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Age grade distribution of high quadriceps angle in a selected Nigerian population

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Abstract. *Introduction*. Abnormally high quadriceps angle (Q-angle) has been reported as one of the main purported causes of patella-femoral problems. The knowledge and measurement of *Q*-angle is thus highly important in clinical evaluation of knee function. This study was designed to investigate the age distribution of high Q-angle and the effect of age with Q-angle in a selected Nigerian population. *Material and Method.* The participants were four hundred, apparently healthy volunteers (200 males, 200 females) aged between 9-50 years, who were classified into pre-puberty, adolescent, young adult and adult age groups. Their Q-angles were assessed from their dominant limbs in supine lying position. Q-angles were then classified as high and normal using the average values for male and female as reported in the literature. Data obtained were analyzed using descriptive statistics of mean, range, standard deviation and inferential statistics of one-way analysis of variance (ANOVA) and chi square. *Results*. 23.25% and 44.5% of the entire participants and female sub-population had incidence of high Q-angle respectively. 15%, 18%, 26%, and 34% of the pre-puberty, adolescent, young adult and adult sub-populations presented with high Q-angles respectively. ANOVA did not show any significant difference in Q-angle among the four groups while a significant association ($p < 0.05$) between age group and class of Q-angle was obtained with Chi square. *Conclusion.* Selected female Nigerians presented with higher incidence of high Q-angle which appears to increase from younger to older ages.
Key Words: *Q-angle, age, knee.*

Introduction

Quadriceps angle (Q-angle) represents an estimate of the resultant force of the quadriceps on the patella as well as a predictor of lateral movement of the patella under dynamic condition (1), and a known index of knee function and patellofemoral kinetics (2). The angle is intended to provide some indication of the direction of the net lateral force applied to the patellofemoral joint by contraction of the quadriceps muscle (3). It is calculated mathematically by drawing an imaginary line from the anterior superior iliac spine (ASIS) to the centre of the patella and from the centre of the patella to the middle of the tibial tuberosity, the acute angle formed by the two lines delineates the Q-angle. The landmarks have been standardized (4).

It is a relevant clinical measurement because abnormally high Q-angle is one of the main purported causes of anterior knee pain and patellofemoral instability (4, 5, 6).The results of both an in vitro experimental study and a theoretical modeling study have shown that increasing the Q-angle tends to increase the lateral patellofemoral contact pressure, while decreasing the Q-angle tends to increase the medial patellofemoral contact pressure (7, 8).

Gender differences, normative values, and differences in the Q-angle between symptomatic and asymptomatic knees have been reported in the literature (9). Asymmetry between right and left limbs Q-angle both in symptomatic and asymptomatic subjects has also been documented in literatures (2, 10). However, the prevalence of abnormally high Q-angle with respect to different stages of human development (pre puberty to adulthood) and the influence of age on Q-angle has not been well documented.

This study has thus been carried out to investigate the age distribution of high Q-angle and the association of age with Q-angle in a selected Nigerian population.

Material and Method

Four hundred participants aged 9-50 years (200 males, 200 females) were recruited for this study, they were volunteers and children of consented

parents from Obafemi Awolowo University community in Ile-Ife, South -Western, Nigeria. They were categorized into pre-puberty (9-12years), adolescent (13-15 years, young adult (20-30years), and adult (35-50 years) groups (11).
The purposive sampling technique was used to recruit participants who were assessed as they became available. Participants satisfied the selection criterion of the study which was based on the observation of their lower extremities. They had no history or evidence of musculoskeletal or neurological disorders in their lower extremities.
The design for the study was ex-post-facto design. Measurements were taken once and there was no intervention.
Instruments for Data Collection were: flexiometer (J.A. Preston Cooperation, Canada), used to measure Q-angle in degrees, with a range between of 0^0 to 180^0; meter rule (Universe, China), used to draw and trace the surface markings of Q-angle; height meter (Constructed by Instrument unit of the University College Hospital, Ibadan), used to measure subjects' height in meters.
Procedure. Approval of the Ethical Review Committee of the Obafemi Awolowo University, was sought and obtained before the commencement of the study.
Written informed consent was sought and obtained directly from the participants in young adult and adult groups while the parents of the children in pre-puberty and adolescent groups signed the consent form on their behalf. Participants' ages were recorded in years and their heights were measured and recorded in meters using standardized procedures.
To rule out the probable effects of leg dominance on Q-angle, participants' dominant lower limbs were determined using the procedure described by Jaiyesimi and Jegede (2) and was chosen for the measurement of Q-angle.
Measurements. Participant lay fully supine in light shorts on the plinth with feet together, thigh muscles relaxed and ankles in neutral position. The centre of patella, tibial tuberosity and anterior superior iliac spine (ASIS) were carefully located by palpation (4).
The meter rule was used to draw a straight line from the centre of the patella to ASIS, and another line from the tibial tuberosity to the centre of patella. The acute angle formed between the two lines was measured with the flexiometer and recorded as Q-angle in degrees. The classification of high and low Q-angle was done based on the mean normal value of Q-angle obtained by Aglietti et al (12) who obtained mean values of 14^0 and 17^0 for males and females respectively. Thus Q-angle values above 14^0 and17^0 for male and female respectively were classified as 'high Q-angle'.
Statistical Analyses. The data collected were analyzed using the descriptive statistics of mean, range, standard deviation and pie chart. Inferential statistics of one- way analysis of variance (ANOVA) was used to compare the mean values Q-angle between the four age groups studied, while chi square was used to test the association between age group and status of Q-angle.
Level of significance (p) was set at 0.05. The data analysis was done using Statistical Package for Social Sciences (SPSS version 16).

Results

The mean age, height, and Q-angle of the entire subjects were 22.31±12.84years, 1.54±0.18m and 14.33±3.19 degrees respectively. The summary of male and female data is presented in table I. 23.25% of the entire population (N=400) presented with high Q-angle and the gender distribution of high and normal Q-angle is presented in table II. One- way ANOVA comparing the mean Q-angles of the four age groups is presented in table III, no statistically significant difference ($p>0.05$) was observed between the Q-angles of the four groups.
Table IV shows the age group distribution of high and normal Q-angle with a chi-square showing association between age group and status of Q-angle.
15% of participants in the pre puberty group presented with high Q-angle and only one of them is a male. 18% of the adolescent group had high Q-angle with all of them being females. The distribution of high Q-angles by age group is also presented by the pie chart in Figure 1. Participants with high Q-angle among the young adults constituted 26% of the total sub-population with three of them being females.
Among the adult group, 34% (all females) were found with high Q-angle.
The result of chi-square used to test the association of age group with class of Q-angle shows a significant association between both variables ($p< 0.05$).

Table I. Summary of male and female variables

VARIABLES	MALE (N= 200)		FEMALE (N=200)	
	Range	Mean ± SD	Range	Mean ± SD
Age(Years)	9 – 50	22.07±12.15	9 – 50	22.55± 13.52
Height(M)	1.20-1.90	1.56 ± 0.21	1.22-1.78	1.52± 0.14
Q-angle(Degrees)	9.00– 14.00	11.78 ± 1.28	15.00 – 22.00	17.18± 1.99

SD- Standard deviation

Table II. Distribution of high and normal Q-angle with respect to gender among subjects

Sex	Normal Q-angle	High Q-angle	Total
Male	196 (98%)	4 (2%)	200
Female	111(55.5%)	89 (44.5%)	200
Total	307 (76.75%)	93 (23.25%)	400

Table III. Summary of one-way ANOVA comparing the Q-angle of the four age groups (N= 100 for each group)

Age group	Q-angle Mean ± SD	F ratio	P-value
Pre-puberty	14.35 ± 2.83	0.07	0.97
Adolescent	14.50 ± 3.15		
Young Adult	14.50 ± 3.19		
Adult	14.55 ± 3.55		

($p<0.05$); SD = standard deviation

Table IV. Distribution of high and normal Q-angle with respect to age group and chi square showing association between age and status of Q-angle

Age group	Normal Q-angle	High Q-angle	Total	$\chi 2$ cal	$\chi 2$critical	P -value
Pre puberty	85	15	100	11.18	7.82	<0.05
Adolescent	82	18	100			
Young Adult	74	26	100			
Adult	66	34	100			
Total	307	93	400			

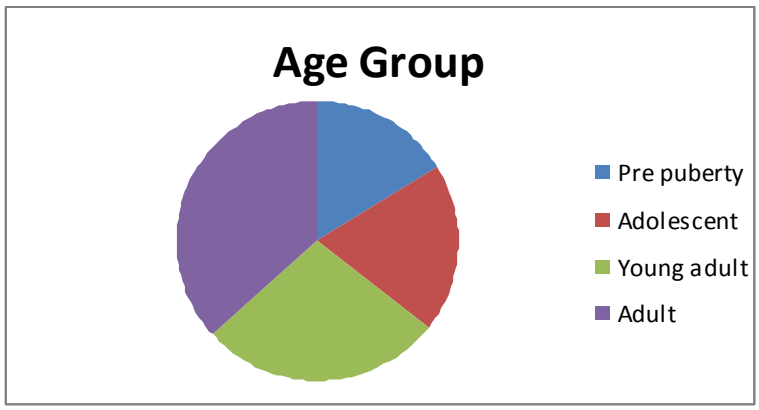

Figure 1. Pie chart representing the age group distribution of high Q-angle

Discussion

The mean values of Q-angle obtained for male and female participants (11.73±1.44 and 16.91± 2.20degrees respectively) is similar to the findings of previous studies (13, 14).

The results of this study shows that 23.25% of total participants studied presented with high Q-angle with majority (about 96%) of them being of

the female gender. This observation is consistent with the findings of Aglietti et al (12) who found 15% and 72% of their healthy and pathologic women participants respectively with high Q-angle in their study on patellar realignment of patients with chondromalacia patellae. Yates and Grana (15) also reported that patellofemoral problems are most common among young women when they observed that 51 (76%) of participants with painful knees were women.

Our results also shows that the adult group recorded the highest incidence of participants with Q-angle; it was also observed that the trend among the four age groups is such that the incidence of high Q-angle increases as one grows from childhood to adulthood (pre-puberty: 15%; adolescent: 18%; young adult: 26%; adult: 34%). To the best of our knowledge, there is paucity of studies relating to these findings, we however reasoned that the observations may not be unconnected with the risk of injuries that the young adults are exposed to during vigorous activities like school sports and work related soft tissue injuries around the knee joint. Injuries sustained during the earlier stages of life have been reported as a major risk factor for joint degenerative changes found in clinical conditions like knee osteoarthritis which occur during later stages of life (16).

One-way ANOVA did not indicate any statistically significant difference ($p<0.05$) between the mean values of Q-angles of participants in the four age groups assessed in this study as the mean values are approximately 14 or 15 degrees (to the nearest whole number) for each of the four groups. There is dearth of studies on the effects of age on Q-angle; our observation is however at variance with the findings of Bayraktar et al (17) who obtained a statistically significant difference between the mean Q- angle values of adult, adolescent and children participants. The difference in findings between the two studies may be attributed to the classification of active (athletic) and sedentary population by Bayraktar and his colleagues; there are evidences in the literature that a significant change in Q-angle is associated with quadriceps muscle's activation (1, 18), we did not classify active and sedentary participants in present study. The age range of their participants was 9-19 years whereas our study involved participant aged: 9-50 years. Racial variation could also be a probable factor as opined by Olagbegi et al (11).

The participants involved by Bayraktar et al were Caucasians compared to our participants who are black West Africans.

The chi square computed for association between class of Q-angle and age group shows a significant association ($p<0.05$) between the two variables even though one-way ANOVA did not reveal any significant difference when the mean values of Q-angle were compared across the four groups.

We don't have reports of previous studies to explain this observation. However, the fact that the incidence of high Q-angles increases as we go from pre-puberty to adults groups as indicated by the results of this study (15% < 18% < 26% < 34%) is a pointer to the observed significant association.

Conclusion

Incidence of high Q-angle is higher among the female gender and increases with age. Clinicians may pay special attention to the assessment of Q-angle among the middle- aged and the elderly in the management of patellofemoral complaints.

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