

Correlation Between Quadriceps Angle and Balance Among Young Females.

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Abstract

Background: Impaired balance and lower limb injuries may be linked to the variations in Q-angle, a significant anatomical variable that provides insight into lower limb alignment in the frontal plane. Females exhibit a considerably larger Q-angle than males. However, the relationship between balance and quadriceps angle has not been investigated in young females.

Aim: The study aimed to determine the correlation between Q-angle and balance among young females.

Material & method: A purposive sample of 100 females of means age 22.32 ± 2.50 years and mean BMI 21.15 ± 2.05 kg/m² were recruited based on selection criteria. The Q-angle was evaluated using a standard 30 cm goniometer while the participant lay supine, ensuring relaxed quadriceps and neutral lower limb rotation. The static balance was assessed by stork test. The dynamic balance was assessed Y balance test using ruler affixed on floor method. The leg dominance was determined by ball-kicking test.

Results: The Kolmogorov-Smirnov test was used to evaluate the normality ($n > 50$) and data was found to be normally distributed. Pearson's correlation coefficient (r) was used to estimate the correlation between Q-angle and static and dynamic balance respectively. Q-angle showed a weak positive correlation with static balance ($r = 0.105$, $p = 0.300$) and a moderate negative correlation ($r = -0.310$, $p = 0.002$) with dynamic balance. Statistical significance was established at a p-value of less than 0.05.

Conclusion: These results collectively imply that a higher Q-angle may contribute to impaired dynamic balance in young females due to altered lower limb biomechanics. However static balance is not significantly impacted by variation in Q-angle. Assessing Q-angle in young females can help identify risks of balance impairments, guiding targeted neuromuscular and biomechanical interventions.

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Introduction

The Quadriceps angle (QA) is an anatomical variable that gives insight into the alignment of the knee joint, femur and tibia in the frontal plane. Q-Angle broadly reflects lower limb biomechanics.[1] A higher Q-angle has been linked to greater femoral anteversion, increased anterior pelvic tilt, increased knee valgus, excessive external tibial rotation, and patellar and foot position.[2] The female individuals exhibited a considerably larger Q-angle on both sides compared to the male subjects.[3] A plausible explanation for why females have higher Q angle values than males that the anatomy of their pelvis is wider than that of men. This is implied by the fact that there is a greater distance between the pelvis and the patella compared to the patella's proximity to the tibial tuberosity. This causes an alteration in the positioning of the ASIS, which greatly affects Q-angle values. [3,4] According to a review of the literature; for men, it is between 10° to 15°, while for women, it is between 15° and 20°.[4]

The results of a study suggest that heavier individuals with greater BMI and Q-angle had a higher incidence of ankle sprains.[5] Studies indicate a higher risk of fall-related injuries among women.[6] Recent studies show that high Q-angle values in females are associated with increased cartilage thickness and grading in female osteoarthritis patients.[3] The alignment of lower extremity structures may have a significant impact on postural control strategies and stability, especially among females. Any changes in structural alignment may increase the risk of lower limb injuries. However, there are inconsistent results in the literature regarding this topic.

To the best of the information we have, no research has addressed the direct association of quadriceps angle with balance in young females.

Original Article

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Keywords

Quadriceps angle, postural balance, biomechanics, stork test, Y balance test

Given that Q-angle deviations may influence balance mechanisms, this study seeks to examine the correlation of quadriceps-angle with static & dynamic balance respectively.

Materials And Methods

A purposive sample of 100 females was recruited based on selection criteria. The female participants were included if they were between the age of 18-30 yr, had a BMI of 18.5-24.9 kg/m², and additionally they were asymptomatic. The females were excluded if they had undergone any lower limb or spinal surgery in past 1 year, had a history of immobilization in last 3 years, a history of pain due to any underlying pathologies like patellar bursitis, OA of hip and knee, achilles tendinitis etc, any neuromuscular disorder, radiculopathy, vestibular and visual impairments, any neurological condition that could impair balance, pregnant woman, had any psychological illness, any documented use of medication 24-48 hours prior to the evaluation.

The trial, registered under CTRI with registration number CTRI/2024/10/074813, was reviewed and approved by the Human Ethical Committee at CSJMU (2024-Jul-003). The study was conducted in Physiotherapy OPD of School of Health Sciences, CSJMU (Kanpur) in accordance with the Declaration of Helsinki.

Selected females received in-depth information regarding the study and informed consent form was signed. After screening, the demographic data was collected. The ball kicking test was done to determine dominance because the study focused on the participant's dominant limb.[7] Participants completed the assessment barefoot, with sufficient rest between trials to prevent fatigue, and tests were stopped if discomfort occurred.

The Q-angle was evaluated using a standard 30 cm goniometer while the participant lay supine, ensuring relaxed quadriceps and neutral lower limb rotation. Three landmarks were identified namely ASIS, mid patellar point and tibial tuberosity. To mark the mid-patellar point, the patellar margins were palpated and outlined. The point where the patella's maximum vertical and transverse diameters intersect was designated as its midpoint. The tibial tuberosity was marked at the site of maximum prominence on the anterior upper end of tibia. To measure the Q-angle, the goniometer's fulcrum was positioned at the patellar center, with its moving arm extending toward the ASIS and the stationary arm toward the tibial tuberosity. The angle at their intersection was recorded.[8]

Outcome Measures: The Stork Test, a reliable and

Variables (Q angle)	r	Sig. (2 tailed)
Static Balance (stork score)	0.105	0.300
Dynamic Balance (YBT)	-0.310	0.002*

r = Pearson's correlation-coefficient, *correlation is significant at the 0.01 level (2-tailed)

valid ICC technique, was used to assess static balance.[9] The subject was instructed to stand on both feet, raise the non-dominant leg, position the other foot against the dominant leg's knee, and the hands across their chest or on their hips. Participants held the posture for two minutes, with time recorded across three trials. The stopwatch was stopped if the participant acquired a double-limb stance, the non-weight-bearing foot lost touch with the knee, or the other foot moved in any direction.

The Y-Balance Test, using a floor-affixed ruler, assessed dynamic balance and demonstrated strong interrater and test-retest reliability.[10] Each participant received both verbal instructions and a visual presentation of the test. The subject was asked to hold a single-leg stance while standing on the dominant foot at the center. The subject was instructed to reach with the other leg in three directions i.e., anterior, posteromedial, and posterolateral in relation to the stance foot as far as possible along the ruler affixed on floor. Participants were required to perform three consecutive trials for each reach direction.

Statistical Analysis

The normality of the data was assessed by using Kolmogorov Smirnov Test ($n > 50$) and data was found to be normally distributed. All statistical analysis was done on SPSS software (Statistical Package for Social Sciences IBM version 26). The Pearson's Correlation Coefficient was employed to determine the strength and direction of the correlation between Q-angle and balance measures. Statistical significance was established at a p-value of less than 0.05.

Results

Total 100 female participants of mean age 22.32 ± 2.50 years and mean BMI 21.15 ± 2.05 kg/m² performed all the tests completely and there were no dropouts. The demographic characteristics are presented in table 1 while table 2 illustrates the relation between QA and both static & dynamic balance.

Table.1 Demographic attributes of the participants

Demographic Details	Total N=100
Age (years)	22.32±2.50
Height (cm)	155.36±6.51
Weight (kg)	51.17±6.83
BMI (kg/m ²)	21.15±2.05
Q angle (degree)	16.84±2.20

Table 2. Relationship between Q angle and balance among females (n=100)

A weak positive correlation was found between Q-angle & static balance, as measured by the stork test ($r = 0.105$, $p = 0.300$). Nevertheless, the correlation did not reach statistical significance ($p > 0.05$). In contrast, a moderate negative correlation was found between the Q-angle and dynamic balance, assessed by Y-Balance Test ($r = -0.310$, $p = 0.002$).

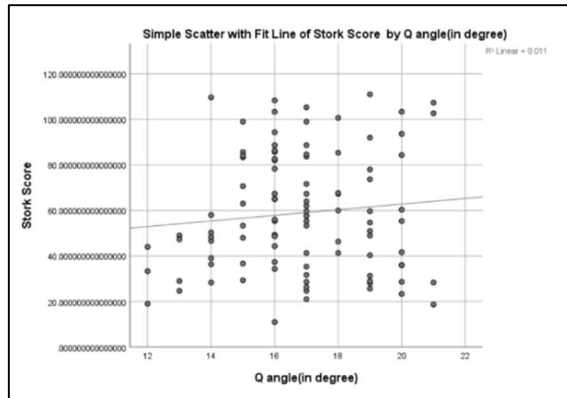


Fig.1 scatter plot for relation between QA and stork test

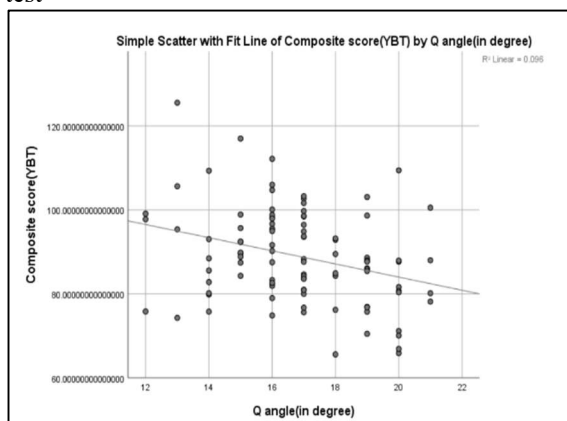


Fig 2. Scatter plot for relation between QA and YBT

Discussion

The current research explored the correlation between Q-angle and balance in young females emphasizing its role in lower limb biomechanics and stability, consistent with previous researches. A study by Denizoglu Kulli et al. (2019) noted that quadriceps angle and static balance, [as measured by the single-leg-stance test (SLST)], did not significantly correlate. Additionally, they noticed a significantly moderate correlation between Q-angle and dynamic balance.[11] In contrast, Skouras et al. (2022) highlighted the clinical relevance of the Q-angle, reporting that a higher dynamic Q-angle is linked to chronic patellofemoral instability.[4] This instability can adversely affect dynamic balance during activities such as walking or single-leg squats. Collectively, these studies indicate that while the Q-angle may not significantly influence static balance, it has a more pronounced effect on dynamic balance.

Sharma et al. (2023) concluded that a larger Q-angle is linked to altered lower extremity mechanics, potentially leading to decreased dynamic balance and increased injury risk.[12] The significant negative correlation observed in the current study underscores the importance of assessing Q-angle in this population to identify individuals at risk for balance impairments and to develop targeted interventions aimed at improving dynamic stability. A higher Q-angle has

been linked to changes in patellar tracking and increased lateral forces on the patella, potentially affecting knee stability during static postures.[12] However, static balance tasks, such as the Stork test, primarily assess the ability to maintain a stationary position with minimal joint movement. This minimal movement may not sufficiently challenge the knee's structural alignment during static balance performance. Neuromuscular Adaptations: Individuals with a higher Q-angle may develop neuromuscular adaptations, such as increased vastus medialis oblique activation, to counteract lateral patellar displacement and enhance knee stability during static tasks.

It is crucial to consider the constraints of our research. The sample size of 100 young females may restrict the applicability of the results to other demographics. Additionally, the use of the Stork test as the sole measure of static balance may not capture all aspects of postural control. Future studies should consider incorporating a variety of balance assessments and including participants of different ages and activity levels.

Conclusion

The clinical implications of these findings suggest that while Q-angle may not significantly affect static balance, it plays a crucial role in dynamic postural control. Therefore, assessing Q-angle in young females could be essential for identifying individuals at risk of dynamic balance impairments and lower extremity injuries. Interventions focusing on neuromuscular training and biomechanical correction may help improve dynamic stability in those with higher Q-angles. Future research should explore the combined effects of Q-angle with other factors, such as hip strength, core stability, and proprioceptive training, to develop comprehensive intervention strategies.

Conflict Of Interest

None

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