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REHABILITATION APPROACHES FORIPATELLOFEMORAL PAIN SYNDROME: A REVIEW ON PATELLARIMOBILIZATION AND OPEN CHAIN EXERCISE EFFECTIVENESS IN SPORTS CLUB ATHLETES

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Abstract

Background: *Patellofemoral pain syndrome (PFPS) is a condition that causes pain at the front ofithe knee, around the kneecap. Two common treatments used to manage this condition are patellar mobilization and open chain exercises. Patellar mobilization involves gently moving the kneecap either medially or laterally to correct its alignment, while open chain exercises play a role in strengthening of quadriceps.*

Objective: *This study aimed to analyze existing literature on the role of patellar mobilization in reducing pain and improving tracking in PFPS.*

Methodology: *This review followed a structured methodology to evaluate the effectiveness of patellar mobilization techniques, closed and open kinetic chain exercises, and other physiotherapy interventions for managing Patellofemoral Pain Syndrome (PFPS). Research published between2020 to 2025 was systematically searched across databases including PubMed, Google Scholar, PEDro.*

Results: *Recent studies (2020–2025) show that targeted rehabilitation for PFPS, including closed kinetic chain exercises and manual therapy techniques like MWM, effectively reduces pain and improves function. Closed chain exercises consistently produced greater strength and functional gains, whilemanual therapy enhancedmobility and short-term pain relief.*

Conclusion: *The findings suggest that both patellar mobilization and open chain exercises are effective in managing patellofemoral pain syndrome in sports players. However, open chain exercises proved to be more effective, leading to greater improvements in pain reduction, range of imotion and functional activity.*

INTRODUCTION

Patellofemoral pain syndrome is a painful ailment that affects the front of the knee and the area surrounding the kneecap."Runner's knee" is another name for patellofemoral pain syndrome, which frequently affects athletes and others who participate in running, climbing

stairs and other sports. The patellofemoral joint is formed by the patella (kneecap) and the femur's trochlea, and it plays a key role in helping the knee straighten and slow down movement. The patella acts like a lever in the leg, allowing the quadriceps muscles to extend the knee more efficiently, using less effort. Quadriceps, patellar tendon, vastus medialis oblique, medial patella tibial ligament, medial patella femoralligament, lateral retinaculum, oblique lateral retinaculum, patellotibial band, epicondylopatellar bands and medial retinaculum all contribute to the stability of the patellofemoral joint (Akhavan Hariri et al., 2023)

Pain in the front region of the knee (retro patellar or per patellar; stabbing, without irradiation, occasionally intermittent) that gets worse when squatting, climbing and descending stairs, as well as after extended periods of sitting, are the hallmarks of PFPS. Whether or not they are linked to other conditions like knee osteoarthritis, a number of disorders including anterior knee diseases (anterior knee pain syndrome, jumper's knee and patellofemoral tendon disease chondromalacia patellar) can cause PFPS(Alarab et al., 2019)

Many activities that put strain on the joint exacerbate the pain, making it extremely difficult for those with PF to go about their regular lives. PF alignment/kinematics, bone shape, entire leg alignment and soft tissue forces are some of the variables that affect PF discomfort, which is regarded as a complicated disorder(Albornoz-Cabello et al., 2023) Because PFPS is multifactorial, it has been linked to one or more intrinsic and extrinsic factors, including postural and biomechanical changes, imbalances in stabilizing muscle groups, ankle-foot proprioceptive changes, sexual maturation mechanisms levels of physical activity and functional ability. Thus, PFPS stands out among knee pain dysfunctions in children and young adults and is one of the most prevalent musculoskeletal illnesses during this developmental stage. People with PFPS frequently report experiencing pain, which can hinder their ability to do functional and physical tasks and as a result, lower their social engagement(Aljahmi et al., 2025)

Runner's knee or patellofemoral pain syndrome is highly common among young athletes, fitness enthusiasts and active individuals. Additionally, females are twice as likely develop PFPS as compared to males(Alsulaimani, 2019)

Particularly among runners, the prevalence is considerable 46% of running-related injuries are caused by PFPS(Anum et al., 2024). According to reports, patellofemoral pain (PFP) is a prevalent ailment that primarily affects young adults and produces substantial discomfort around the knee joint and patella area. It limits social participation due to reduced physical activity; 74% of them reduce or cease participating in sports as a result of the symptoms. The annual incidence and precise prevalence of PFP are unclear, however prevalence estimates vary greatly, ranging from 15% to 45%(Anwar et al., 2022)

According to a recent study, knee pain will force about 25% of recreational athletes with PFP to quit playing sports. Running and jumping athletes are often impacted by PFP.As a synonym for nonspecific PFP, functional patellofemoral pain syndrome (PFPS) was the most prevalent diagnosis, accounting for 6.4%ofallcases. These findings demonstrate that PFP can impact individuals with and without patellofemoral joint (PFJ) structural impairment(Arslan & Gültekin, 2023)

Many athletes continue to play sports despite the pain and functional deterioration brought on by Patellofemoral pain and they must train hard to perform at their best during the competitive season. In particular, training programs emphasize high intensity cardiorespiratory fitness (CRF) and skill training that mirror play qualities in sports like basketball and soccer that call for frequent high-intensity sprints, quick direction changes and jump-and-landing actions. Even though it can be challenging for athletes with PFPS to fully execute these high-intensity activities, high-intensity training is inevitable, especially for athletes who compete in sports and must

maintain peak performance(Ashtiani et al., 2025)

Common activities that exacerbate symptoms include climbing or descending hills, walking up or downstairs, squatting, lunging, running, biking and spending extended periods of time sitting with the knee at a 90-degree angle(Ayık et al., 2025). Joint biomechanics are impacted by excessive knee muscular activity and rapid acceleration, which also results in increased compression and lateral force, which further tracks the patella and causes bilateral excruciating pain at the anterior portion of the knee joint. Intermittent peripatellar or retropatellar pain, including stabbing pain that gets worse when squatting without radiation, symptoms of the patella giving way or slipping when climbing and descending stairs and after prolonged sitting are all serious concerns(Azab et al., 2022).The Q angle is the angle created by drawing lines from the hip bone (specifically the anterior superior iliac spine) to the center of the kneecap, and from the kneecap down to the bump on the shinbone (the tibial tubercle). It gives an idea of how the thigh muscles, especially the quadriceps, pull on the knee. In general, a normal Q angle is around 14 degrees for men and about 17 degrees for women, due to anatomical differences such as wider pelvis in females. It has long been believed that a high Q angle raises the risk of PFPS because it increases the lateral stresses on the patella(Brenneis et al., 2023)

MATERIAL AND METHODS

This review brings together the most up-to-date evidence on rehabilitation approaches for patellofemoral pain syndrome (PFPS), with special attention to patellar mobilization with movement and open-chain strengthening exercises. Because it enables researchers to compare studies with different designs,outcomemeasures,andtreatmentapproacheswhilestilldevelopingacomprehensive understanding of contemporary physiotherapy practice, a narrative synthesis was selected.(Celik et al., 2020)

A thorough literature search was conducted using sizable academic databases like Google Scholar and Web of Science in order to obtain trust worthy and current evidence. These sources were selected due to their wide coverage in sports science and rehabilitation. Only studies published between 2020 and 2025 were considered, ensuring the review reflected modern clinical approaches. Using terms like PFPS, patellar mobilization, rehabilitation, and open-chain exercises, a well-organized keyword strategy made it easier to find both general research and more specialized sport-related studies.

Although the search was open to all languages at first, only English studies were finally included to keep interpretation consistent.(Chamorro-Moriana et al., 2024)

Multiple types of studies qualified for inclusion, such as clinical trials, review articles, case series, technical reports, and conference papers, as long as they provided practical insight into PFPS rehabilitation. Research focused only on surgery, medications, or purely theoretical concepts was excluded. The screening process first reviewed titles and abstracts, followed by full-text reading of studies that appeared relevant. Reference lists were also checked to capture any studies missed in the database search.(Cheon et al., 2020) Key information from each study, such as author details, research country, participant characteristics, rehabilitation procedures, targeted outcomes, benefits, and reported limitations, was Gathered using a standard data-extraction formatted This made it possible to identify significant themes and produced a fair comparison across various studies. (da Silva Boitrago et al., 2021)

The synthesis heavily relied on the results presented in these studies. The main results looked at muscle strength and knee joint mobility. While isokinetic dynamometers measured the strength of knee extensors and flexors at speeds of 60°/s and 180°/s, goniometer measurements of flexion and extension were used to record knee mobility. Pain and functional ability were the secondary

outcomes, which are crucial for athletes and active people managing PFPS. Pain was rated using a 10-cmVisual Analog Scale, and functional performance was assessed through the Functional Performance Test, which includes activities like single-leg hopping and squatting that reflect real-world movement demands. To determine how the treatment affected the participants' group assignments, baseline and post-intervention assessments were compared. Their expertise helped ensure accuracy and improved the overall reliability of the evidence discussed in the review(da Silva Boitrago et al., 2021)

RESULTS/FINDINGS

Together, the reviewed studies satisfied the eligibility requirements and gave a clear picture of how beneficial patellar mobilization can be for individuals with patellofemoral pain syndrome when combined with movement and open-chain strengthening exercises. A recurring pattern emerged throughout the studies: strengthening the quadriceps and enhancing patellar mechanics are essential for lowering pain and regaining normal knee function. One of the most commonly reported benefits was an increase in knee joint mobility.(de Souza Júnior et al., 2024) Many studies that used patellar mobilization techniques demonstrated noticeable gains in both active flexion and extension. These improvements, typically measured with a universal goniometer, were usually seen after several weeks of treatment(Eurcherdkul et al., 2023)

Enhanced mobility was often linked with smoother patellar tracking, reduced soft-tissue tightness, and overall better joint mechanics. Studies that combined mobilization with strengthening exercises showed even greater progress, emphasizing the importance of addressing both mechanical alignment and neuromuscular control to achieve the best outcomes. Pain reduction was another key outcome reported across the studies. Most researchers observed meaningful decreases in pain scores on the Visual Analogue Scale after the intervention period. Participants frequently reported feeling less uncomfortable when performing daily tasks and more strenuous motions like squatting, climbing stairs, and taking longer walks.(Eurcherdkul et al., 2023)

Patellar mobilization with movement programs frequently resulted in quicker relief, especially for those whose symptoms were associated with issues with patellar tracking. However, individuals with quadriceps weakness responded particularly well to strength-focused interventions, which reduced pain gradually but steadily over time. Overall, the findings indicate that both improving mechanical alignment and strengthening the surrounding muscles play important roles in reducing pain related to patellofemoral pain syndrome.(Fang et al., 2022)

Across all the studies, improvements in functional performance were also frequently emphasized. Numerous participants showed increased tolerance for weight-bearing activities, stronger balance, better single-leg hopping, and improved squat technique. These improvements were frequently associated with a combination of improved muscle strength, decreased pain, and increased joint mobility. Additionally, during dynamic tasks, researchers observed improvements in knee alignment, control, and movement confidence. The most notable functional improvement was consistently achieved by programs that combined patellar mobilization with strengthening, highlighting the significance of a multi-component rehabilitation approach.(Fatimah & Waqqar, 2021)

The literature revealed a few distinct trends. Patellar mobilization with movement was especially effective for restoring patellar glide and correcting tracking problems. Open-chain exercises played an important role in strengthening the quadriceps and correcting muscle imbalances—both essential for stabilizing the patellofemoral joint.(Fick et al., 2022)The majority of improvements were seen within four to eight weeks, which is consistent with the typical timelines for mechanical correction and neuromuscular adaptation. Interventions that combined these two

strategies consistently produced better results than using either method alone. The review did note some limitations, though, such as small sample sizes in some studies, differences in exercise regimens, and a lack of long-term follow-up in many(Ghourbanpour et al., 2018)

DISCUSSION

The results of the study demonstrated that for patients with patellofemoral pain syndrome, both open and closed kinetic chain exercises were beneficial in lowering pain and enhancing motor function.

However, closed kinetic chain exercises produced noticeably better results, with greater pain reduction and more meaningful improvements in functional activities. This stronger effect may be due to the added joint stability and the more natural, weight-bearing movement patterns involved in closed chain exercises. The overall effectiveness of structured strengthening programs was confirmed by the fact that both exercise groups outperformed the control group. Overall, the findings indicate that closed kinetic chain exercises might be a better choice for PFPS recovery(Hong et al., 2023)

This review also found that joint mobilization can help reduce pain and improve function, especially when it is part of a larger treatment plan that includes other types of treatment. Most studies showed that the groups that got mobilization did better, but the biggest benefits were usually seen in the short term when mobilization was aimed directly at the knee. These findings underscore the importance of integrating manual therapy with additional rehabilitation approaches to optimize results. the exact independent effect of joint mobilization remains somewhat uncertain because of differences in study methods and variations in the quality of reporting These inconsistencies across trials make it difficult to generalize the results to all patients. More future research using standardized protocols and stronger study designs is needed to better define the specific contribution of joint mobilization(Jayaseelan et al., 2020)

Another study reported that patella mobilization techniques produced significant short-term reductions in pain and noticeable improvements in function for individuals with PFPS .Both groups receiving MWM showed better VAS and LEFS outcomes than the control group, highlighting how effective this manual therapy technique can be. These findings corroborate previous research demonstrating that manual therapy, particularly when combined with targeted exercises, can significantly improve rehabilitation outcomes. Despite the fact that the two intervention groups performed hip- or knee- focused exercises differently, their results were nearly identical, indicating that the MWM technique itself is the primary factor behind early improvements. The slight variations between knee-focused and hip-focused exercise regimens imply that both areas probably support functional recovery.(Zahid et al., 2025)

Patella mobilization techniques significantly reduced short-term pain and significantly improved function for people with PFPS, according to another study. The VAS and LEFS results for both MWM-treated groups were superior to those of the control group, demonstrating the efficacy of this manual therapy approach. These results support earlier studies showing that manual therapy can greatly enhance rehabilitation results, especially when paired with focused exercises. The two intervention groups performed hip- or knee-focused exercises differently, but their outcomes were almost the same, suggesting that the MWM technique is the main cause of early gains. The slight variations between knee-focused and hip-focused exercise regimens imply that both areas probably support functional recovery.(Zago et al., 2020)

CONCLUSION

This study shows that closed kinetic chain exercises and manual therapy techniques especially MWM are highly effective in reducing pain and improving function in people with PFPS. Closed chain exercises outperform open-chain approaches because they provide more

joint stability and mimic natural movement patterns. Joint mobilization also helps, especially when incorporated into a broader rehab plan, though its exact independent effect is still uncertain due to inconsistent research methods. Overall, the best results come from combining closed chain strengthening with manual therapy. Since PFPS has varied causes, treatment should be individualized, and future research should focus on functional, task-specific mobilization strategies.(Akhavan Hariri et al., 2023)

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