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**ORIGINAL RESEARCH**

# Determining the Value, Bilateral Variability and Relationship of Quadriceps Angle with Height Weight and BMI in Supine Position in Female Population of Hilly and Plain Region of Uttarakhand

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**ABSTRACT**
**Background:** The quadriceps angle (Q angle) is actually the alignment of the quadriceps femoris muscle. A perpendicular line from anterior superior iliac spine to centre of the patella, another line from centre of patella to tibial tuberosity and the point of intersection of these lines forms an angle known as Q angle. **Aim and objective;** Determining the value, bilateral variability and relationship of Quadriceps angle with Height Weight and BMI in supine position in female population of hilly and plain region of Uttarakhand. **Methods:** 370 healthy females 200 from hilly region and 170 from plain region of age group 18-65 were included in the study. A perpendicular line was drawn from anterior superior iliac spine to centre of the patella, another line from centre of patella to tibial tuberosity and the point of intersection of these lines forms an angle which was measured with the help of goniometer. **Result and interpretation:** Q angle was bilaterally significant, high in plains than hills, left and right a Q angle in hills was 11.49 and 12.02. In plains left and right Q angle was 12.62 and 13.27. Angle had strong positive correlation with each other and weak positive correlation with BMI and weight. Height may not be a predictor of Q angle.

**Key words:** Quadriceps angle, Bilateral variability, variation, Uttarakhand Population.



## INTRODUCTION

The quadriceps angle (Q angle) is much important to assess mechanism behind patellofemoral joint and very helpful to clinicians. It is actually the alignment of the quadriceps femoris muscle.[1] Brattstrom in 1964 defined q angle between the ligamentum patellae, the quadriceps femoris muscle and apex at the patella.[2] Proper measuring technique was described by Insall in 1976 locating the anterior superior iliac spine (ASIS). The line joining the ASIS and the centre of the patella (CP) was used to approximate the angle of the quadriceps femoris resultant force.[3] Thus, the value of the Q angle is dependent on the relative positions of these bony landmarks. Variation in values of Q angles mentioned by various researchers. It is well appreciated that the normal Q-angle should fall between 12° and 20°, where males being at the lower end of this range and females having higher measurements. An increase in Q-angle beyond the normal range has been associated

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with knee extensor dysfunction leading to patellar instability, Patellar subluxation and dislocation, chondromalacia patellae, Knee osteoarthritis, Overuse injuries, Anterior cruciate ligament injury. Decrease value may be associated with chondromalacia, patella Alta, patella instability and patellofemoral pain syndrome.[4] Patella is a sesamoid bone starts ossifying at 5 to 6 years of age, lying under Fascia Lata and Rectus Femoris tendon. It usually dislocates in flexion position due to extensor mechanism which follows the shortest route between origin and insertion and resulting in lateral dislocation of patella. As soon as the knee is flexed there is major role of tibia rotating outwards because the lateral pulling powers are stronger than the medial and patella is not completely set into sulcus, therefore first 10-20 degree of flexion is critical and in case of extension dislocation does not occur.[2] Bony factors such as dysplastic patella, Patella Alta and shallow intercondylar groove may also be responsible for lateral tracking of patella.

High quadriceps angle in females may due to increased pelvic width, shorter femur length, more laterally placed tibial tuberosity.[5] Increased q angle is an indicator of disturbance in the alignment of extensor mechanism, may be a sign of recurring injuries and has been associated with patellofemoral pain syndrome, excessive movement of knee joint, chondromalacia patellae, recurrent subluxation of patella and anterior cruciate ligament tears.[3,6,7,8, 9]The anatomical position while taking measurement is of great importance because angle depends on knee movement and muscle activation.[5]

Factors that affects the Q-angle are Height, Age, Gender, External tibial torsion, femoral anteversion more than 20 degree, laterally displaced tibial tubercle, Genu valgum and Quadriceps contraction. Abnormal values received in case of Genu valgum, Genu recurvatum, Genu varum, can be improved with the help of physiotherapy exercises like strengthening stretching, pain management.[10] Keeping in mind the clinical and biomechanical importance of the Q-angle, this study was done to see the effect of various parameters in regional population of Uttarakhand.

**Aims and Objectives**

**Aim:** Determining the value, bilateral variability and relationship of Quadriceps angle with Height Weight and BMI in supine position in female population of hilly and plain region of Uttarakhand.

**Objectives:** The objective of this study is to document bilateral variability and effects of various parameters in Hilly and Plain Region of female population of Uttarakhand

## MATERIALS AND METHODS

**Type of study:** This study was a cross-sectional study done over a period of 3-5 years, from march 2019 to august 2023 the study included 370 healthy females of Plain region and hilly region. Out of these 370 females 200 females were from hilly region and 170 females were from plain region. The age group of these healthy females were 18 – 65 years. Individuals with any lower limb injury or any diagnosed knee disorder, such as a fracture, acute or chronic knee pain, patellar dislocation, any previous history of orthopaedic surgery in the lower extremities, were excluded from the study. The clearance was given by institutional ethics committee. The procedure was explained to the subjects and written consent was taken. The height, weight, BMI and value of q angle of both the lower limb were noted on a specific investigation sheet. Measurement for q angle were done bilaterally in all subjects in supine position and parametric values were noted.

**Measurement procedure**: In order to determine Q angle located in relation to anterior superior iliac spine, the patella's border and tibial tuberosity. A perpendicular line was drawn from anterior superior iliac spine to centre of the patella, another line from centre of patella to tibial tuberosity and the point of intersection of these lines forms an angle which is Q angle. The centre of the patella served as the goniometer's fulcrum. The tibial tuberosity was the target of one arm. The anterior superior iliac spine was the target of the opposite arm. So, measurements were taken of parameters the Q-angle in degrees of both sides. The data was collected by using Goniometer (Mitutoyo South Asia Private Limited, New Delhi, India) Weighing machine and measuring scale.

Data Analysis: Data were analysed using independent sample t-tests, ANOVA, and Pearson correlation coefficients. The data for the study were analysed using descriptive statistics of mean and standard deviation. Test are used for correlation and to determine significant difference in the q angle with left and right lower limb and q angle value in female population of both hills and plains of Uttarakhand and effect of various parameters on it.

## RESULT

Table 1. shows 30.3% of the females fall into this weight range of 40-50kg.41.4% weighs between 50-60 kg, 21.9% weighs between 60-70 kg. Only 6.5% weighs more than 70 kg.5.4%have a height within the range of 140-150,74.9%a larger percentage were within the range150-160 cm, 19.7% are taller falls within the range of 160-170 cm. 4.6% of females had a BMI below 18.5, which might indicate being underweight. The majority 68.1% had BMI between 18.5-24.9, indicating normal weight.27.3% have a BMI above 24.9, which could indicate being overweight.

Table 2 showed that in hills left q angle value was 11.49 and12.02 on the right. In plains left Q angle was 12.62 and right was 13.27 degree, showed a significant difference in the average angles of plains stating that female population of plains have higher value bilaterally than hills.

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Table 3. Average height of individuals living in hills and plains was157.3 and 156.94 with a t- value of 4.03 and a p value of <0.001. Mean weight in hills and plains was 54.9and 57.41with a t-value of 10.46 and p-value of <0.001, BMI values in female population of hills and plains was 22.14and 23.28with a t-value of 9.79 and a p-value of <0.001. The result was statistically significant.

Table 4& 5 provides a comparison of left and right q angle with height related data between two groups of those females living in hills and in plain region evaluated non-significant results in plains with a p value of 0.675 and statistically significant in left and right in hills with a p value of 0.001 and <0.001.

Table 6 & 7 provides a comparison of left and right q angle with weight related data between two groups of those females living in hills and plain region with a p value of <0.001, evaluated significant results

Table 8 &9provides a comparison of left and right q angle with BMI value which was higher in females of plains than in hills. Value of weight was found higher in hills than plains with a p value of <0.001, The result was statistically significant.

Table 10 provides strength and direction relationship between two variables of hills where Weight had strong positive correlation with BMI and Height, moderate positive correlation with angles. Height had moderate positive correlation with weight and BMI and weak positive correlation with angles. BMI had strong positive correlation with weight, moderate positive correlation with angles. Angles had strong positive relation among each other, moderate with weight and BMI, weaker but positive with height.

Table 11 provides strength and direction relationship between two variables of Plains where weight had strong positive relation with BMI, moderate positive correlation with angles and moderate positive correlation with height p value <0.001. Height had moderate positive correlation weight, no significant correlation with BMI and angle. BMI had strong positive correlation with weight, moderate correlation with angle. Angle had strong correlation with each other but moderate positive correlation with BMI and angle p value <0.001.

**Table 1. Shows estimated frequency and percentage**

| Variable | Frequency | Percentage |
|---|---|---|
| **Weight** | | |
| 40-50 | 112 | 30.3 |
| 50-60 | 153 | 41.4 |
| 60-70 | 81 | 21.9 |
| 70+ | 24 | 6.5 |
| **Height** | | |
| 140-150 | 20 | 5.4 |
| 150-160 | 277 | 74.9 |
| 160-170 | 73 | 19.7 |
| **BMI** | | |
| >18.5 | 17 | 4.6 |
| 18.5-24.9 | 252 | 68.1 |
| >24.9 | 101 | 27.3 |

**Table 2 Right and left quadriceps angle of hills and plains**

| | Hills | Plain | t value | p value |
|---|---|---|---|---|
| Angle (LT) | 11.49 | 12.62 | 5.97 | <0.001 |
| Angle (RT) | 12.02 | 13.27 | 7.01 | <0.001 |

**Table 3. comparison of parameters between two groups**

| | Hills | Plain | t value | p value |
|---|---|---|---|---|
| Height | 157.3 | 156.94 | 4.03 | <0.001 |
| Weight | 54.9 | 57.41 | 10.46 | <0.001 |
| BMI | 22.14 | 23.28 | 9.79 | <0.001 |

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**Table 4 comparison of left Q angle with height**

| Hills | Angle (LT) | F value | p value |
|---|---|---|---|
| Variable | Mean ±SD | 6.96 | 0.001 |
| Height | | | |
| 140-150 | 13.10±2.76 | | |
| 150-160 | 11.64±1.68 | | |
| 160-170 | 12.63±1.5 | | |
| Plain | | | |
| Variable | | | |
| **Height** | | 0.394 | 0.675 |
| 140-150 | 12.60±2.01 | | |
| 150-160 | 12.07±2.29 | | |
| 160-170 | 12.31±1.83 | | |

**Table 5 comparison of right Q angle with height**

| Hills | Angle (RT) | F value | p value |
|---|---|---|---|
| Variable | Mean ±SD | 9.47 | |
| **Height** | | | <0.001 |
| 140-150 | 13.50±2.83 | | |
| 150-160 | 12.14±1.74 | | |
| 160-170 | 13.48±1.85 | | |
| Plain | | | |
| Variable | | | |
| **Height** | | 0.394 | 0.675 |
| 140-150 | 12.90±2.23 | | |
| 150-160 | 12.66±2.25 | | |
| 160-170 | 13.10±1.90 | | |

**Table 6 comparison of angle (LT) with weight**

| Hills | Angle (LT) | F value | p value |
|---|---|---|---|
| Variable | Mean ±SD | 14.36 | <0.001 |
| **Weight** | | | |
| 40-50 | 10.92±1.58 | | |
| 50-60 | 12.03±1.70 | | |
| 60-70 | 12.74±1.71 | | |
| 70+ | 13.57±1.13 | | |
| Plain | | | |
| Variable | | 17.06 | <0.001 |
| **Weight** | 13.57±1.16 | | |
| 40-50 | 11.39±1.78 | | |
| 50-60 | 11.63±1.56 | | |
| 60-70 | 13.02±2.18 | | |
| 70+ | 14.76±2.90 | | |

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**Table 7 comparison of angle (RT) with weight**

| Hills | Angle (RT) | F value | p value |
|---|---|---|---|
| Variable | Mean ±SD | 18.42 | <0.001 |
| **Weight** | | | |
| 40-50 | 11.35±1.44 | | |
| 50-60 | 12.60±1.81 | | |
| 60-70 | 13.38±1.85 | | |
| 70+ | 14.71±1.25 | | |
| Plain | | | |
| Variable | | 21.6 | <0.001 |
| **Weight** | | | |
| 40-50 | 11.76±1.77 | | |
| 50-60 | 12.28±1.67 | | |
| 60-70 | 13.88±1.95 | | |
| 70+ | 15.41±2.55 | | |

**Table 8 comparison of angle (LT) with BMI**

| Hills | Angle (LT) | F value | p value |
|---|---|---|---|
| Variable | Mean ±SD | 11.37 | <0.001 |
| **BMI** | | | |
| >18.5 | 11.20±1.92 | | |
| 18.5-24.9 | 11.55±1.66 | | |
| >24.9 | 12.86±1.85 | | |
| Plain | | | |
| Variable | | | |
| **BMI** | | 17.92 | <0.001 |
| >18.5 | 11.66±1.49 | | |
| 18.5-24.9 | 11.56±1.65 | | |
| >24.9 | 13.59±2.65 | | |

**Table 9 comparison of angle (RT) with BMI**

| Hills | Angle (RT) | F value | p value |
|---|---|---|---|
| Variable | Mean ±SD | 13.65 | |
| **BMI** | | | <0.001 |
| >18.5 | 11.2±1.64 | | |
| 18.5-24.9 | 12.09±1.73 | | |
| >24.9 | 13.53±1.94 | | |
| Plain | | | |
| Variable | | | |
| **BMI** | | 22.54 | |
| >18.5 | 12.25±1.76 | | <0.001 |
| 18.5-24.9 | 12.12±1.70 | | |
| >24.9 | 14.34±2.42 | | |

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**Table 10 Correlation of angles in hills with various parameters**

| HILLS | | Weight | Height | BMI | Angle (RT) | Angle (LT) |
|---|---|---|---|---|---|---|
| Weight | Pearson Correlation | 1 | .629** | .944** | .463** | .441** |
| | Sig. (2-tailed) | | .000 | .000 | .000 | .000 |
| | N | 200 | 200 | 200 | 200 | 200 |
| Height | Pearson Correlation | .629** | 1 | .339** | .274** | .282** |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .000 |
| | N | 200 | 200 | 200 | 200 | 200 |
| BMI | Pearson Correlation | .944** | .339** | 1 | .445** | .415** |
| | Sig. (2-tailed) | .000 | .000 | | .000 | .000 |
| | N | 200 | 200 | 200 | 200 | 200 |
| Angle (RT) | Pearson Correlation | .463** | .274** | .445** | 1 | .883** |
| | Sig. (2-tailed) | .000 | .000 | .000 | | .000 |
| | N | 200 | 200 | 200 | 200 | 200 |
| Angle (LT) | Pearson Correlation | .441** | .282** | .415** | .883** | 1 |
| | Sig. (2-tailed) | .000 | .000 | .000 | .000 | |
| | N | 200 | 200 | 200 | 200 | 200 |

**Table 11 correlation matrix for various variables in plains**

| Plains | | Weight | Height | BMI | Angle (RT) | Angle(LT) |
|---|---|---|---|---|---|---|
| Weight | Pearson Correlation | .472** | 1 | .409** | .907** | .491** |
| | Sig. (2-tailed) | .000 | | .000 | .000 | .000 |
| | N | 170 | 170 | 170 | 170 | 170 |
| Height | Pearson Correlation | .099 | .409** | 1 | -.010 | .027 |
| | Sig. (2-tailed) | .198 | .000 | | .895 | .728 |
| | N | 170 | 170 | 170 | 170 | 170 |
| BMI | Pearson Correlation | .480** | .907** | -.010 | 1 | .528** |
| | Sig. (2-tailed) | .000 | .000 | .895 | | .000 |
| | N | 170 | 170 | 170 | 170 | 170 |
| Angle (RT) | Pearson Correlation | .446** | .491** | .027 | .528** | 1 |
| | Sig. (2-tailed) | .000 | .000 | .728 | .000 | |
| | N | 170 | 170 | 170 | 170 | 170 |
| Angle (LT) | Pearson Correlation | .391** | .426** | -.018 | .477** | .887** |
| | Sig. (2-tailed) | .000 | .000 | .813 | .000 | .000 |
| | N | 170 | 170 | 170 | 170 | 170 |

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## DISCUSSION

Shantanu et al conducted a study on 100 healthy adults between the age group18-35 and measured Q-angles, bicondylar distances, and femur lengths were measured. Individuals with any lower limb injury that resulted in a ligamentous, muscular, or bony defect; any diagnosed knee disorder, such as a fracture, acute or chronic knee pain, patellar dislocation, or prior orthopaedic surgery in the lower extremities, were excluded from the study. Data were analysed using paired t-tests, independent sample t-tests, ANOVA, and Pearson correlation coefficients. Outcome was that Q-angle in males higher on the right side 10.84° than left side. In females, higher 13.68° on the right side than left side 13.61°. In males, right and left Q-angles showed significant positive correlations with height, weight, BMI, right femur length, left femur length, right bicondylar distance, and left bicondylar distance. The highest correlation was found between weight and BMI. In females, the right Q-angle showed significant positive correlations with weight and BMI. The highest correlation was found with weight.[10]

Choudhary in conducted a study on 450 adult healthy volunteers. Q angle was measured in all subjects bilaterally in both supine and standing positiongoniometer. Height and weight were measured. Females had statistically significant higher Q angles in both knees, more often greater on left side than right side. Q angle increased in case of position changing from supine to standing. No effect of height and physical activity seen on Q angle, concluded that increased angle is clearly associated with patellofemoral problems. Higher Q angle among females may lead to sports related injuries. Factors like sex, height, posture, side, foot rotation and muscle's relaxation must be considered for measuring q angle.[5]

Khasawneh et al in 2019 on 400 Arab population found a considerable variation in Q angle with height was bilaterally in female subjects. Statistically significant increase in q angle with increase in condylar distance. Right side had value more often greater than the left. No variation in Q angle with weight was observed in both sides of the female subject.[11]

Bayraktar et al in 2004 studied that children and adolescents have higher angle values than adults, a change in quadriceps strength and tone, caused by both growth and activity, results in a decrease of the Q angle with change in quadriceps strength and tone which is caused by growth and activity.[12]

Sra et al conducted a study in 2008 on 140 male subjects of age group 20-35 years. Values were found higher on left side of lower limb. concluded that Q value increased with increased knee pain. Recommended that Q-angle assessment is important for physiotherapy of knee joint pathology. Values do not vary significantly with the weight. No variation in the Q angle with weight.[13]

## CONCLUSION

Height cannot be a major predictor of Q angle. Weight was slightly higher in hills than plains, weight and BMI was slightly higher in plains than hills. Q angle with comparison to weight and BMI were statistically significant. Right and left Q angle had strong correlation with each other. These observations will be helpful for sports therapists in understanding the evaluation of Q-angle in athletes as a prognostic value for probable knee pathologies that may appear in the future.

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