International Journal of Physiotherapy and Research,
Int J Physiother Res 2026, Vol 14(3):4991-95. ISSN 2321-1822
***DOI:** https://dx.doi.org/10.16965/ijpr.2026.134*

Original Research Article

Correlation Between Q Angle and Hip Abductor Strength in Patellofemoral Pain Syndrome

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ABSTRACT

Background: Young active females are frequently exposed to dynamic lower limb loading during physical activity, rendering them susceptible to patellofemoral pain syndrome (PFPS). The quadriceps angle (Q angle) and hip abductor strength are critical biomechanical parameters influencing patellar tracking and patellofemoral joint stress. Alterations in these factors may contribute to or result from patellofemoral dysfunction.

Context and Purpose of Study: To evaluate the correlation between Q angle and hip abductor strength (HAS) in young female individuals diagnosed with patellofemoral pain syndrome.

Results: Karl Pearson's correlation analysis revealed a statistically significant moderate negative correlation between Q angle and HAS (r = “0.599, $p < 0.001$) among 55 young female patients with PFPS. The mean Q angle was 20.90 ± 3.10 degrees, and the mean hip abductor strength was 12.90 ± 5.06 kg. As Q angle increased, HAS consistently decreased across the study cohort.

Conclusion: Young female patients with PFPS exhibit a significant inverse relationship between Q angle and HAS, indicating that structural malalignment and proximal muscular weakness jointly contribute to patellofemoral dysfunction. These findings reinforce the clinical value of incorporating hip abductor strengthening into rehabilitation protocols for PFPS management in young females.

KEYWORDS: Hip Abductor Strength, Patellar Malalignment, Patellofemoral Pain Syndrome, Quadriceps Angle.

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Access this Article online	Journal Information
Quick Response code	**International Journal of Physiotherapy and Research** ISSN (E) 2321-1822 | ISSN (P) 2321-8975 **https://www.ijmhr.org/ijpr.html** **DOI-Prefix:** https://dx.doi.org/10.16965/ijpr
	Article Information
DOI: 10.16965/ijpr.2026.134	Received: 31 May 2026 Peer Review: 02 Jun 2026 Revised: 12 Jun 2026 Accepted: 19 Jul 2026 Published (O): 11 Aug 2026 Published (P): 11 Aug 2026

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INTRODUCTION

One of the most common knee-related issues in an active population is patellofemoral pain syndrome (PFPS), with females facing a double risk of acquiring this condition in comparison to their male counterparts [1]. Despite this high occurrence of PFPS, there are considerable physical strains resulting from altered biomechanical patterns, such as irregular patellar tracking, resulting from postures such as sitting, squatting, or running on uneven terrain. Such postures often lead to knee- related issues, with a focus on anterior knee pain, resulting from factors such as malalignment, excessive articular pressure, and lack of muscular support. Studies have shown that females are more likely to acquire PFPS due to their wider pelvic anatomy, resulting in malalignment of the knee and hip, leading to pain and disability in this group of people [2]. Anatomical characteristics inherent to the female musculoskeletal system, particularly a broader pelvis, predispose women to greater patellofemoral joint stress and kinematic instability [3].

A key structural parameter in this regard is the quadriceps (Q) angle defined as the angle subtended between the line of pull of the quadriceps muscle, drawn from the anterior superior iliac spine (ASIS) to the mid-patellar point, and the patellar tendon [4]. An elevated Q angle is associated with compensatory knee valgus, asymmetric mechanical loading, and altered lower limb kinematics, all of which are further modulated by variations in locomotion speed and terrain [5]. When the Q angle is pathologically increased, the resultant lateral patellar displacement amplifies contact stress at the patellofemoral articulation, accelerating cartilaginous wear. Concurrently, elevated shear forces across the joint promote chronic inflammation, muscle overuse, and progressive joint instability [6]. The co-existence of a high Q angle and deficient hip abductor strength creates a compounding mechanical disadvantage, wherein femoral alignment is compromised both proximally and distally, predisposing the patellofemoral joint to recurrent overload [7].

The hip abductor muscle group comprising the gluteus medius, gluteus minimus, and tensor fasciae latae plays a critical role in maintaining pelvic stability, coronal plane limb alignment, and controlled knee mechanics during dynamic tasks Progressive weakening of the gluteus medius, in particular, results in contralateral pelvic drop and proximal femoral adduction, triggering a cascade of compensatory muscle recruitment that further burdens the patellofemoral joint [8,9].

Repetitive functional activities such as stepping, pivoting, and stair negotiation impose sustained demand on these muscles, rendering them susceptible to fatigue-induced inhibition [7]. This biomechanical deterioration manifests as dynamic knee valgus, a well-recognised precursor to anterior knee pain, patellar maltracking, and long-term chondral degeneration [10].

Despite PFPS being a widely encountered condition among young active females, the existing literature offers limited investigation into the concurrent relation between Q angle and HAS within this demographic. Women engaged in regular physical activity are disproportionately exposed to the combined mechanical burden of a structurally elevated Q angle and functionally compromised hip abductors two factors that independently worsen patellofemoral loading and, in combination, may synergistically accelerate joint deterioration. Understanding the correlation between these two biomechanical variables is essential not only for elucidating the pathomechanics underlying PFPS in females, but also for guiding the development of targeted, evidence-based rehabilitation strategies. Therefore, this study aims to evaluate the correlation between the Q angle and HAS in young female individuals diagnosed with PFPS.

METHODS

The present study is a cross-sectional study with 55 participants with PFPS from the AJ Institute of Medical Science and Research Centre. Participants were selected based on specific inclusion criteria using a non-probability, convenience sampling. Data was collected for a duration of 10 months.

PROCEDURE

The study received approval from the Institutional Ethics Committee (DCGI Reg no EC/NEW/INST/2020/741), and participants were recruited according to specified inclusion and exclusion criteria. Inclusion criteria includes 55 females with patellofemoral pain syndrome under the age group 18-30 years, patients with Kujala score less than 85, patients able to comprehend or understand the verbal instruction given by the examiner, participants willing to participate.

Participants who have undergone knee surgeries, patients with alternative diagnosis, patients with knee fractures, Patients with congenital anomalies, participants with any neurological disorders are excluded.

Fifty-five female participants with patellofemoral pain syndrome satisfying inclusion criteria were selected to assess the Q angle using the goniometer method. Participants were positioned in a supine manner with the lower limbs relaxed and in neutral. The hip and knee were extended, and the feet aligned, pointing directly upwards. The anatomical landmarks, including the ASIS, middle of patella and tibial tuberosity were identified and indicated with a skin-safe marker. A universal goniometer was used to check the Q angle. The fulcrum of goniometer was placed over the centre of the patella. The stationary arm was aligned with the line from the ASIS to the patella, and the movable arm parallel to the line from the patella to the tibial tuberosity. The examiner instructed the participant to remain relaxed and still during the measurement and ensure the limb is not externally or internally rotated.

HAS was assessed using a hand-held dynamometer. Participants were positioned in a side-lying manner on a treatment couch, with the testing leg on top and lower leg flexed at the hip and knee for stability. The testing hip was positioned in neutral (0° flexion/extension and rotation) and the knee was fully extended. The examiner placed the hand-held dynamometer on the lateral side of the thigh, approximately 5 cm above the lateral femoral condyle (just above the knee joint) and supported the pelvis with one hand and instructed the participant to "push upwards" (abduct) against the dynamometer while maintaining limb alignment. They were asked to gradually build up to maximum force over 2 seconds, then maintain a maximum voluntary isometric contraction for 5 seconds. Verbal encouragement was provided throughout the effort. The examiner resisted the force by holding the dynamometer in place, matching the participant's force without allowing movement. The reading was noted in Kilograms (Kg) or Newtons, depending on the dynamometer's display. Three repetitions of the 5-second contraction were performed on the dominant leg, with a 30 second rest interval between each trial. The mean of the three measurements was taken for analysis.

RESULTS

The statistical analysis for the present study on the correlation between Q-angle and hip abductor strength in patients with patellofemoral pain syndrome was performed using SPSS version 23.0. Descriptive statistics were expressed as mean ± standard deviation (Mean ± SD) for continuous variables such as Q-angle and HAS, while categorical variables such as affected side were presented as frequency and percentage (%). The relationship between Q-angle and HAS was analysed using Karl Pearson's correlation coefficient (r). A p-value of <0.05 was considered statistically significant.

Table 1: Summary of clinical characteristics and correlation among patients with Patellofemoral Pain Syndrome (n = 55).

A. Distribution of Affected Side			
		Frequency	**Percent (%)**
Affected side	**Left leg**	27	49.1
	Right leg	28	50.9
	Total	**55**	**100**
B. Descriptive Statistics			
Variable	**Minimum**	**Maximum**	**Mean ± SD**
Q-angle (degrees)	14	26	20.91 ± 3.11
Hip abductor strength (kg)	7.33	26.7	12.90 ± 5.07
C. Correlation between Q-Angle and HAS			
Variable	**Pearson r**	**p value**	**N**
Q-angle vs. Hip abductor strength	−0.599	< 0.001*	55

Statistically significant at p < 0.001. SD = Standard Deviation.

The distribution of the affected side among patients with patellofemoral pain syndrome showed that out of 55 subjects, 28 patients (50.9%) had right leg involvement, while 27 patients (49.1%) had left leg involvement. The descriptive statistics for Q-angle among 55 patients with patellofemoral pain syndrome showed a mean of 20.90 ± 3.10 degrees, with values spanning from 14.00 to 26.00 degrees. The descriptive statistics of HAS among 55 patients with patellofemoral pain syndrome showed that the mean HAS was 12.90 ± 5.06 kg, with values ranging from a minimum of 7.33 kg to a maximum of 26.70 kg. The correlation analysis between Q-angle and HAS among 55 patients with patellofemoral pain syndrome revealed a moderate negative correlation ($r = -0.599$), which was statistically highly significant ($p < 0.001$*).

DISCUSSION

The present study revealed a statistically significant moderate negative correlation between Q angle and HAS ($r = -0.599$, $p < 0.001$) among young female patients with patellofemoral pain syndrome (PFPS). This indicates that as the Q angle increases, hip abductor strength tends to decrease, suggesting that structural malalignment and proximal muscular weakness coexist to amplify patellofemoral joint stress.

These findings align with Ireland et al. (2003), who demonstrated that young females with PFPS exhibited 26% reduction in HAS and 36% reduction in hip external rotation strength compared to similar-aged asymptomatic controls, establishing hip abductor weakness as a consistent feature of this population [11]. A systematic review by Meira and Brumitt (2011) further confirmed that PFPS is associated with decreased HAS and external rotator strength, alongside faulty hip mechanics, including adduction and internal rotation [12]. The weakening of the gluteus medius promotes contralateral pelvic drop and ipsilateral femoral adduction, which increases the dynamic Q angle and lateral patellar tracking, contributing to elevated patellofemoral contact pressure.

Cichanowski et al. (2007) reported that females with PFPS demonstrated significantly weaker hip abductors and external rotators than healthy controls, consistent with the proximal muscular deficiency observed in the present cohort [13]. Furthermore, Prins and van der Wurff's systematic review (2009) concluded that females with PFPS consistently exhibit hip muscle weakness, reinforcing the clinical relevance of evaluating hip abductor strength in this population [14].

The exclusive inclusion of females is justified by their anatomically wider pelvis and greater femoral anteversion, which inherently elevate the Q angle and predispose them to greater patellofemoral joint stress. Future research employing three-dimensional motion analysis with larger, multi-centre samples would strengthen the evidence base.

Clinically, these findings support the routine assessment of hip abductor strength in PFPS patients with elevated Q angles and reinforce the integration of targeted hip strengthening into rehabilitation protocols to reduce patellofemoral overload and improve functional outcomes.

CONCLUSION

The present study concludes that there is a statistically significant moderate negative correlation between Q angle and HAS in young female patients with patellofemoral pain syndrome. As Q angle increases, hip abductor strength decreases, indicating that structural malalignment and proximal muscular weakness jointly contribute to patellofemoral dysfunction. These findings highlight the clinical importance of incorporating hip abductor strengthening into rehabilitation protocols targeting PFPS management in young females.

ABBREVIATIONS

HAS - Hip Abductor Strength
Q angle - Quadriceps angle
PFPS - Patellofemoral Pain Syndrome

ACKNOWLEDGEMENTS

The authors would like to thank all the faculty and students of Laxmi Memorial College of Physiotherapy for their invaluable support in facilitating and completing this study.

AUTHORS CONTRIBUTION

Priya S: conception of the study, guided throughout the manuscript preparation process and identifying the topic, performed critical revisions, and provided guidance in topic selection.

Harish S Krishna: reviewing the study and providing critical intellectual input to ensure the accuracy and integrity of the work.

Denson Alphonse: Conceptualised and identified the research topic, performed data collection, collected study samples, conducted statistical analysis in collaboration with a statistician, and prepared the manuscript.

Conflicts of interest: None

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How to cite this article: Priya S, Harish S Krishna, Denson Alphonse. Correlation Between Q Angle and Hip Abductor Strength in Patellofemoral Pain Syndrome. Int J Physiother Res 2026;14(3):4991-4995. **DOI:** 10.16965/ijpr.2026.134