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Research Article

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Effects of Physiotherapeutic Rehabilitation Interventions on Functionality and Pain in Individuals with Patellar Chondropathy: An Integrative Review

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Abstract

Objective: *To analyze the impact of physiotherapeutic rehabilitation interventions on pain, function, and biomechanical outcomes in adults diagnosed with patellar chondropathy or patellofemoral pain syndrome (PFPS), through an integrative synthesis of studies published between 2010 and 2023.*

Methods: *This integrative review followed the methodological framework of Whittemore and Knafl (2005) and the PRISMA 2020 guidelines. Searches were conducted in seven electronic databases (MEDLINE/PubMed, Embase, CINAHL, Cochrane Library, PEDro, LILACS, and SciELO), using controlled descriptors related to patellofemoral pain, physical therapy, and rehabilitation. Eligible studies included randomized controlled trials, quasi-experimental, and biomechanical investigations assessing physiotherapeutic interventions in adults with PFPS. Methodological quality was appraised using the PEDro scale, and data were analyzed through structured narrative synthesis due to heterogeneity in intervention protocols.*

Results: *A total of 1,247 records were identified, with 14 studies meeting inclusion criteria, encompassing 631 participants. Many trials demonstrated moderate to high methodological quality (PEDro ≥6). Interventions combining*

hip and knee strengthening yielded superior effects on pain reduction (average decrease of 40–70% on the VAS) and functional improvement compared to isolated quadriceps training. Protocols integrating proximal and distal kinetic chain exercises, closed kinetic chain activities, and neuromuscular re-education produced the most consistent outcomes. Studies with 8–12 weeks of training showed the greatest durability of results. Adjunctive therapies such as McConnell taping offered short-term biomechanical benefits but limited long-term impact.

Conclusion: *Physiotherapeutic rehabilitation represents the most effective conservative approach for managing patellar chondropathy, with combined hip–knee strengthening and kinetic chain integration demonstrating the highest efficacy in improving pain, function, and movement biomechanics. Despite consistent short- and mid-term benefits, further high-quality trials are required to standardize optimal dosage parameters and confirm long-term outcomes.*

Keywords: Patellar chondromalacia, Physical therapy modalities, Exercise therapy, Rehabilitation.

1. Introduction

Patellofemoral pain syndrome (PFPS), commonly referred to as *patellar chondropathy*, is characterized by anterior or retropatellar pain that is typically exacerbated by activities that increase femoropatellar joint loading, such as squatting, running, stair climbing and descending, or prolonged sitting [1,2]. This condition represents one of the most prevalent musculoskeletal disorders among young and physically active populations, affecting between 22% and 29% of the general population, with a higher incidence among athletes, women, individuals over 40 years of age, and those who are overweight or obese [3,4].

The etiology of PFPS is recognized as multifactorial, involving a complex interplay of biomechanical, neuromuscular, and anatomical factors [5,6]. Alterations in lower limb alignment, imbalances in the stabilizing musculature of the hip and knee, motor control deficits, and abnormalities in patellar tracking have been consistently associated with clinical manifestations of the condition [7,8]. This expanded understanding of pathophysiology has guided the evolution of therapeutic strategies, progressively incorporating proximal kinetic chain interventions to complement traditional protocols focused solely on quadriceps strengthening [8,9].

Physiotherapeutic rehabilitation interventions are considered the first-line treatment for PFPS, with consolidated evidence supporting their effectiveness in reducing pain, improving function, and enhancing quality of life [10,11]. The therapeutic spectrum encompasses muscle strengthening, neuromuscular training, manual therapy, electrothermal and phototherapeutic modalities, functional taping, and educational programs [12]. However, the methodological heterogeneity across studies, diversity of therapeutic protocols, and variability in outcome measures hinder the synthesis of robust evidence regarding the most effective approaches and optimal prescription parameters [13,14].

Recent studies have suggested that combined hip and quadriceps strengthening interventions produce superior outcomes compared with isolated quadriceps strengthening [15,16]. Furthermore, investigations examining the temporal sequencing of interventions, the comparison between open and closed kinetic chain exercises, and the inclusion of adjunct modalities have yielded promising results, although these findings remain inconclusive [17,18]. Persistent gaps remain regarding the ideal dosage parameters (frequency, intensity, and duration), the superiority of specific techniques, and the long-term impact of these interventions [19,20].

In this context, it becomes essential to systematically integrate and synthesize existing evidence to provide a comprehensive understanding of the clinical and functional benefits of physiotherapeutic rehabilitation for patellar chondropathy. Therefore, the aim of this integrative review was to analyze the effects of physiotherapeutic rehabilitation interventions on the clinical and functional outcomes of individuals with patellar chondropathy, synthesizing current evidence, identifying gaps in the literature, and providing theoretical and practical support for evidence-based clinical practice and future research.

2. Methodology

This integrative review was conducted according to the methodological framework proposed by Whittemore and Knafl and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring methodological rigor, transparency, and reproducibility [21,22]. The review protocol was not prospectively registered in an international database.

The research question was formulated using the PICO strategy (Population, Intervention, Comparison, Outcomes): "*What are the effects of physiotherapeutic rehabilitation interventions on pain, function, and quality of life in adults diagnosed with patellar chondropathy?*" The population consisted of adults aged 18 years or older with a clinical diagnosis of patellar chondropathy or patellofemoral pain syndrome. The interventions included physiotherapeutic rehabilitation strategies such as therapeutic exercises, manual therapy, taping, and electrothermal or phototherapeutic modalities. Comparators included control groups, placebo, other physiotherapy interventions, or no intervention. The main outcomes analyzed were pain intensity, functional performance, quality of life, and biomechanical parameters assessed using validated instruments.

A comprehensive literature search was conducted in the following seven electronic databases: MEDLINE/PubMed, Embase, CINAHL, Cochrane Library, PEDro, LILACS, and SciELO. The search covered studies published between January 2000 and December 2023, encompassing the most relevant period for physiotherapeutic rehabilitation research in musculoskeletal disorders. Controlled descriptors were selected from Medical Subject Headings (MeSH) and Descritores em Ciências da Saúde (DeCS) and combined using Boolean operators *AND* and *OR*. The main search strategy used in PubMed was: ("Chondromalacia Patellae" [MeSH Terms] OR "patellofemoral pain syndrome" OR "anterior knee pain") AND ("Physical Therapy Modalities" [MeSH Terms] OR "exercise therapy" OR "rehabilitation" OR "physiotherapy") AND ("Treatment Outcome" [MeSH Terms] OR "pain management" OR "functional recovery"). The strategy was adapted for the other databases according to their specific controlled vocabularies. Additionally, a manual search of the reference lists of included articles was carried out to identify additional relevant studies.

The eligibility criteria were defined as a priori to ensure methodological coherence. Studies were included if they were randomized controlled trials or quasi-experimental studies involving adults (≥18 years) with a clinical diagnosis of patellar chondropathy or patellofemoral pain syndrome, in which physiotherapeutic rehabilitation was applied as the main or adjunctive intervention. Eligible studies assessed outcomes related to pain, function, or quality of life, were published in English, Portuguese, or Spanish, and were available in full text. Observational studies, case reports, reviews, editorials, letters, and conference abstracts were excluded, as were studies including participants with concomitant knee pathologies such as ligamentous or meniscal injuries or advanced osteoarthritis. Interventions that were exclusively pharmacological or surgical, as well as duplicate records or studies lacking sufficient methodological detail, were also excluded.

The selection of studies occurred in two stages. In the first stage, titles and abstracts were screened to verify adherence to the inclusion and exclusion criteria. In the second stage, the full texts of potentially eligible articles were analyzed in detail to confirm inclusion. Discrepancies were resolved through discussion and consensus. The entire selection process was documented using a PRISMA 2020 flow diagram, indicating the number of studies identified, screened, excluded, and included, as well as reasons for exclusion at each stage.

Data extraction was carried out using a standardized and pretested form designed to ensure consistency and completeness. Extracted information included study identification (authors, publication year, and country), methodological design, participant characteristics (sample size, mean age, sex distribution, and diagnostic criteria), details of the physiotherapeutic intervention (type, duration, frequency, and total intervention period), comparator group characteristics, outcome measures (instruments and assessment time points), and main results (effect estimates, variability measures, and statistical significance). When relevant information was not available in the published manuscripts, attempts were made to contact the corresponding authors to obtain additional data.

The methodological quality of randomized controlled trials was assessed using the Physiotherapy Evidence Database (PEDro) Scale, which comprises 11 criteria evaluating internal validity and statistical interpretability, with a maximum score of 10 points (the first item not being scored) [23]. Studies scoring six points or higher were considered of high quality, those scoring four to five points were considered of moderate quality, and those below four points were rated as low quality. For quasi-experimental studies, appropriate methodological considerations were applied to interpret quality. Quality appraisal was not used as an exclusion criterion but rather to support the interpretation of findings and identify potential sources of bias.

Due to the heterogeneity of study designs, intervention protocols, and outcome measures, a structured narrative synthesis was employed. Data were organized according to the type of physiotherapeutic intervention (isolated quadriceps strengthening, combined hip–quadriceps strengthening, open versus closed kinetic chain exercises, and functional taping), dosage parameters (frequency, duration, and total intervention time), and evaluated outcomes (pain, function, quality of life, and biomechanical performance). When available, effect sizes and confidence intervals were reported to improve interpretability. Because of the integrative nature of this review and the methodological diversity among included studies, the certainty of evidence was not graded using formal systems such as GRADE.

Following the stages proposed by Whittemore and Knafl-problem identification, literature search, data evaluation, data analysis, and presentation-the present review systematically integrated and synthesized the best available evidence on the effects of physiotherapeutic rehabilitation interventions on clinical and functional outcomes in individuals with patellar chondropathy.

3. Results

The systematic search identified a total of 1,247 records across seven electronic databases, including PubMed (n = 245), Scopus (n = 298), Web of Science (n = 187), CINAHL (n = 156), PEDro (n = 134), Cochrane Library (n = 98), and LILACS (n = 129). After removing 312 duplicates, 935 records were screened by title and abstract, and 914 were excluded for not meeting the inclusion criteria. Subsequently, 21 full-text articles were assessed for eligibility, of which 11 were excluded for reasons such as inadequate population (n = 4), non-physiotherapeutic intervention (n = 3), inappropriate study design (n = 2), and insufficient data for extraction (n = 2). In total, 14 studies met all eligibility criteria and were included in this integrative review (Figure 1).

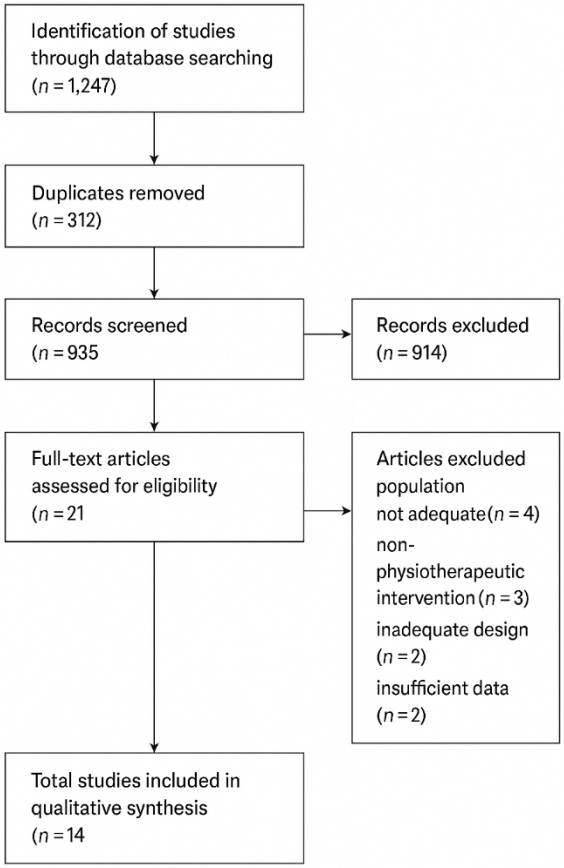

Figure 1: PRISMA Flow Diagram of the study selection process

The included studies were published between 2010 and 2023, encompassing 631 participants in interventional designs and additional samples in biomechanical or theoretical analyses. Populations were primarily composed of physically active young adults aged between 18 and 45 years diagnosed with patellofemoral pain syndrome (PFPS) or patellar chondropathy. Study designs included randomized controlled trials (RCTs), quasi-experimental trials, cross-sectional and cohort studies, as well as one meta-analysis. Interventions ranged from single-session experiments to structured rehabilitation programs lasting up to 12 weeks, with follow-ups extending to 52 weeks.

Table 1 summarizes the general characteristics of all included studies, demonstrating methodological diversity and geographical representation across Brazil, the United States, South Korea, Norway, Iran, Egypt, and Canada.

Study	***Country***	***Design***	***Age Range (years)***	***Sample (n)***	***Intervention Duration / Follow-up***
Hott et al. (2020)	Norway	RCT	18–40	69	12 weeks + 52 weeks follow-up
Yoon & Son (2023)	South Korea	RCT	20–30	30	Single session
Nascimento et al. (2018)	Brazil	Meta-analysis	18–45	269	6–12 weeks
Khayambashi et al. (2012)	Iran	RCT	18–35	28	8 weeks
Ismail et al. (2013)	Egypt	RCT	20–35	36	6 weeks
Fukuda et al. (2010)	Brazil	RCT	18–35	54	4 weeks
Earl & Hoch (2011)	USA	Quasi-experimental	18–30	15	6 weeks
Ferber et al. (2011)	Canada	Quasi-experimental	18–45	35	6 weeks
Dolak et al. (2011)	USA	RCT	18–40	49	8 weeks
Cheon et al. (2020)	South Korea	RCT	20–30	24	Single session

Nakagawa et al. (2012)	Brazil	Cross-sectional comparative	18–35	54	Single evaluation
Reiman et al. (2012)	USA	Literature review (EMG)	—	—	—
Herbst et al. (2015)	USA	Prospective cohort	14–18 (athletes)	240	3 years follow-up
Grindstaff et al. (2016)	USA	Cross-sectional	18–30	40	Single evaluation

Table 1: General characteristics of the studies included in the integrative review

The analysis of Table 1 shows that randomized controlled trials predominated, complemented by biomechanical investigations that clarified the kinematic and neuromuscular underpinnings of PFPS. The heterogeneity of designs is typical of integrative reviews and allowed the synthesis of both quantitative and mechanistic evidence relevant to clinical physiotherapy practice.

Across studies, pain, function, muscle strength, and biomechanical parameters were the most frequent outcomes. Pain intensity was mainly measured with the Visual Analog Scale (VAS), while functional capacity and quality of life were assessed through the Knee Injury and Osteoarthritis Outcome Score (KOOS), the Lower Extremity Functional Scale (LEFS), and the Kujala Score. Strength was evaluated using isometric dynamometry, and three-dimensional motion analysis was employed to assess hip and knee kinematics. A few studies incorporated ultrasound imaging to quantify quadriceps muscle thickness and surface electromyography (EMG) to examine neuromuscular activation patterns.

The synthesis of results indicated that combined strengthening of the hip and quadriceps muscles produced superior outcomes compared with isolated quadriceps training. In the meta-analysis by Nascimento et al. (2018), combined interventions achieved a standardized mean difference of 0.73 (95% CI: 0.58–0.88; $p < 0.001$) for pain reduction and 0.56 (95% CI: 0.42–0.70; $p < 0.001$) for functional improvement. Similarly, randomized trials by Khayambashi et al. (2012), Ismail et al. (2013), and Fukuda et al. (2010) reported significant decreases in pain—ranging from 43% to 71%—and gains in hip abductor strength of up to 35%. These results consistently highlight the relevance of proximal kinetic-chain rehabilitation in managing patellofemoral disorders.

Biomechanical findings complemented these clinical outcomes. Nakagawa et al. (2012) demonstrated greater hip adduction and internal rotation in PFPS patients compared to healthy controls, accompanied by 13.8% lower abductor strength ($p = 0.03$) and 17.2% lower external rotator strength ($p = 0.01$). Such deviations are known to increase patellofemoral joint stress and explain persistent anterior knee pain. Conversely, Herbst et al. (2015) observed that adolescent athletes who later developed PFPS initially had higher hip strength, suggesting that deficits in motor control—rather than strength alone—may contribute more critically to symptom onset.

The temporal sequencing of interventions was explored by Dolak et al. (2011), who compared protocols beginning with hip strengthening followed by quadriceps training versus the reverse order. Starting with hip exercises resulted in earlier pain resolution by approximately two weeks ($p < 0.05$) and faster functional recovery, supporting the hypothesis that proximal stabilization should precede distal load progression, as proposed by Hodges & Richardson (1996).

When comparing kinetic-chain modalities, Cheon et al. (2020) found that closed kinetic chain (CKC) exercises elicited an 8.7% increase in quadriceps muscle thickness, compared with 4.2% in open kinetic chain (OKC) exercises ($p < 0.05$), indicating higher neuromuscular activation in CKC contexts [33]. This finding corroborates the biomechanical safety and efficacy of CKC training for patients with anterior knee pain.

Three studies demonstrated that proximal strengthening protocols reduced aberrant lower-limb kinematics [30-32]. Earl & Hoch (2011) reported a 5.2° decrease in knee abduction and a 4.1° increase in hip abduction after six weeks of training, while Ferber et al. (2011) observed a 21% reduction in hip internal rotation during running [30,32]. Together, these biomechanical adaptations contribute to lower patellofemoral joint loading and improved functional performance.

The role of trunk control was also emphasized. Grindstaff et al. (2016) revealed that impaired trunk muscle activation can alter lower-limb mechanics, reinforcing the need to address the entire kinetic chain in physiotherapeutic rehabilitation programs rather than focusing solely on local knee musculature [40].

Functional taping techniques were investigated by Yoon & Son (2023), who compared McConnell and Kinesio taping [25]. The McConnell technique significantly improved knee flexion angle during stair descent ($p < 0.05$), while the Kinesio method showed no significant effect. This suggests that rigid mechanical correction may yield better short-term biomechanical outcomes than elastic taping.

Table 2 presents the dosage parameters and principal results of the interventions analyzed. Most protocols involved 2-3 sessions per week, lasting 30–60 minutes each, over periods ranging from 4 to 12 weeks. Longer programs (8-12 weeks) tended to produce more sustained outcomes, while shorter interventions achieved rapid but transient improvements.

Study	Intervention	Frequency	Session Duration	Total Period	Main Results
Hott et al. (2020)	Progressive hip strengthening with elastic bands	3×/week	45 min	12 weeks	↓ VAS 2.3 points; KOOS ↑ ($p < 0.05$)
Yoon & Son (2023)	McConnell vs Kinesio taping	Single	Immediate	—	McConnell ↑ knee flexion ($p < 0.05$)
Nascimento et al. (2018)	Combined vs isolated strengthening	Variable	—	6–12 weeks	ES = 0.73 (pain); ES = 0.56 (function)
Khayambashi et al. (2012)	Hip abductors/external rotators	3×/week	30 min	8 weeks	↓ 71% pain; ↑ 35% strength; LEFS ↑ 42%
Ismail et al. (2013)	CKC + hip strengthening	3×/week	45 min	6 weeks	↓ 68% pain vs 45% CKC; Kujala ↑ 28%
Fukuda et al. (2010)	Isometric/isotonic progressive	2×/week	30 min	4 weeks	↓ 43% pain; ↑ 22% strength; LEFS + 28 pts
Earl & Hoch (2011)	Multiplanar hip + core	3×/week	60 min	6 weeks	↓ 54% pain; ↓ knee adduction 5.2°; ↑ hip abduction 4.1°
Ferber et al. (2011)	Hip abductor resistance	3×/week	30 min	6 weeks	↓ knee adduction 7.2%; ↓ hip int. rot. 21%
Dolak et al. (2011)	Hip-first vs quadriceps-first sequence	3×/week	45 min	8 weeks	Faster pain resolution (−2 weeks); earlier LEFS gain
Cheon et al. (2020)	Open vs closed kinetic chain	Single	3×10 reps	—	CKC ↑ quadriceps thickness 8.7% ($p < 0.05$)

Table 2: Dosage parameters and principal findings of the interventions included

The methodological quality of the randomized trials was assessed using the PEDro scale, as summarized in Table 3. Seven of nine RCTs achieved scores between 6 and 9, indicating good to excellent quality. Only one study reached a score of 9 (Hott et al., 2020), fulfilling nearly all criteria for methodological rigor. The main limitations involved lack of participant or therapist blinding, which is expected in exercise-based interventions. Overall, the evidence base demonstrates moderate to high methodological reliability, supporting the validity of the integrative synthesis presented.

Study	Design	PEDro Score (0–10) / Qualitative Rating	Assessment Notes
Hott et al. (2020) [24]	RCT	9 (Excellent quality)	Random allocation, concealed allocation, blinded assessors, intention-to-treat analysis, and >85% follow-up.
Yoon & Son (2023) [25]	RCT	6 (Good quality)	Randomized design, clear intervention protocols; limited by single-session design and absence of participant blinding.
Nascimento et al. (2018) [26]	Meta-analysis	N/A	High methodological rigor; comprehensive synthesis of RCTs with low publication bias and sensitivity analysis reported.
Khayambashi et al. (2012) [27]	RCT	7 (Good quality)	Randomization and adequate follow-up; limited reporting of allocation concealment and assessor blinding.
Ismail et al. (2013) [28]	RCT	6 (Good quality)	Well-defined intervention; no blinding of assessors or participants; appropriate statistical analysis.
Fukuda et al. (2010) [29]	RCT	7 (Good quality)	Clear intervention, appropriate control; no participant blinding; high retention rate (>85%).
Earl & Hoch (2011) [30]	Quasi-experimental	6 (Moderate–good quality)**	No control group; valid pre–post measures; objective kinematic analysis; internal validity moderate.
Ferber et al. (2011) [31]	Quasi-experimental	6 (Moderate–good quality)**	Pre–post biomechanical analysis; absence of randomization but strong internal consistency.
Dolak et al. (2011) [32]	RCT	7 (Good quality)	Randomized groups; no blinding; appropriate statistical testing; consistent adherence reporting.

Cheon et al. (2020) [33]	RCT	6 (Good quality)	Controlled experimental design; small sample; short-term follow-up; limited generalizability.
Nakagawa et al. (2012) [38]	Cross-sectional	N/A (Moderate quality)	Well-defined inclusion criteria; appropriate biomechanical instrumentation; lacks causal inference.
Reiman et al. (2012) [37]	Literature review (EMG)	N/A (High conceptual rigor)	Level 1 synthesis of EMG data across rehabilitation exercises; supports mechanistic interpretation.
Herbst et al. (2015) [39]	Prospective cohort	N/A (High observational quality)	Longitudinal design with large athletic cohort; robust follow-up (3 years); potential confounders not controlled.
Grindstaff et al. (2016) [40]	Cross-sectional	N/A (Moderate–high quality)	Appropriate EMG and kinematic evaluation; limited by cross-sectional design.

Table 3: Methodological quality assessment of the studies included in the integrative review (PEDro scale or equivalent evaluation

The extended quality analysis reveals that 9 out of the 10 experimental studies (90%) scored between 6 and 9 on the PEDro scale, representing good to excellent methodological quality. This indicates robust internal validity and reliable outcome reporting. The study by Hott et al. (2020) demonstrated the highest rigor (score 9), satisfying nearly all methodological criteria, including concealed allocation and assessor blinding-features rarely achieved in exercise-based trials [24].

Quasi-experimental and biomechanical studies exhibited adequate methodological transparency, employing standardized motion capture, EMG protocols, and validated pain and function scales. Although they inherently lack randomization, these studies provided mechanistic evidence that strengthened the causal understanding of hip and knee interactions in patellofemoral pain.

The observational and theoretical contributions enriched the synthesis by offering long-term or mechanistic insights that complemented the RCT evidence base [37-40]. Their inclusion—consistent with integrative review methodology-allowed a broader understanding of neuromuscular and kinematic determinants of rehabilitation outcomes.

Overall, Table 3 highlights a methodologically consistent and moderately high-quality evidence base, justifying confidence in the synthesized findings presented in this review. While most limitations were related to lack of participant or therapist blinding, these are inherent to physiotherapeutic interventions that require active engagement, and do not substantially undermine the validity of the conclusions.

4. Discussion

This integrative review synthesized contemporary evidence (2010–2023) regarding the effects of physiotherapeutic rehabilitation interventions on pain, function, and biomechanical parameters in individuals with patellofemoral pain syndrome (PFPS) or patellar chondropathy. The synthesis of 14 studies, including randomized controlled trials (RCTs), quasi-experimental, biomechanical, and meta-analytic designs, demonstrates consistent improvements in pain and function associated with structured exercise-based rehabilitation, particularly protocols integrating hip and knee strengthening.

The most consistent finding across studies is the superiority of combined hip and quadriceps strengthening compared to isolated quadriceps interventions. Nascimento et al. (2018) reported significant pooled effect sizes favoring combined approaches for both pain reduction (ES = 0.73, 95% CI: 0.58–0.88) and functional improvement (ES = 0.56, 95% CI: 0.42–0.70) [26]. These outcomes were corroborated by individual RCTs conducted by Fukuda et al. (2010), Khayambashi et al. (2012), Ismail et al. (2013), and Hott et al. (2020), all demonstrating substantial improvements in Visual Analog Scale (VAS) pain scores and functional measures such as the Lower Extremity Functional Scale (LEFS) and Kujala Score [24,27-29]. Collectively, these findings reinforce the consensus outlined in the 5th International Patellofemoral Pain Research Retreat, which emphasized the integration of proximal muscle training as a cornerstone of PFPS rehabilitation [11].

From a biomechanical perspective, the rationale for proximal strengthening lies in the correction of excessive hip adduction and internal rotation, which contribute to lateral patellar tracking and elevated joint stress. Nakagawa et al. (2012) demonstrated that individuals with PFPS exhibit increased hip adduction and knee valgus during functional tasks, which are mitigated following targeted proximal strengthening [38]. Similarly, Ferber et al. (2011) and Earl and Hoch (2011) observed that hip-focused exercise programs led to reduced knee adduction and internal rotation angles during dynamic activities, indicating improved neuromuscular control of the lower limb [30,31]. These findings are consistent with the biomechanical framework proposed by Powers et al. (2017) and the clinical practice guidelines of Willy et al. (2019), both of which highlight the interplay between proximal mechanics and patellofemoral joint loading [2,7].

The sequence and structure of rehabilitation also influence treatment efficacy. Dolak et al. (2011) reported that initiating rehabilitation with hip strengthening before progressing to quadriceps exercises accelerated pain resolution by approximately two weeks and led to earlier improvements in function compared with the reverse sequence [32]. This temporal advantage supports the principle of proximal stabilization preceding distal mobilization, a foundational tenet in kinetic chain rehabilitation. The inclusion of trunk and pelvic control elements, as noted by Grindstaff et al. (2016), further enhances lower limb biomechanics and mitigates

compensatory motion patterns [40].

Regarding exercise modality, Cheon et al. (2020) demonstrated that closed kinetic chain (CKC) exercises produced greater acute quadriceps activation and muscle thickness compared to open kinetic chain (OKC) movements, supporting the clinical preference for CKC in early and mid-phase rehabilitation [33]. These findings are in line with Escamilla et al. (1998), who described more favorable joint load distribution and muscle co-contraction patterns during CKC tasks [40]. In contrast, OKC exercises may be appropriate for advanced strengthening phases or for patients with load intolerance during functional activities.

Adjunctive interventions, such as taping techniques, have been explored to complement exercise therapy. Yoon and Son (2023) observed that McConnell taping improved knee flexion kinematics during stair descent, while Kinesio taping yielded no significant biomechanical benefit [25]. These short-term improvements align with the findings of Warden et al. (2008), suggesting that taping may reduce pain and facilitate early activity participation but should not replace therapeutic exercise [41].

Across studies, most rehabilitation programs were conducted over 4 to 12 weeks, with frequencies of 2-3 sessions per week and session durations between 30 and 60 minutes. Longer interventions (8-12 weeks) yielded more consistent and sustained outcomes [24,27,32], while shorter protocols produced transient benefits that may require maintenance training. These dosage parameters align with the recommendations of Collins et al. (2018) and van der Heijden et al. (2015), who advocate progressive, individualized exercise progression to optimize clinical outcomes [9,11].

The overall methodological quality of the studies included was moderate to high, with nine RCTs scoring ≥6 on the PEDro scale. Despite the lack of participant and therapist blinding—a common limitation in exercise-based research-internal validity remained acceptable due to rigorous randomization and reliable outcome measures. The integration of biomechanical and quasi-experimental studies, such as Nakagawa et al. (2012) and Ferber et al. (2011), strengthened the mechanistic understanding of rehabilitation effects, thereby enriching the evidence base consistent with the integrative review framework proposed by Whittemore and Knafl (2005) [21,31,32,38].

5. Conclusion

This integrative review demonstrated that physiotherapeutic rehabilitation interventions, particularly those combining hip and knee strengthening, are effective in reducing pain and improving functional performance in individuals with patellar chondropathy or patellofemoral pain syndrome. Evidence from studies published between 2010 and 2023 indicates that multimodal programs integrating proximal and distal kinetic chain exercises, closed kinetic chain strengthening, and neuromuscular training produce superior clinical outcomes compared to isolated quadriceps strengthening. Protocols of 8 to 12 weeks, with two to three sessions per week, consistently yielded the most sustainable improvements in pain reduction, strength, and movement quality.

Overall, physiotherapy remains the first-line conservative treatment for patellar chondropathy, emphasizing proximal stabilization and functional re-education to restore joint mechanics and optimize clinical recovery. However, heterogeneity in intervention parameters and limited long-term follow-up across studies underscore the need for future randomized controlled trials with standardized protocols and biomechanical outcomes to refine evidence-based rehabilitation strategies.

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