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Original Research Article

Effect of Gender and Physical Lifestyle on Quadriceps Angle in Young Adults

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Abstract

Introduction: Quadriceps angle (q-angle) is an important anatomical vector describing the alignment of the lower extremity and plays a significant role in evaluating patients with patellofemoral syndrome. **Aim:** To evaluate the magnitude and variations trends of q-angle in asymptomatic young males and females and to assess the effect of daily physical activity on its values. **Materials and Methods:** A total of 120 asymptomatic adults were divided into three groups of male students (MS), male laborers (ML), and female students (FS) with sixty subjects in each group. Normal values of Q angle were recorded in a standardized Romberg standing position using a flexible plastic goniometer. Data were statistically analyzed. **Results:** Q angles noted were in the range of 9-20°. Higher mean q-angle values were in females than males and it was found to be statistically significant. The mean q-angle obtained was 12.98° and 14.83° in males and females respectively. Mean q-angle was greater on the left side 13.11° & 14.90° than on right 12.84° & 14.83° in males and females, respectively. Comparison of q-angle in MS and ML revealed lower Q angle values, on both sides, in the ML group but it was not statistically significant. **Conclusion:** The study established normal reference values in adults of the Rajasthan region. The results concorded with most other studies of a higher q-angle in females and its bilateral asymmetry. The lower mean q-angle in the male laborer group does indicate physical lifestyle effect on q-angle but the study needs to be performed on a larger scale.

Keywords: Physical Lifestyle, Quadriceps Angle, Young Adults

Introduction

The Quadriceps angle (q-angle) is an important anatomical variable depicting the alignment in the lower extremity. It is an acute angle formed by the bisection of a line from the anterior superior iliac spine to the mid-patella and another line from mid-patella to the tibial tuberosity[1,2]. Anterior superior iliac spine, mid-patella,

and tibial tuberosity have been the landmarks used in all measurements of q-angle and these landmarks are easily palpable.

The relevance of the q-angle is that it is an important vector affecting the patellofemoral joint[3]. In normal physiological kinematics patella has to cope with the potential large stress especially during activities such as running and has the thickest articular cartilage in the body. An abnormally increased q-angle puts additional stress on the knees during the motions of flexion and extension, causing disruption to normal patellar tracking mechanisms, as well as there is increased pull on the tibia which could affect the patellar articular cartilage and tibiofemoral surfaces during movement[4]. Thus, increased q-angle can result in an increased risk of patellofemoral syndrome and can be problematic in affected individuals with malalignment syndrome of the lower limb[5,6]. These problems included chondromalacia patellae, frequent patellar subluxations, and diffuse patellofemoral pain[7,8]. Heiderscheit et al stated that malalignment of the lower limb has been implicated as a potential cause of running injury[9]. Therefore, q-angle has typically been the focus of the research, especially in sportspersons.

Another crucial aspect of angle is the gender-related differences, females have exhibited greater q-angle values than males[10,11]. Based on published literature it is relevant to mention that normal limit values of the aforementioned angle are up to 15° for men and up to 20° for women, and the values above are suggested to be problematic[12,13,14]. Lathinghouse and Tremble also concluded that women have greater q-angles values than men and are more affected by patellofemoral disorders[6]. There have also been reports indicating collegiate women basketball players were more likely to sustain an anterior cruciate ligament injury than their male counterparts[15].

The higher normal limit of q-angle is noticed to vary among different races on account of changes in anthropometric characteristics, therefore subjective abnormal values should be defined differently among races. One purpose of this study is to define normal q-angle magnitude in the asymptomatic adults of the Rajasthan region[11,16]. This study measures q-angle in a standardized standing position for the reason that as it is a weight-bearing functional position.

Hahn and Foldspang believed that the stronger the quadriceps muscle group, the smaller the Q angle[17]. The tone and bulk of the quadriceps muscle are influenced by the physical activities of an individual. Another aim of this study is to assess the impact of daily physical lifestyle activity on Q-angle by comparing the data obtained in two cohorts, one is of male college-going students and another of male laborers. Any difference noted will show the significance of the correlation between daily physical lifestyle activities and lower extremity alignment and anthropometrics.

Materials and methods:

One hundred and eighty subjects, of age range 18-30 years, were recruited from two cohorts. The first cohort comprised 120 college-going students (M-60, F-60) of Jaipur, Rajasthan region. And the second cohort was of 60 male laborers involved in manual labor jobs for daily wages. Three groups were formed according to gender and profession: 1) Male laborers (ML), 2) Male students (MS) and 3) Female students (FS).

Initially, individuals were approached with the proposal and design of the study. Written consent was taken from interested volunteers. A detailed proforma was filled comprising of demographics, medical history, and clinical examination. Individuals with a clinical history of the following conditions were excluded from

the study: 1) history of any fracture of the lower limb, acute or chronic knee pain, dislocation of the patella, neurological or vascular disorder. 2) any previously diagnosed knee disorder or surgery involving the knee. 3) history of injury to structures associated with knee joint, meniscal injury, ligament tear or instability, bursitis, and patellar tendinitis. 4) congenital deformity involving the lower limb. 5) any chronic illness.

In the methodology, the subject stood barefooted in the normal weight-bearing position; with the feet facing forwards in the Romberg position where the medial borders of the feet are touching each other; knees fully extended; and without voluntary quadriceps contraction[12,18]. Anatomical landmarks were marked at their maximum prominence with a delible ink pen: anterior superior iliac spine (ASIS), center of patella (CP), and center of the tibial tuberosity (TT). The center of the patella was marked at the bisection of its maximum vertical and transverse diameters[19]. Bilateral q-angles were measured with a transparent, flexible, plastic, full circle goniometer; with 1° increment and with two arms. The pivot of the goniometer was placed over the CP. The lower fixed arm of the goniometer was aligned with the TT and the upper movable arm was aligned with the ASIS. The angle formed between the above two lines was defined as the Q angle and was measured in degrees. The angle was collected three times to accommodate for sway and the average of the three was used in further analysis.

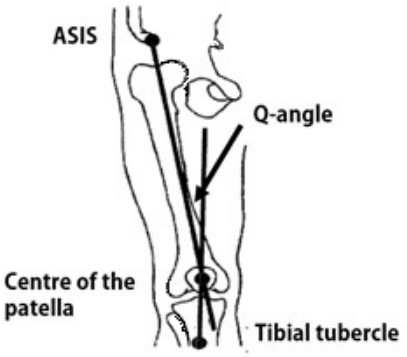

Fig. 1. Q-angle formed by the bisection of two lines, from ASIS to CP and from CP to TT.

Data and statistical analysis

The mean and standard deviation were determined for q-angle values. Comparisons of q-angle values within-group as well as between groups were performed using a one-way analysis of variance (ANOVA) test. Bilateral differences in the q-angle values were tabulated. All statistical significance was kept at $p<0.05$. The software utilized for statistical analysis are Microsoft excel and IBM SPSS Statistics v20.

Results:

Bilateral q-angle was obtained in 180 adult healthy volunteers. The descriptive statistics for the q-angles measurements of all the volunteers are shown in table 1. Data for the right and left q-angles, for male and female counterparts, and values in MS and ML groups were analyzed separately. One way ANOVA test was used to compare the q-angle between the groups and for bilateral comparison.(Table-2) Analysis of data suggests that the female student group had higher mean q-angle values for both right and left knees than both the male groups. Whereas, the ranges observed in the three groups did not show noticeable variation among genders. When observed statically,

significant differences in q-angles were observed, for both the right and left q-angles, between FS and both the male group-MS and ML. The male groups (MS & ML) did not show any statistical difference in q-angle among them.(Table 2) There was no statistically significant difference (p-value > 0.05) between bilateral q-angle values for all three groups. It is noteworthy that in most cases (37.22%) difference was only 1° and in a few (6.11%) it was more than 3°.

Table 1: Descriptive statistics for q-angles (°) among the three groups

Parameter	Male laborer (ML)	Male student (MS)	Female student (FS)
Right Knee (n=60)	12.52± 2.44	13.17± 2.51	14.83± 2.20
Left Knee (n=60)	12.78± 2.19	13.43± 2.66	14.90± 1.90
Average Q-angle (n=120)	12.65± 2.32	13.3± 2.58	14.87± 2.05
Maximum right Q- angle	20	19	20
Minimum right Q-angle	10	9	10
Maximum left Q-angle	18	20	20
Minimum left Q-angle	9	9	11

Table 2: ANOVA table results for q-angle comparison between groups

Statistical comparison of Q angle in subjects of different groups						
S.no	**Group**	**Side**	**Group**	**Side**	**p-value**	**Result**
1.	**FS**	Right	**MS**	Right	<0.05	Significant
2.	**FS**	Left	**MS**	Left	<0.05	Significant
3.	**MS**	Right	**ML**	Right	>0.05	Not significant
4.	**MS**	Left	**ML**	Left	>0.05	Not significant
5.	**FS**	Right	**ML**	Right	<0.05	Significant
6.	**FS**	Left	**ML**	Left	<0.05	Significant
7.	**MS**	Right	**MS**	Left	>0.05	Not significant
8.	**FS**	Right	**FS**	Left	>0.05	Not significant
9.	**ML**	Right	**ML**	Left	>0.05	Not significant

MS-male student, ML-male laborers, and FS-female student

Table 3: Shows the bilateral differences within subject in standing position

Difference between right and left Q angle (°)	Right=Left (n=60)			Right>Left (n=60)			Right<Left (n=60)		
	MS	**ML**	**FS**	**MS**	**ML**	**FS**	**MS**	**ML**	**FS**
0	15	17	13	-	-	-	-	-	-
1	-	-	-	14	7	11	13	12	10
2	-	-	-	5	6	5	6	8	9
3	-	-	-	1	2	4	2	3	6
>3	-	-	-	1	2	2	3	3	0

MS-male student, ML-male laborer, and FS-female student

Table 3 depicts the descriptive statistics for bilateral comparison of q-angle.

Discussion:

The preliminary goal of this study was to measure the q-angle in healthy adults and to notice any effect caused by daily physical activity. The methodology used in this study was based on an extensive review of the literature and a non-invasive goniometric method was preferred. It is noteworthy that the goniometric method is popular among clinicians. It has been suggested in the literature that the critical

factor in q-angle assessment is the position of the subject during measurement as the q angle may increase or decrease with knee movement and quadriceps activation[12,6]. External or internal rotation of lower limbs can bring about the change in q-angle values. In an attempt to find an ideal standing position Livingston and Spaulding suggested Romberg stance after noticing the change in q-angle with different stances. Romberg stance is defined as when the medial borders of feet are touching each other, and it can be replicated by different investigators. Therefore, in this study, the Romberg stance was chosen as the static position, as it demonstrated the best representation of the quadriceps angle in a standing position. Lathinghouse and Trimble observed that increased quadriceps activation has resulted in smaller q-angles[6]. That said, this study analyzed the q-angle always with the knee in full extension and quadriceps muscle relaxed, since besides being the most used method in present studies it was of interest to evaluate the aforementioned angle without the influence of quadriceps muscle contraction.

The average q-angle for males was lower compared to females and the measures between legs were asymmetric. This finding is in association with findings of most other studies of a higher angle in females[11,20,10]. It has been suggested that higher q-angles in women were due to them having wider hips, shorter femur length, or femoral neck anteversion[6]. Since q-angle is reported to be not symmetrical between legs[21,17]. It is of interest to note that when comparing the magnitude of q-angles bilaterally, the left leg yielded greater values in both males and females. A possible explanation was given by Livingston and Mandigo that higher muscle bulk and tone in the dominant side causes a pull on the patella, displacing it and decreasing the value of the angle. However, Raveendranath et al attributed this difference to a relative lateral position of the tibial tuberosity[19]. Though the bilateral difference was also noted in most published literature, only a few obtained statistical significance[12,18].

Table 4: Q-angle results (in degrees) obtained in standing position by different authors

S. No.	Author	Year	Population	Gender	Number of subjects	AQA	RQA	LQA
1.	Tarawneh I. et al[22]	2016	Jordanian	M	219	14.4±1.9	14.6±1.9	14.3±1.9
				F	200	18.42±1.8	18.6±1.9	18.3±1.7
2.	Ebeye O.A. et al[23]	2014	Nigerian	M	90	-	12.92±1.32	12.27±1.48
				F	100	-	16.93±1.35	16.30±1.2
3.	A SRA et al[18]	2007	Nigerian	M	70	-	12.88±1.30	15.70±1.72
4.	HORTON & HALL[10]	1989	American	M	50	11.2±3.0	-	-
				F	50	15.8±4.5	-	-
5.	JAIYESIMI & JEGEDE[24]	2009	Nigerian	M	200	-	12.20±3.96	10.38±3.49
				F	200	-	17.09±3.64	14.84±3.47
6.	RAMADA	2019	Mixed	M	233	14.1±0.21	-	-

	R.K. et al[25]		(Middle East)	F	267	17.35±0.26	-	-
7.	Swati P. et al[26]	2019	Indian	F	100	22.87±3.77	-	-
8.	Amr A.A. et al[27]	2014	Egyptian	M	30	11.87±4.02	-	-
9.	Aparna S. et al[28]	2008	Indian	F	23	16.2±3.49	-	-
10.	R. maharajan et al[29]	2013	Nepalese	M	614	-	13.89±1.74	13.76±1.66
				F	586	-	13.94±1.74	13.90±1.61
11.	Omulolu B. et al[30]	2008	Nigerian	M	354	-	12.3±2.2	11.7±2.8
				F	123	-	22.8±4.7	22.7±4.6
12.	Sanchez H.M. et al[31]	2014	Brazilian	M	30	-	10.13±7.40	11.24±7.77
				F	32	-	17.78±7.56	19.79±7.16
13.	Raizada A. et al[32]	2019	Indian	M	68	-	8.6±2.20	8.1±1.83
				F	80	-	8.9±2.52	8.8±2.33
14.	Present study	2011	Indian	M	120	12.98±2.47	12.84±2.48	13.11±2.45
				F	60	14.87±2.05	14.83± 2.20	14.90± 1.90

*****mean±SE; AQA-average q angle, RQA-right q angle, LQA-left q angle

It is of importance to correlate the individual measurements with the published literature. Table 4 depicts the comparison of q-angle results, in the standing position, obtained among different authors. Although our values are within the range of published literature but differed from other Indian studies. One reason for this difference could be the different static positions used by Aparna S. et al, they kept feet shoulder feet apart and parallel to each other in position. Swati P. et al. used the Romberg position but they obtained a much higher value in 100 females 22.87° as against our 14.87°, they did not make it clear whether their readings were bilateral or on one side. Markedly lower results were by Raizada A. et al, in both males and females, 8.9° & 8.8° in females and 8.6° & 8.1° in males on right and left side, respectively[32]. They reported a much lower range of q-angle, especially in females, from this study as well as other authors. The reason could be racial or the difference in measurement procedure or the difference could also be to findings of Weiss et al where they reported that goniometric measurements may show up to 3° of the discrepancy between assessors[33]**.** The gender-based discrepancy of average q-angle (AQA) obtained in our study is similar to Tarawneh I et al, Ebeye O. A. et al and Ramada R.K. et al who obtained higher AQA in females as against male counterparts. Additionally, our methodology is also similar to the Jordanian study by Tarawneh I. et al[22] who used Romberg position during measurement and they obtained higher AQA of 14.4° and 18.42° as against in this study of 12.98° and 14.87° in males and females, respectively**.** This difference appears to be due to anthropometric and racial factors. In this study higher RQA as well as LQA were obtained in women than men, similar findings were obtained in other international studies by Ebeye O.A. et al, Jaiyesimi and Jegede, Omulolu B. et al and Sanchez H.M. et al. Still, on the difference between results, in this study the difference among gender fall within the between the range of 1.5-2° whereas greater difference magnitude was noticed in Tarawneh et al 4-4.5°; Ebeye O.A. et al 4-4.5°; Hortan and Hall 4.6°; Jaiyesimi and Jegede 4-5°; Ramada et al 3.25°; Omulolu B. et al 10.5-11°; Sanchez H.M. et al 7.5-9°. However, a much lesser magnitude difference, of less than 1°, was seen in the results of Maharajan R. et al and Raizada A. et al. (Table-4) The reason

for this discrepancy could be a difference in methodology, static position, racial, or anthropometric variables.

Byl et al (2000)[6] reported that q-angle magnitude is inversely related to quadriceps tone. Related information was given by Bayraktar et al (2004)[20] who compared q-angle in sedentary and soccer players and observed that physical activity causes a change in quadriceps muscle strength and tone, which greatly influenced q-angle and resulted in a decreased magnitude.

One aim of this study was to observe the effect of lifestyle, if any, on Q angle. For this purpose, Q angles between male students and laborers were compared. Sixty laborers included within this study, were all fairly equal with their daily physical activity. These subjects were compared on the premise that strength and tightness of the lower extremity muscles in the body may have a direct effect on the femoral, patellar, and tibial alignment. Although results showed a lesser mean Q angle in male laborer than male students it was not statistically significant. Though, the difference could be due to the difference in quadriceps muscle tone and strength.

The limitation of the study is that Q-angle measurements analysis in this study was derived from young, healthy, and adult volunteers. Whether similar results would be observed in those symptomatic for patellofemoral syndrome or patellar subluxation or any chronic illness is unknown.

conclusion:

This study contributed to the data of normal reference q-angle values in young males and females of the Rajasthan region. The comparison of values obtained revealed different normal subjective values among races. This study exhibited that gender differences in q-angle do exist and females had bilateral higher q-angle. It is emphasized that clinicians should measure q-angle bilaterally as asymmetry is common. Lower mean q-angle in laborer group is of interest as it might indicate physical lifestyle effect on tone and bulk of quadriceps muscle causing a pull-on patella, thereby causing a decrease in q-angle but this evaluation needs to be performed on a larger scale.

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