Original Article

Influence of gender on quadriceps (Q) angle among adult Urhobos in Nigeria population

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Abstract

Background: The Quadriceps angle (Q-angle) is defined as the angle formed between the longitudinal axis of the femur representing the pull of the quadriceps muscle and the patellar tendon. **Materials and Methods:** This study comprises of 90 male and 100 female adult Nigerian population of Urhobo ethnicity between the age range of 19-32 years, measurements were taken from healthy individuals with no previous history of musculoskeletal disorder to establish a standard value. The Q-angle was taken using a goniometer with the subject standing on a weight bearing position. **Results:** Results show that in the male subject the Q-angles were 12.92 + 1.320 and 12.27 + 1.480 for the right and left lower limb, while the female Q-angle was 16.93 + 1.350 and 16.30 + 1.200 for the right and left limb respectively. Further analysis reveals that the right Q-angle is higher than the left ($P < 0.05$) for both gender with the female Q-angle being slightly higher than the male ($P < 0.05$). **Conclusion:** The result obtained showed difference in the values of the left Q-angle for both gender when compared with the other indigenous research on this subject suggesting there is difference in the Q-angle values across the various ethnic groups in Nigeria.

Key words: Q-angle, gender, Urhobo

INTRODUCTION

The measurement of body dimensions such as body mass index, Quadriceps angle, cranial capacity, facial angle, and flat foot has been used in anthropometric studies of different population groups (Okukpe *et al*., 1984). An anatomical variable, which is associated with alignment in the lower limb, is the quadriceps femoris angle (Q-angle).

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Access this article online	
Quick Response Code:	Website: www.jecajournal.com
	DOI: 10.4103/1596-2393.154399

The Q-angle is the angle formed between a vector connecting the anterior superior iliac spine (ASIS) to the patella (knee cap) and a vector connecting the patella to the tibial tuberosity (Livingston and Spaulding, 2002).

The first vector represents the quadriceps muscles, and the second vector represents the patella tendon. It has statistically been shown that the Q-angle of females is larger than that of males (Woodland and Francis, 1992).

Recently, values between 8° and 10° for men and up to 15° for women are considered normal and values higher than these can indicate an abnormality (Greene *et al*., 2001). The angle is clinically relevant because of the pull it exerts on the patella as higher Q-angles increase the lateral pull of the quadriceps muscle on the patella and potentiates disorders like chondromalacia patellae or recurrent lateral subluxation of the patella.

There are postulations that women may have more lateral shift of the patella during quadriceps femoris muscle contraction secondary to more widely spaced hips, theoretically the combination of wider hip and shorter

femurs could increase the valgus of the lower limbs and thus increase the Q-angle (Outerbridge, 1964).

If increased Q-angles indicate the presence of pathological lateral forces on the patella and if women do have greater Q-angles than men then women could be at greater risk than men for developing patellofemoral joint problems, these theory was supported by the findings of Hvid *et al*., 1989 after taking the measurement of the Q-angles of 12 women and 10 men who were treated nonoperatively for chondromalacia, their data showed that 11 of the 12 women had Q-angles of at least 15° and 7 women had angles >20°, but only one male subject had an angle >15° (Hvid *et al*., 1989). In a prospective study on patellofemoral pain, Yates and Grana found that patellofemoral problems are most common among young women, reports showed that 51 (76%) of the painful knees in their study belonged to women (Yates and Grana, 1986).

Lathinghouse and Trimble, (2000) proposed that an excessive Q-angle may predispose women to greater lateral displacement of the patella during activity requiring high levels of quadriceps activation (Lathinghouse and Trimble, 2000). It has been determined that hip breadth or femur length do not account for the discrepancy in Q-angle between men and women (Byl *et al*., 2000) However, the hip width-femur length ratio is slightly lower in men although it has not been scientifically correlated to Q-angle (Horton and Hall, 1989).

Q-angle has typically been the focus of the research surrounding patellofemoral disorders, Only recently has the Q-angle been associated with tibiofemoral mechanics (Mizuno *et al*., 2001). A Q-angle >20° increases the likelihood of the quadriceps pulling the kneecap laterally, increasing the risk of knee disorders. Davies and Larson do not state a range for normal values, but they do describe Q-angles >20° as excessive (Davies and Larson, 1978). The American Orthopaedic Association considers 10° to be normal and 15–20° to be abnormal (Manual of Orthopaedic Surgery, 1972).

Livingston and Mandingo (1997) reported asymmetry with the differences ranging from 0.9° in men and 1.7° in women stating that 50% of the subject displayed a bilateral difference of at least 4° between the right and left Q-angle (RQA and LQA) (Livingston and Mandigo, 1997).

Grelsamer *et al*. (2005) opined that due to the long distance between the pelvis and patella relative to the distance from the patella to the tibia tuberosity and changes in the position of the ASIS were necessary to effect significant changes in Q-angle. Grelsamer *et al*. (2005) Jaiyesimi and Jegede (2009) reported the Q-angle in male subject to be 12.30° +4.0° and 10.38° +3.49° for the right and left lower limb respectively, whereas in females the Q-angle was 17.06° +3.64° and 14.84° +3.47° for the right and left lower limb Jaiyesimi and Jegede (2009).

A lot of study have been carried out to establish different values for Q-angles in men and women among the Caucasians, Americans, and other continents of the world, however only a few have been done in Nigeria, especially among the southwestern population to confirm the other foreign values and there exist difference when compared to other part of the world, these study was undertaken to investigate bilateral difference the evaluate the normal value of Q-angle for men and women within south-southern Nigerian, especially among the Urhobo ethnicity since it is the most populated, it will be of help to check if differences in Q-angles do exist across the various regions in Nigeria and help establish the normal Q-angle values for this ethnic as this will be of great importance in forensic studies.

METHODOLOGY

The study population comprises of 90 male and 100 female, volunteers from Delta state university aged 19-32 years, approval for these study was obtained from the ethical committee of the Department of Anatomy, Delta State University, Abraka.

Materials used include

- A Universal Goniometer used to measure angles between adjacent bones
- A bathroom Scale to measure body weight
- A meter rule
- A mobile height meter to measure the standing height.

Procedure

The age, gender, weight, and height of each subject was taken and measurements were obtained with the individual in a standing position, the anatomical landmarks including the border of the patella, tibia tubercle and the ASIS were palpated. The falcum of the goniometer was placed at the midpoint of the patella and its long arm is positioned to the line joining the ASIS and the short arm is pointed directly to the line joining the tibia tuberosity, the small angle on the goniometer is then read as the Q-angle [Figure 1]. (Horton and Hall, 1989).

Q-Angle and Marker Locations: Anterior Superior Iliac Spine, Mid-Patella (MP) and Tibial Tuberosity Anterior View (Livingston and Mandigo, 1999).

Normal Q-angle values and ranges were established by calculating the mean and standard deviation for each group, the independent *t*-test was used to compare the Q-angles in the male and female groups whereas the

paired *t*-test was used to test for bilateral symmetry within the subject Q-angle difference.

RESULTS

Descriptive statistics for the Q-angles of all the male and female subjects are shown in Tables 1 and 2, respectively.

Table 3 compares the difference between RQA and LQA in male and female, the paired *t*-test was used in each group, while [Table 4] displayed the different RQA and LQA for both male and female within the study population using the independent *t*-test to compare them.

The independent *t*-test was used to compare the Q-angles between male and female subject. The result summarized in this table shows that the female subject has significantly higher Q-angles than their male counterpart ($P < 0.001$) in both legs.

DISCUSSION

The result of this investigation establishes the average Q-angle for the right and left lower limb in the adult male population of the Urhobo ethnic group as 12.90 + 1.32° and 12.27 + 1.48° respectively while the female group had their RQA and LQA as 16.93 + 1.35° and 16.30 + 1.20° respectively, although this results generally support commonly accepted Q-angle range from previous works but when compared to the Nigerian study carried out by Jaiyesimi and Jegede (2009) who reported their resultant Q-angle average in the male subject ($n = 200$) as 12.30 + 4.0° and 10.38 + 3.49° for the right and left limb while their female subject ($n = 200$) had a Q-angle average of 17.06 + 3.64° and 14.84 + 3.47° for the right and left limb, there seems to be consistency with the obtained result for the RQA for both gender however there exist differences in the values presented for the LQA in the male and female population of the different regions.

The result obtained is higher than those reported by Byl and Livingstone (1999) whose male ($n = 16$) and female ($n = 18$) subjects had 6.3° and 10.1° as their RQA and 5.9° and 9.7° as their LQA; these differences may be due to racial discrepancy and slight alteration in method of research.

The RQA was significantly higher than the LQA ($P < 0.05$), this is consistent with the result of Jaiyesimi and Jegede (2009) but does not correspond with that of Livingston and Mandigo (1997) and Akinbo *et al*. (2008) who reported higher LQA than RQA. However, the average difference between the RQA and LQA obtained for male and female subject is lower when compared with the study of Jaiyesimi and Jegede (2009).

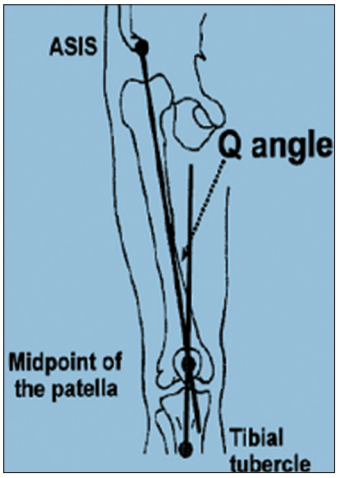

Figure 1: Q-Angle and Marker Locations: Anterior Superior Iliac Spine, Mid-Patella (MP) and Tibial Tuberosity [Livingston and Mandigo, 1999] Anterior View

Table 1: Descriptive statistics on quadriceps angle among the male group

Parameters	*n*	Range	Minimum	Maximum	Mean	SE	SD	Variance
Age	90	13.00	19.00	32.00	24.167	0.29361	2.78540	7.758
Weight	90	43.00	53.00	96.00	68.144	0.92511	8.77632	77.024
Height	90	29.00	163.20	192.30	175.5	0.65644	6.22750	38.782
RQA	90	6.00	10.00	16.00	12.917	0.13939	1.32234	1.749
LQA	90	6.50	9.00	15.50	12.272	0.15586	1.47861	2.186

SE: Standard error, SD: Standard deviation, RQA: Right Q-angle, LQA: Left Q-angle

Table 2: Descriptive statistics on quadriceps angle among the female group

Parameters	*n*	Range	Minimum	Maximum	Mean	SE	SD	Variance
Age	100	13.00	19.00	32.00	23.4000	0.29814	2.98142	8.889
Weight	100	71.00	20.00	91.00	65.0400	0.10855	11.08545	122.887
Height	100	74.40	106.70	181.00	165.77	0.78687	7.86874	61.917
RQA	100	5.50	14.00	19.50	16.9300	0.13466	1.34656	1.813
LQA	99		14.00	19.00	16.3025	0.11948	1.18882	1.413

SD: Standard deviation, SE: Standard error, RQA: Right Q-angle, LQA: Left Q-angle

Table 3: Paired difference between the right and left quadriceps angle in male and female

Statistical variables	Male (*n*=90)	Female (*n*=90)
Minimum different	0.41628	0.41800
Maximum different	0.87261	0.83553
Mean	0.64444	0.62677
SD	1.08939	1.04672

SD: Standard deviation

Table 4: Independent *t*-test to compare Q-angles in male and female subject

Region	Male (*n*=90)	Female (*n*=100)	Calculated *t*	*P*
Right				
X	12.9167	16.9293	5.612	0.000
SD	1.32234	1.35340		
Left				
X	12.2722	16.3025	5.958	0.000
SD	1.47861	1.18882		

SD: Standard deviation

Higher Q-angle were recorded in both the RQA and LQA of the female subject, this is consistent with previous studies (Woodland and Francis, 1992). Thus, the research suggests that women have larger Q-angles and a greater incidence of patellofemoral joint pain than do men. The reason women have larger Q-angles than men can be explained from the report of Grelsamer *et al*. (2005), they were of the opinion that long distance between the pelvis and patella relative to the distance from the patella to the tibia tuberosity and large changes in the position of the anterior superior iliac spine are necessary to effect significant changes in the Q-angle, in their study they did not find such a large difference in the position of the anterior superior iliac spine but derived a mean difference of 2.3° between the Q-angles of men and women, but further discovered that men and women of equal height demonstrated similar Q-angles with taller people having slightly smaller Q-angles, it was concluded that the slight difference in Q-angles between men and women can be explained by the fact that men tend to be taller (Grelsamer *et al*., 2005). Although, Outerbridge proposed that women may have more lateral shift of the patella during quadriceps femoris muscle contraction due to the presence of widely spaced hips in women (Outerbridge, 1964).

CONCLUSION

This study reaffirms the already established fact that bilateral symmetry do exist even within the Urhobo ethnic group of the south-southern Nigerian population, but the values obtained showed slight difference with that gotten from the study in south western Nigerian though similar methods was used to obtain the results, we strongly recommend that further studies should be carried out on this subject among the different ethnic groups in Nigerian in order to establish a standard value as this will be of great relevance in forensic anthropology

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How to cite this article: Ebeye OA, Abade PO, Okwoka BO. Influence of gender on quadriceps (Q) angle among adult Urhobos in Nigeria population. J Exp Clin Anat 2014;13:50-3.

Source of Support: Nil, **Conflict of Interest:** None declared.