في فهم نطاق معدل قيمة قياس QA في مجموعة من البالغين الأصحاء ظاهريًا ومحاولة إنشاء قيمة مرجعية لجراحي العظام ومهندسي الطب الحيوي، المتخصصين في الطب الشرعي، وعلماء الأنثروبولوجيا.

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INTRODUCTION

The quadriceps femoris muscle (QFM) is made up of four major muscles located on the anterior side of the leg. It is the only knee extensor, with a massive flesh mass covering the anterior and lateral sides of the femoral bone. Its name derives from "Latin four-headed muscle of the femur." The muscle has four sections (heads): rectus femoris (originating from the anterior superior iliac spine—ASIS) and three vasti muscles: vastus medialis, vastus lateralis, and vastus intermedius (originating from the front and sides of the femur). The four heads form a single tendon that inserts into the patella and connects to the tibial tuberosity (TT) via a

patellar tendon (PT) [1,2]. The acute angle that forms between the QFM and the PT is known as the Q angle [3]. Measuring the QFM mechanism on the patellofemoral joint is crucial for understanding the biomechanical function of the lower limb. It also indicates how the thigh muscles influence knee movement and how the patella moves within the joint grooves [4,5]. The angle is a crucial indicator for determining knee function and health in individuals experiencing anterior knee discomfort [6,7]. Proper angle measurement offers useful information concerning leg, foot, and pelvic alignment [8,9]. Malalignment will undoubtedly cause problems for the knee joint. As a result, Q-angle assessment is critical for those who are sporty and physically active [10]. The reported quadriceps angle varies. Experts generally agree that the quadriceps angle spans from 12° to 20°, with females often having higher values than males [11–14]. Some research suggests that a measurement of less than 10° is abnormal. Other investigations regarded a measurement greater than 20° as excessive [15]. Excessive quadriceps angle causes mechanical pressure on the knee joint, disrupting even patellar drive in the femoral groove [3,4]. Over time, this issue may lead to muscle disparities, which in turn can cause cartilage degradation and the removal of the knee joint's articular surface (16). The current study is planned to investigate the mean Q angle measurements in Iraqi adult individuals using a universal goniometer and correlate them with the age and various body parameters, including height, weight, BMI, BSA, and leg dominance, with the goal of developing a reference value to help improve the clinical diagnosis and evaluation of patients with knee joint malalignments and to be used for biomedical engineers, forensic specialists, and anthologists.

METHODS

Study design

The study is an analytical, cross-sectional design undertaken in the Department of Human Anatomy at Mustansiriyah Medical College, Baghdad, Iraq. The research included 200 adult patients who attended a private orthopedic clinic in Baghdad from February 2023 to June 2023, seeking treatment for various diseases, excluding lower limb and back problems.

Inclusion criteria

Male and female Iraqi adults who are willing to join the study and how have a palpable ASIS, patella and TT (which are used as landmarks for measuring QA) are included in this study.

Exclusion criteria

History of trauma, disease, or surgery affecting the lower limbs or spine, any neurological or endocrine disorder affects the musculoskeletal system.

Outcome measurements

A professional universal 360° goniometer, manufactured in Baseline, China, is utilized to measure Q angles in degrees. Height and weight were documented to the nearest tenth, BMI estimated by the formula ($BMI = W/H^2$, where W = weight in kg and H = height in meter) [17], and BSA estimated by using the Mosteller formula ($BSA = 0.0167 * H^{0.5} * W^{0.5}$, where H = height in meter and W = weight in kg) [18]. The individuals were asked to lie supine on a flat couch with the knee joint extended, the QFM in relaxation, and the foot in a neutral position perpendicular to the couch [19]. The ASIS, the midpoint of the patella (MP), and the tuberosity of the tibia (TT) were localized manually. One end of a string was positioned at the ASIS, while the other end was positioned inferior to the MP. The goniometer's hinge was hired at the MP, while the immobile goniometer arm was allied with the string portion that led to ASIS, and the mobile goniometer arm was allied with the TT [20]. Two readings were taken, and the average was recorded as the final reading (Figure 1).

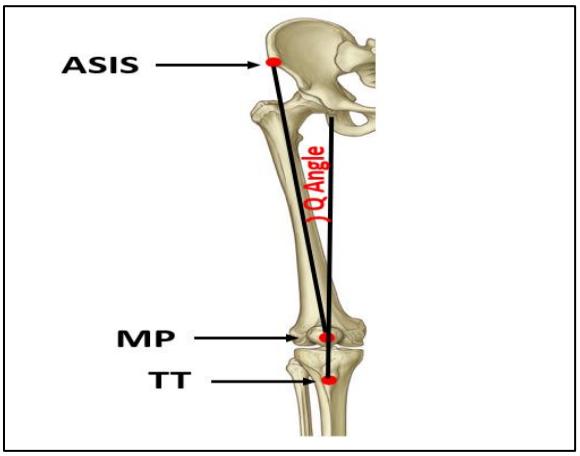

Figure 1: Anatomy of quadriceps angle (ASIS: Anterior Superior Iliac Spine, MP: Midpoint of Patella, TT: Tibial Tubercule)

Ethical approval

The research was performed under the ethical rules that originated in the WMA Declaration of Helsinki and was conducted with the participant's verbal and analytical approval before any examination and was ethically approved by the local committee of the College of Medicine, Mustansiriyah University.

Statistical analysis

Statistical analyses were accomplished using SPSS "Statistical Package for the Social Sciences-IBM-

Chicago-USA," version 26. Continuous data were presented as mean±SD. Intergroup and intragroup comparison was executed using ANOVA and t-tests. The correlation between two continuous data was determined by Pearson's correlation coefficient (r). Bivariate regression and the "coefficient of determination" R^2 were determined and were used to predict the relationship (if any) among different data. The probability value of P<0.05 was considered statistically significant [21,22].

RESULTS

The total number of participants in this study was two hundred (n = 200). The percentile contribution of males and females was 47.5% and 52.5%, respectively. Their descriptive statistics are summarized in Table 1. The mean right Q angle for males measured 15.63±2.13° and for females was 17.58±2.41°. The mean left Q angle for males measured 14.18±1.89° and for females was 16.14±1.76°.

Table 1: Descriptive statistics of the cases

Variables	Age	Height	Weight	BMI	BSA	RQA	LQA
Males							
Range	18-50	152-182	58-90	20.06-34.13	1.58-2.08	12-20	11-18
Mean±SD	37.87±9.42	167.98±6.64	75.61±8.98	26.85±3.32	1.8752±0.13	15.63±2.13	14.18±1.89
Variance	88.75	44.12	80.58	11.023	0.02	4.55	3.57
Females							
Range	17-67	150-181	58-102	19.37-34.27	1.58-2.25	14-22	13-20
Mean± SD	35.64±11.19	169.98±7.65	78.27±10.15	27.16±3.69	1.91±0.142	17.58±2.41	16.14±1.76
Variance	125.23	58.53	103.10	13.68	0.020	5.82	3.10
All							
Range	17-67	150-182	58-102	19.37-34.37	1.58-2.25	12-22	11-20
Mean± SD	36.70±10.42	169.03±7.24	77.01±9.68	27.01±3.51	1.89±0.13	16.66±2.47	15.21±2.06
Variance	108.62	52.44	93.71	12.38	0.02	6.147	4.277

BMI: Body mass index, BSA: body surface area, RQA: right Q angle, LQA: left Q angle, SD: standard deviation

The study subjects were stratified into five groups according to age, each with a 10-year interval, as follows: < 20 years (n = 20), 20-29 years (n = 29), 30-39 years (n = 55), 40-49 years (n = 84), >50 years (n = 12). A one-way ANOVA test was performed, which shows no significant difference in Q angle measurements among different age groups (p = 0.106). The mean RQA in the right-side dominant subjects was slightly greater than that of the left-side dominant subjects (16.75° *vs*. 15.91°); however, a t-test reveals no significant differences (p > 0.05). Similarly, the mean LQA in the left-side dominant subjects was slightly greater than that of the right-side dominant subjects (15.39° *vs*. 15.19°), yet the t-test reveals no significant differences (p > 0.05). The cases were stratified into five groups according to height, each with a 10-cm interval as follows: < 160 cm (n = 12), 160-169 cm (n = 84), 170-179 cm (n = 90), ≥ 180 cm (n = 14). A one-way ANOVA test was performed, which shows a statistically significant difference in Q angle measurements among different height groups (p<0.001), where the Q angle shows a significant decrease in measurement with increasing height. The cases were stratified into four groups according to weight, each with a 10-kg interval, as follows: < 70 kg (n = 42), 70-79 kg (n = 75), 80-89 kg (n = 56), and ≥ 90 kg (n = 27). A one-way ANOVA test was performed, which shows no significant difference in Q angle measurements among different weight groups (p = 0.102). The study subjects were divided into three groups according to BMI, each with a 5 kg/m^2 interval as follows: < 25 kg/m^2 (n = 69), 25-29 kg/m^2 (n = 78), and ≥ 30 kg/m^2 (n = 53). A one-way ANOVA test was performed, which shows no significant difference in Q angle measurements among different BMI groups (p = 0.401). The study subjects were divided into two groups according to BSA as follows: < 2 m^2 (n = 154), ≥ 2 m^2 (n = 46). A one-way ANOVA test was performed, which shows no significant difference in Q angle measurements among different BSA groups (p = 0.084). A Pearson's correlation test was performed to investigate the effect of an individual's age and anthropometric parameters (height, weight, BMI, and BSA) upon QA; the test concludes a negative correlation between height and QA and BSA and QA, but no correlation was founded with the age, weight, and BMI (Table 2).

Table 2: Pearson's correlation–Q-angles versus age and anthropometric parameters

	Age	Height	Weight	BMI	BSA
Correlation coefficient (r)	0.058	-0.243	-0.125	0.031	-0.128
p-value	0.412	0.001	0.077	0.664	0.010

Bivariate regressions were conducted to see if any of the anthropometric parameters could predict the QAs. The results are summarized in Table 3 and Figure 2.

Table 2: Linear regression statistics: Q- angles versus anthropometric parameters

Parameters	R	R^2	Adjusted R^2	p
Height	0.243	0.059	0.054	0.001
Weight	0.125	0.016	0.011	0.077
BMI	0.031	0.001	-0.004	0.664
BSA	0.182	0.033	0.028	0.010

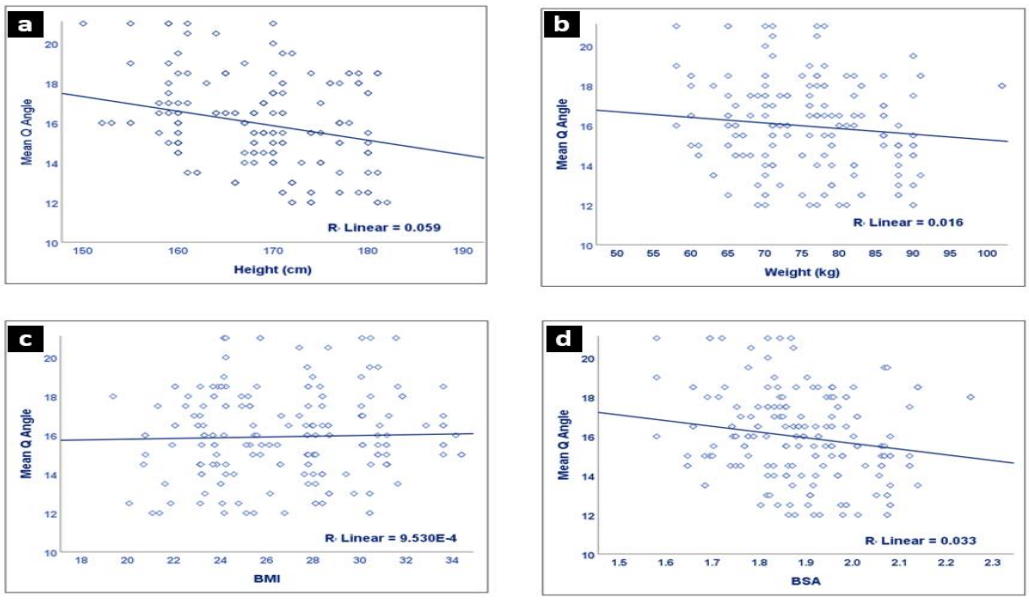

Figure 2: Scatter correlations and linear regressions: Q angle versus anthropometric parameters. (A) Height vs Q angle, (B) Weight vs Q angle, (C) BMI vs Q angle, (D) BSA vs Q angle.

DISCUSSION

The Q angle is a clinical indicator that is mostly used to diagnose a wide range of painful knee problems and disorders. The anterior thigh muscle is strongly associated with knee joint alignment indicators (such as the Q angle). Any misalignment that widens the Q angle is intended to increase the force on the knee patella. This is usually a bad thing since the additional force causes the patella to put greater strain on the lateral femoral lip. When the QFM is contracted on an extended knee joint, it may eventually result in a patellar subluxation or dislocation. However, an aberrant Q angle can also affect the quadriceps reflex reaction time and neuromuscular response, thus increasing the risk of anterior cruciate ligament injury [24]. The current study aimed to assess the relationship between the Q angle and a variety of body parameters. Several studies have been conducted internationally with this goal [11,12,25]. This study presents new findings on the Q angle and its relationship to several anthropometric indices in Iraqi populations. The study found that males had a Q angle of approximately 16° (RQA), 14° (LQA), and 15° (mean QA). Females' values were roughly 18° (RQA), 16° (LQA), and 17° (mean QA). These findings were like those reported from the Jordanian population [20], somewhat lower than those from the Nigerian population [12], and much higher than those recorded from the Indian population [26] (Table 4).

Table 3: Comparisons of Q-Angles described among different countries

Country	Technique	No.	Gender	RQA	LQA	Mean Q angle
Iraq (present study)	Goniometer	200	Male	16	14	15
			Female	18	16	17
Jordan [20]	Goniometer	500	Male	-	-	14
			Female	-	-	17
Nigeria [11]	Goniometer	477	Male	11	10.5	-
			Female	21	20	-
India [26]	Goniometer	140	Male	-	-	12
			Female	-	-	13

RQA: right Q angle, LQA: left Q angle.

In general, only a few international studies have investigated the Q-angle variability associated with leg dominance. Hahn *et al*. were among the first to conduct extensive investigation into such variability [9]. Other researchers have since identified similar variances [13,14,26,27], with only two showing significant variability. Livingston and Mandingo ascribed variability to increased tropism and muscle tone in the dominant leg, which may cause a drive on the patella, moving it and reducing the angle [27]. Raveendranath *et al*. attributed the variances to changes in the location of the tibial tubercle relative to the patellar midpoint [13]. The study found a negative link between Q angle measurement and height, supporting earlier findings that taller persons have a lower Q angle measurement [26,28]. The study also discovered a small negative connection between Q angle and BSA. According to the findings of the current investigation, the Q angle does not vary significantly with the weight of the study group. This was consistent with studies conducted by Sra *et al*.

[29], Choudhary and collaborators [19], and Khasawneh *et al*. [20]. The study found no significant association between Q-angle and BMI in the studied population. This finding was consistent with Kumar *et al*.'s research [30], although Prakash *et al*.'s study [28] revealed a substantial association.

Conclusion

The study enhances the understanding of the normative Q angle range within a cohort of ostensibly healthy adults, aiming to establish a reference value for orthopedic surgeons, biomedical engineers, forensic specialists, and anthropologists.

Conflict of interests

No conflict of interest was declared by the authors.

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Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

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