International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Correlation between Gluteus Maximus and Gluteus Medius Muscle Strength with Anterior Knee Pain with PFPS for Runners – A Pilot Study

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Abstract

Background: The gluteus maximus (GMax) and gluteus medius (GMed) muscles is central to maintaining lower limb stability and functional knee mechanics. Muscle weakness is related with altered lower extremity biomechanics and may contribute to reduced functional performance. The Kujala Score isused for assessing knee function and symptoms. Understanding the link between gluteal muscle strength and Kujala Score may facilitate the assessment and rehabilitation of individuals with knee dysfunction.

Objective: To determine the relationship between GMax strength, GMed strength, and Anterior Knee Pain.

Methods: 14 participants are included in this correlation study. GMax and GMed muscle strength were quantified in kilograms (kg), and anterior knee pain was assessed using Kujala ascore is used to assess knee function. Age, muscle strength, and Kujala Score were analysed by using descriptive statistics. Pearson correlation analysis used to calculate the relationship between muscle strength and Kujala Score.

Results: Fourteen participants were included in this analysis. The mean age, GMax strength and GMed strength were 22.50 ± 1.83 years, 7.44 ± 1.07 kg, 7.57 ± 0.93 kg respectively. The mean Kujala Score was 83.07 ± 7.28. Correlation analysis illustrated strong positive correlation between gluteus maximus strength and Kujala Score (r = 0.736), a very strong positive correlation in between gluteus medius strength and Kujala Score (r = 0.884), and a moderate positive correlation between GMax and GMed strength (r =0.586).

Conclusion: The findings suggest that greater gluteus muscle strength is linked with better Kujala scores and improved knee function. Gluteus medius strength demonstrated the strongest relationship with Kujala score. These results highlight the importance of strengthening the gluteal muscles in rehabilitation programs aimed at improving knee function.

Keywords: Gluteus Maximus, Gluteus Medius, Knee Function, Kujala Score, Muscle Strength.

Introduction:

Patellofemoral pain (PFP) is one of the most common musculoskeletal disorders affecting physically active individuals and is characterized by anterior knee pain during activities such as running, stair climbing, squatting, and prolonged sitting. Although lower-extremity muscle weakness is commonly observed in individuals with PFP, the relationship between muscle strength and clinical outcomes remains uncertain. Kim et al. reported that lower-extremity strength has only a weak or no direct association with pain intensity and functional outcomes, highlighting the multifactorial nature of patellofemoral pain. [(1)] Patellofemoral pain syndrome (PFPS) is a frequent cause of anterior knee pain in runners and other physically active individuals. Barton et al. suggested that altered activation of the gluteus medius (GMed) and gluteus maximus (GMax) may contribute to abnormal hip biomechanics, increasing patellofemoral joint stress. Their systematic review emphasized the importance of gluteal muscle function in the development and rehabilitation of PFPS [(2)]

Females with patellofemoral pain syndrome often demonstrate abnormal hip kinematics during running, including excessive hip adduction and internal rotation. Willson et al. investigated gluteal muscle activation during running and reported that delayed gluteus medius activation was associated with altered lower-limb biomechanics, suggesting that impaired neuromuscular control contributes to increased patellofemoral joint loading and anterior knee pain [(3)] Gluteus maximus and gluteus medius muscles play an essential role in maintaining pelvic stability and controlling lower-limb alignment during running. Arul Mozhi et al. demonstrated that reduced strength of these muscles was significantly associated with increased anterior knee pain in runners with patellofemoral pain syndrome, supporting the importance of targeted hip muscle strengthening in physiotherapy rehabilitation.[(4)] Similarly, recent research investigating gluteus medius activation reported that neuromuscular deficits may coexist with muscle weakness, highlighting the importance of assessing both muscle strength and motor control in individuals with PFPS [(5).] Current evidence also supports the implementation of comprehensive rehabilitation programmes that include hip strengthening, neuromuscular training, gait retraining, flexibility exercises, patient education, and load management to improve pain and functional performance in runners with PFPS. These interventions have shown promising results in restoring lower-limb biomechanics and reducing patellofemoral joint stress [(6,7)]

Objective assessment of gluteus maximus and gluteus medius muscle strength provides a more accurate evaluation of hip muscle performance and its influence on lower-extremity biomechanics. However, studies assessing muscle activation alone or combining participants with different functional demands may not accurately reflect the relationship between gluteal muscle strength and anterior knee pain in runners. Therefore, the present study specifically investigates runners diagnosed with PFPS by objectively assessing gluteus maximus and gluteus medius muscle strength and examining its correlation with anterior knee pain. By focusing on this specific population, the study aims to determine whether reduced gluteal muscle strength is associated with increased pain intensity and functional impairment in runners with PFPS.

Methods

This pilot cross-sectional correlational study was part of a larger study being conducted with the same objectives and recruited recreational runners aged 20–25 years with clinically diagnosed Patellofemoral

Pain Syndrome (PFPS) from the Department of Physiotherapy, Laxmi Memorial College of Physiotherapy, Mangalore, between January and June 2026. Participants were included if they had anterior knee pain during running or activities such as stair climbing, squatting, prolonged sitting, or jumping for at least four weeks, were recreational runners, and were willing to participate. Individuals with previous knee surgery, ligament or meniscal injuries, inflammatory joint disease, neurological disorders, hip or ankle pathology, lower limb fractures within the previous six months, or any condition affecting normal gait or muscle strength were excluded. Written informed consent was obtained from all participants before data collection.

Gluteus maximus muscle strength was measured using a calibrated handheld dynamometer with the participant positioned prone and the knee flexed to 90°. Resistance was applied over the distal posterior thigh while the participant performed maximal isometric hip extension. Gluteus medius strength was assessed using the handheld dynamometer with the participant positioned in side lying and the test limb maintained in neutral rotation during maximal isometric hip abduction. Three maximal contractions were performed for each muscle group with one-minute rest intervals between trials, and the highest value recorded in kilograms (kg) was used for statistical analysis. Functional status and symptom severity were assessed using the Kujala Anterior Knee Pain Scale, a validated questionnaire consisting of 13 items with a total score ranging from 0 to 100, where higher scores indicate better knee function and fewer symptoms.

All measurements were obtained by the same examiner under standardized testing conditions to minimize measurement bias. Statistical analysis was performed using IBM SPSS Statistics Version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were summarized using mean and standard deviation, while categorical variables were presented as frequencies and percentages. Karl Pearson's correlation coefficient was used to determine the relationship between GMax strength, GMed strength, and Kujala scores. Statistical significance was established at $p < 0.05$.

Result

Statistical analysis was performed using SPSS version 29.0 (IBM SPSS Statistics for Windows, Version 29.0; IBM Corp., Armonk, NY). Continuous variables were summarized using mean and standard deviation. Correlation was performed using Karl-Pearson's correlation method. A p value less than 0.05 was considered statistically significant. The descriptive statistics showed that the GMax strength ranged from 6.00 to 10.20 kg, with a mean of 7.443 ± 1.066 kg. The GMax strength ranged from 5.50 to 9.00 kg, with a mean of 7.568 ± 0.934 kg. The Kujala Score ranged from 70.00 to 92.00, with a mean of 83.071 ± 7.280.

Table 1: Correlation between GMax Strength and Kujala Score

		Kujala Score
GMax strength	r value	.736**
	p value	0.003*
	N	14

The correlation analysis showed that Gluteus maximus strength had a strong positive relationship with the Kujala Score (r = 0.736). The association was statistically significant (p = 0.003, N = 14), indicating that greater gluteus maximus strength was associated with better knee function.

Table 2: Correlation between GMed Strength and Kujala Score

		Kujala Score
GMed strength	r value	.884**
	p value	p<0.001*
	N	14

The correlation analysis showed that Gluteus medius strength had a very strong positive correlation with the Kujala Score (r = 0.884). The association was statistically significant (p < 0.001, N = 14), indicating that greater gluteus medius strength was associated with better knee function.

Discussion

The present pilot study investigated the relationship between GMax and GMed strength, and knee function in recreational runners with PFPS. The findings demonstrated significant positive correlations between hip MS and Kujala scores, indicating that stronger gluteal muscles are associated with better functional outcomes in individuals with PFPS. The study demonstrated a strong positive correlation between gluteus maximus strength and Kujala score (r = 0.736, p = 0.003). This finding suggests that greater gluteus maximus strength is associated with improved knee function and reduced anterior knee pain.

The present study is supported by the findings of Zhang et al. who reported that individuals with patellofemoral pain syndrome consistently demonstrate reduced hip abductor and external rotator muscle strength, accompanied by altered hip biomechanics such as excessive hip adduction and femoral internal rotation during functional activities. These biomechanical alterations increase patellofemoral joint stress and contribute to anterior knee pain. The authors emphasized that strengthening the gluteus medius and gluteus maximus, along with improving neuromuscular control, is essential for restoring lower-limb alignment and reducing symptoms. Similarly, the present study investigates the correlation between gluteus maximus and gluteus medius muscle strength and anterior knee pain in runners with PFPS, and the observed relationship supports the concept that deficits in gluteal muscle strength are associated with increased anterior knee pain. Therefore, the findings of the present study are consistent with those reported by Zhang et al., reinforcing the importance of targeted hip strengthening in the rehabilitation of runners with PFPS [8]

Baellow et al. reported that women with patellofemoral pain demonstrated altered landing biomechanics during the drop-vertical jump along with deficits in hip and knee muscle strength compared with healthy individuals. These impairments may increase patellofemoral joint loading and contribute to persistent anterior knee pain. The authors emphasized that rehabilitation programmes should include strengthening of the hip abductors and extensors, neuromuscular training, and correction of faulty landing mechanics to improve lower-extremity function and reduce pain [9]

Samuel et al. found that women with patellofemoral pain exhibited significantly lower voluntary activation of the gluteus medius than healthy controls, suggesting that gluteal muscle weakness may be partly due to central muscle inhibition rather than reduced muscle strength alone. The authors concluded that assessment of gluteus medius activation should complement strength testing and that rehabilitation should incorporate both strengthening exercises and neuromuscular activation strategies to enhance hip stability, improve movement control, and reduce patellofemoral pain [10]

Conclusion

This pilot study demonstrated significant positive correlations between gluteus MS and knee function in recreational runners with PFPS. Greater GMax and GMed strength were associated with higher Kujala scores, indicating better knee function and fewer symptoms. Among the two muscles, GMed strength showed the strongest association with functional outcomes. These highlight the need for assessing and strengthening the gluteal musculature during rehabilitation programmes for runners with PFPS. Incorporating targeted GMax and GMed strengthening exercises may improve lower-limb biomechanics, reduce anterior knee pain, and enhance functional performance. Larger prospective studies are recommended to confirm these findings and establish causal relationships.

Abbreviations

PFPS- Patello femoral pain syndrome
GMax- Gluteus Maximus
GMed – Gluteus Medius
MS- Muscle Strength
IR- Internal Rotation
ER- External Rotation

References

1. Kim S, Zuk E, DiStefano LJ, Briani RV, et al. Lower extremity strength has weak or no associations with clinical outcomes in individuals with patellofemoral pain: a systematic review with evidence gap map and meta-analysis. JOSPT Open. 2024;2(3).
2. Barton CJ, Lack S, Malliaras P, Morrissey D. Gluteal muscle activity and patellofemoral pain syndrome: a systematic review. Br J Sports Med. 2013;47(4):207-214.
3. Willson JD, Kernozek TW, Arndt RL, Reznichek DA, Straker JS. Gluteal muscle activation during running in females with and without patellofemoral pain syndrome. Clin Biomech (Bristol, Avon). 2011;26(7):735-740.
4. Arul Mozhi C, Senthil Kumar P, Muthu Kumar S. Correlation between gluteus maximus and gluteus medius muscle strength with anterior knee pain in runners with patellofemoral pain syndrome. In: Current Trends in Physical Therapy and Rehabilitation. 2024. p. 65-72.
5. Rabieifar H, Niknam H, Khademi Kalantari K. Exploring the relationship between gluteus medius activation and pain intensity in patients with patellofemoral pain syndrome: a cross-sectional study. Sci J Rehabil Med. 2025;14(5).
6. Kunene SH, Taukobong NP, Ramklass S. Rehabilitation approaches to anterior knee pain among runners: a scoping review. S Afr J Physiother. 2020;76(1):1342.
7. Chen G, Gu Z, Wang P, Qi Y, Dai J. Analysis of lower limb muscle strength characteristics of amateur runners with patellofemoral pain: a cross-sectional study. PLoS One. 2024;19:e0305141.
8. Zhang X, Huang J, Wang X, et al. The relationship between patellofemoral pain syndrome and hip biomechanics: a systematic review with meta-analysis. Healthcare (Basel). 2023;11(1):99.
9. Baellow A, Glaviano NR, Hertel J, Saliba SA. Lower extremity biomechanics during a drop-vertical jump and muscle strength in women with patellofemoral pain. J Athl Train. 2020;55(6):615-622.
10. Samuel MN, Lee SP, Hooyman A, Miller KC, Young DL, Glaviano NR. Comparison of gluteus medius muscle activation in women with and without patellofemoral pain. J Athl Train.

2025;60(11):756-762.