

[LITERATURE REVIEW]

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Evaluation of the Scope and Quality of Systematic Reviews on Nonpharmacological Conservative Treatment for Patellofemoral Pain Syndrome

Patellofemoral pain syndrome (PFPS) is the most common diagnosis of knee pain found in the orthopaedic clinical setting,³⁰ usually developing with an insidious onset.^{13,21} The condition commonly affects adolescents and young adults,^{13,63} and is defined by the presence of pain in the retropatellar or peripatellar region during tasks that increase patellofemoral joint loading,²³ such

as walking, running, negotiating stairs, squatting, prolonged sitting, and kneel-

ing.^{13,35} Causes of PFPS are thought to be multifactorial, including footwear,¹³ pa-

tella alignment and structure,^{13,30,79} soft tissue flexibility,^{13,30} neuromuscular control of the vastii,^{13,30} lower extremity kinematics,^{51,64,74,78} and flexibility of the lower extremity musculature.^{13,63} The multitude of potential contributing factors to PFPS has led to varied treatment approaches.

Conservative physical therapy treatment is the most common management strategy for PFPS,^{13,30} with interventions including patellar taping,^{13,19,54} exercise,^{13,30,41} vastus medialis oblique biofeedback,¹⁹ patella mobilization,^{13,63} stretching lateral structures of the patellofemoral joint (PFJ),¹³ orthoses designed to control patellar tracking,^{13,23} and foot orthoses aiming to control tibial and femoral rotation in those with excessive pronation,^{23,26,27,47,72} all of which are believed to benefit individuals with PFPS. In response to noted weakness of the hip abductors and external rotators in individuals with PFPS,^{11,46,66} more recent interventions have focused on hip muscle retraining.⁵³ As with many musculoskeletal conditions, multiple biophysical agents, such as ultrasound, electrical stimulation, and ice, are also often used to treat individuals with PFPS.

To optimize patient outcomes for such a complex condition it is essential that therapists be provided with clear guidelines based on the best available evi-

- **STUDY DESIGN:** Systematic literature review.
- **OBJECTIVE:** To evaluate the quality and scope of recently published systematic reviews on the topic of patellofemoral pain syndrome (PFPS) and to provide an overview of their findings.
- **BACKGROUND:** PFPS is a commonly treated condition. There is a large body of literature on conservative nonpharmacological interventions for PFPS, including multiple systematic reviews, which require critiquing and summarizing.
- **METHODS AND MEASURES:** A systematic review of systematic reviews on conservative nonpharmacological treatment strategies for PFPS was performed. Published systematic reviews were identified by searching MEDLINE, EMBASE, CINAHL, SPORTDISCUS, Current Contents, The Cochrane Library, and PEDro electronic databases from the year 2000 until May 2007. Cited reference searches of each author in the Web of Science complemented this search. Review quality was evaluated by a specifically designed scale and only high-quality reviews were retained to validate and summarize reported findings.

- **RESULTS:** Ten reviews met the inclusion criteria. Among them, only 3 were considered to be high quality, covering exercise, foot and knee orthoses, and ultrasound intervention for PFPS. None of the 3 reviews included literature published after the year 2001. Some limited evidence for the use of exercise, exercise combined with taping, and exercise combined with the use of a Protonics brace was found for treatment of individuals with PFPS.
- **CONCLUSION:** Published systematic reviews and clinical trials need to be conducted with more rigorous methodological design. There are no up-to-date, high-quality systematic reviews covering conservative nonpharmacological treatments for individuals with PFPS, which indicates that updates in all areas are needed.
- **LEVEL OF EVIDENCE:** Therapy, level 1a. *J Orthop Sports Phys Ther* 2008;38(9):529-541. doi:10.2519/jospt.2008.2861
- **KEY WORDS:** exercise, literature, orthoses, physical therapy, ultrasound

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TABLE 1

SEARCH STRATEGY AND RESULTS FROM EACH INCLUDED DATABASE

Key Words	MEDLINE (1950- May 2007)	EMBASE (1988- May 2007)	CINAHL (1982- May 2007)	SPORTDiscus (1830-De- cember 2006)	Current Contents (1993-May 2007)
1. arthralgia/ or pain.mp	281574	23660	54296	13198	140569
2. knee joint/ or knee/ or patella/	37810	9454	4354	9739	0
3. 1 and 2	5119	1439	1280	1193	0
4. anterior knee pain.mp.	493	462	211	263	417
5. ((patell\$ or femoropatell\$ or femoro-patell\$ or retropatell\$) adj (pain or syndrome or dysfunction)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	1027	1001	508	682	646
6. ((lateral compression or lateral facet or lateral pressure or odd facet) adj (pain or syndrome or dysfunction)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	16	15	4	7	8
7. ((chondromalac\$ or chondropath\$) adj (knee\$ or patell\$ or femoropatell\$ or femoro-patell\$ or retropatell\$)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	363	730	52	121	232
8. or/3-7	6019	3130	1594	1702	1108
9. exp physiotherapy/ or exp physical therapy/ or exp therapy/ or exp manual therapy/ or manipulation, chiropractic/ or manipulation, orthopedic/ or manipulation, osteopathic/ or exp massage/ or myofascial release/ or exp osteopathy/ or exp cryotherapy/ or exp electrotherapy/ or exp electric stimulation/ or exp home physical therapy/ or exp hydrotherapy/ or exp infrared therapy/ or exp joint mobilization/ or exp therapeutic exercise/ or exp acupuncture/ or exp conservative treatment/ or exp drug therapy/ or exp ultrasound therapy/ or exp rehabilitation/	621217	1808298	118375	19077	0
10. exp "Physical Therapy (Specialty)" / or exp Physical Therapy Modalities/	82145	17342	0	0	0
11. exp exercise/ or exp closed kinetic chain exercise/ or exp exercises/ or exp open kinetic chain exercise/ or exercise\$.mp.	159150	111291	44283	73527	90365
12. Stretch\$.mp. or exp Muscle Stretching/	32506	23227	2688	6073	53713
13. exp STRENGTH/ or exp MUSCLE STRENGTH/ or Strength\$.mp.	126970	98084	19813	28916	259653
14. stabil\$.mp.	235433	199358	7234	5975	451692
15. exp Ultrasonography/ or exp ultrasonic therapy/ or exp ultrasonics/	192057	212179	8679	696	0
16. ((ultrasound or ultrason\$) and (treatment or therapy or intervention)).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	51405	41547	2528	622	29527
17. (orthos?s or orthotics or brace or splint).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	8081	8296	3576	1899	4210
18. (tape or taping).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	11096	5710	2202	1688	10939
19. (massage or mobili?ation or manipulation).mp. [mp=title, original title, abstract, name of substance word, subject heading word]	72599	59994	8920	3638	64960
20. Electric\$ stimulation.mp. or exp Electrostimulation/	113457	30663	3614	1674	17621
21. or/9-20	1425723	2310426	175049	121692	934314
22. 8 and 21	1434	1481	909	686	321
23. limit 22 to (humans and english language and yr="2000-2007")	546	841	642	264	205

dence. Recently there has been a strong emphasis to adopt evidence-based practice behaviors, encouraging therapists to take advantage of the results from existing systematic reviews.^{42,52} The Cochrane Collaboration is an independent international organization dedicated to providing health care professionals with up-to-date and accurate information, primarily via dissemination of unbiased systematic reviews.⁴³ While the Cochrane Collaboration adheres to stringent methods for evaluating and summarizing the evidence,⁵⁴ this may not always be the case with other sources of systematic reviews. Given the large body of literature on PFPS, there have been several published systematic reviews on the nonpharmacological conservative management of this condition. Because the objective of a systematic review is to provide the reader with easily accessible high-quality information,⁶⁹ the quality of each systematic review needs to be evaluated before the conclusions or recommendations can be properly considered. Lower-quality reviews may include articles with known sources of bias²² and introduce bias in their own methodological process, making conclusions potentially invalid.

There is currently no consensus as to a rating scale to use when evaluating the quality of a systematic review. Authors of a few previous systematic reviews of systematic reviews in other areas of health care have not used a quality assessment scale.^{28,29} Other reviews^{45,50} have used a simple scale consisting of 9 items developed by Hoving et al⁴⁵ using the Oxman checklist.⁶¹ Despite its moderate to excellent reliability (weighted kappa statistics between 0.66 and 0.94 for each item), we decided that an improved rating scale of a similar design would be more appropriate for the current systematic review. The rating scale proposed by Hoving et al⁴⁵ required a search of only 1 electronic database and only 1 alternate search (eg, letter to primary authors) for a review to get full credit for comprehensiveness of the search strategy. However, in our opinion, a comprehensive search requires the use

of multiple databases, a range of alternate searches, and a range of key words specific to the review question.^{68,69} Hoving et al's⁴⁵ scale also does not account for aspects related to external validity, including the adequacy of each review's inclusion/exclusion criteria to ensure that only data related specifically to the population in question (eg, PFPS) is retrieved.

Therefore, the objectives of this paper were (1) to develop a novel quality assessment scale for published systematic reviews related to PFPS, (2) to evaluate the quality and scope of recently published systematic reviews on interventions for PFPS, and (3) to provide an overview of findings from high-quality systematic reviews that focused on nonpharmacological conservative treatment for PFPS.

METHODS

Inclusion and Exclusion Criteria

REVIEWS PUBLISHED IN ENGLISH with an unbiased search strategy that was documented and reproducible were included. Non-English and non-peer-reviewed publications were excluded. The inclusion criteria required participants to be described as having the following: retropatellar, peripatellar, or patellofemoral pain; anterior knee pain; patella or patellofemoral dysfunction; chondropathy; or chondromalacia patellae. Each included review needed to focus on PFPS and to include evaluation of primarily nonpharmacological interventions, such as exercise therapy, manual therapy, taping, orthotic devices, ultrasound, or other biophysical agents. Reviews focusing on surgical or pharmacological interventions were excluded.

Search Strategy

MEDLINE, EMBASE, CINAHL, SPORT-DISCUS, and Current Contents electronic databases were searched for the period January 2000 until May 2007. A search for systematic reviews prior to the year 2000 was not deemed valuable, as the aim of this paper was to identify and evaluate only recent reviews. Reviews pub-

lished prior to 2000 were considered to be outdated, given this widely researched topic area. Searching was limited to the English language only to minimize time and costs related to translation.

A search strategy with key words related to diagnosis was taken and modified from Heintjes et al's⁴¹ Cochrane systematic review on exercise therapy for PFPS. To narrow the search, a number of key words related to treatment were applied to each database's search tools to develop the most sensitive search strategy filters for that database. The following key words were explored in database search tools: *physiotherapy, physical therapy, exercise, stretch, strength, stability, ultrasound, electrophysical, electrical orthoses, orthotic, brace, splint, tape, taping, massage, manipulation, and mobilization*. Search words established in each database were then combined to form common sensitive search filters. These filters were combined with the diagnostic key words and used in all databases. The strategy and search results are outlined in **TABLE 1**.

The Cochrane Musculoskeletal Injuries Group register, Cochrane Database of Systematic Reviews, Cochrane Database of Abstracts of Reviews of Effectiveness, and PEDro were searched following the initial database search to ensure that all relevant papers had been identified in the initial electronic search. Key words searched in these registers included *patella, patellofemoral, anterior knee pain, and chondromalacia patellae*.

Following electronic searches, references of included systematic reviews were searched, a cited reference search in the Web of Science (Thomson Reuters, Philadelphia, PA) for each author of reviews found in the electronic search was conducted, and the terms patellofemoral pain syndrome, anterior knee pain, and chondromalacia patellae were searched in the Web of Science.

Unpublished work was not sought in this review. This could potentially lead to publication bias because clinical trials with positive findings are more likely to be published.⁵⁴ However, attempting to

identify unpublished work on the treatment of PFPS from all institutions and authors around the world was deemed impossible.

Review Process

All titles and abstracts initially found through the searches were downloaded into Endnote Version 9 (Thomson Reuters). The set was cross-referenced, and any duplicate references were deleted. Each title and abstract was evaluated for potential inclusion by 2 independent reviewers using the inclusion/exclusion criteria outlined above. If insufficient information was contained in the title and abstract to make a decision on a paper, it was retained until the full text could be obtained for evaluation. Any discrepancy regarding papers was resolved by a consensus meeting between the 2 reviewers. If this failed to resolve the issue, we sought the opinion of a third person. Once all papers of interest were identified, the review was then divided into 2 phases. The first phase was to evaluate the quality of each included review, while the second phase was to summarize and validate the reported findings in reviews considered to be of high quality.

Quality Assessment of Reviews and Scale Development

For the purpose of this review, a novel quality assessment scale was developed specifically to evaluate systematic reviews related to PFPS (TABLE 2). Original criteria for the quality assessment scale were devised from the checklist developed by Oxman,⁶¹ consideration of Hoving et al's⁴⁵ scale, texts addressing quality expectations from systematic reviews,^{68,69} and discussions between 3 reviewers.

The original individual criteria (15 items) were applied by 3 independent reviewers on 10 PFPS reviews. Kappa (κ) statistics and percentage (%) agreement scores (ie, percentage of items which received the same score by all 3 primary reviewers) were calculated to assess reliability prior to any consensus meetings. The reliability and validity of the original

15 criteria were further tested by randomly selecting 1 high-quality (D'Hondt²³) and 2 lower-quality (Overington⁶⁰ and Selfe⁷⁰) reviews for further testing. This selection was based on a similar ratio to the overall quality distribution (3 high quality, 7 lower quality) found following assessment of the 3 primary reviewers using the original 15 criteria. Eight new reviewers with varying backgrounds and research experience who were blinded to consensus quality scores then independently applied the scale without further instruction to the 3 papers. Their results were compared against the 3 primary reviewers' consensus scores using percentage agreement statistics. This process was considered important to validate the wider use of the scale by both health professionals and researchers who were not involved in the scale's development or had not received any training on the use of the scale. The 8 reviewers included 2 physiotherapy doctoral candidates, an orthopaedic surgeon conducting a research fellowship, an orthopaedic surgeon, a postdoctoral research fellow with a background in clinical biomechanics, a university lecturer in physiotherapy, a research officer with a background in physiotherapy, and an honors graduate physiotherapist with 2 years clinical experience.

The original 15-item scale was then modified following results from the above validation process and suggestions from the 8 additional reviewers. All 10 identified reviews scored full marks for logically grouping studies relevant to their primary question, and 9 of 10 reviews scored full points (1 review scoring "in part") for making conclusions relevant to their primary question. Therefore, these criteria were removed as they were thought to be of little value in discriminating between higher- and lower-quality reviews. Originally there were 2 criteria related to the use of a quality assessment scale, 1 related to the explicit description to allow replication and 1 related to the validity and reliability of the scale used. Each of the reviews scored the same for

both criteria (ie, 2 and 2, or 0 and 0), indicating that combining these 2 criteria was warranted. Based on suggestions from the additional reviewers and recommendations in the literature, an additional criterion addressing the inclusion of non-English literature (criterion 5) was included. This left a finalized scale containing 13 items, each worth a total of 2 points, for a possible maximum score of 26 points (TABLE 2).

Following its inclusion, criterion 5 was applied by the 3 primary reviewers independently so that it could be added to the 12 retained items. Kappa and percentage agreement statistics were calculated for the new criterion prior to a consensus meeting for this item. Intraclass correlation coefficients ($ICC_{3,1}$), corresponding 95% confidence intervals, and percentage agreements were used to assess the reliability of the overall scores for both the finalized 13-item scale and the original 15-item scale. Following application of the final scale to all 10 included trials by the 3 reviewers and consensus meetings, a score equal or greater than 20 on the 26-point scale was considered high quality. It was thought that this cutoff score would require reasonable quality scores for all aspects of the scale, and that this threshold clearly separated high-quality reviews from lower-quality reviews in the current sample.

Data Analysis

Phase 1 The following information was extracted from all included systematic reviews: databases used, alternate searches used, diagnostic key words used, inclusion/exclusion criteria, number of reviewers, quality assessment scale used, groupings/comparisons of treatment interventions, whether effect sizes and confidence intervals were reported, and conclusions made.

Phase 2 Only systematic reviews found to be of high quality on the quality assessment scale were included in phase 2 data analysis and only data related to pain, functional outcome measures, disability questionnaires, or treatment satisfaction

TABLE 2

QUALITY ASSESSMENT SCALE FOR SYSTEMATIC REVIEWS*

Criteria	Yes	In Part	No	Total
Were the search methods used to find evidence (original research) on the primary question(s) stated?				
1. Explicitly described to allow replication (ie, 100% confident that you could replicate it). If explained but you can't be 100% confident of replication = in part	_____	_____	_____	_____
Was the search for evidence comprehensive?				
2. Adequate number and range of databases (3 = in part, >3 = yes). Search engines which rely on other databases (eg, PEDro) not applicable	_____	_____	_____	_____
3. Alternative searches such as manual searches, Web of Science, reference lists, contact of prominent authors or other sources of information (1 of these = in part, 2 or more = yes)	_____	_____	_____	_____
4. Adequate range of key words (search likely to be sensitive). At least 2 of patellofemoral, patella peripatellar, retropatellar, knee, anterior knee pain, arthralgia, chondromalacia patellae, and chondropathy = in part, 4 or more = yes	_____	_____	_____	_____
5. Non-English language papers included in the search. Must explicitly state that no language restrictions were applied, or something of similar meaning to score yes	_____	_____	_____	_____
Were the criteria for deciding which studies to include in the overview reported?				
6. Explicitly described to allow replication (unambiguous). If described but not 100% clear = in part	_____	_____	_____	_____
7. Excludes reviews which do not adequately address inclusion (diagnosis of patellofemoral pain syndrome) and exclusion (previous knee surgery or any other sources of knee pathology, eg, patella tendonopathy, osteoarthritis, etc) criteria. One of inclusion or exclusion = in part, both = yes	_____	_____	_____	_____
Was bias in the selection of articles avoided?				
8. Two independent reviewers	_____	_____	_____	_____
Were the criteria used for assessing the quality of included studies reported?				
9. Explicitly described to allow replication. If described scale is not valid, and/or reliability not reported, score = in part	_____	_____	_____	_____
Were the methods used to combine and/or compare the findings of relevant studies appropriate?				
10. Meta-analysis conducted on only homogenous data or limitations to homogeneity discussed	_____	_____	_____	_____
11. Confidence intervals/effect sizes reported where possible	_____	_____	_____	_____
Were conclusions made by the author(s) appropriate?				
12. Supported by the meta-analysis or other data analysis findings (effect sizes, confidence intervals, etc) in the review. If only significance levels relied upon = in part	_____	_____	_____	_____
13. Conclusions address levels of evidence for each intervention/comparison (eg, level A-D evidence, strong-weak evidence, etc)	_____	_____	_____	_____
	Total:	_____	_____	_____

*Scoring: yes, 2; in part, 1; no, 0.

were extracted. Once the descriptive statistics were extracted, they were then crosschecked against the original papers to ensure that they had been reported and calculated accurately. Homogeneity of any pooled data and the level of logic used for grouping study findings was also verified. These processes were used to ensure any conclusions made in the high-quality systematic reviews were valid. Only conclusions from high-quality systematic reviews that were validated by the above processes were to be considered accurate. Non-English language papers were only to be included in this crosschecking process if translated copies were available.

RESULTS

Review Selection and Identification

THE INITIAL SEARCH YIELDED 2070 citations. Following application of the inclusion/exclusion criteria to each citation's title and abstract, this number was reduced to 13. After viewing full texts and reaching consensus, the final yield was 10 reviews. Only 1 discrepancy existed during the selection of reviews, and this was the failure to include the review by Bolga et al¹⁰ by 1 of the 2 reviewers selecting trials. After application of the quality assessment scale, 3 systematic reviews^{12,23,41} were retained as high-quality reviews. These were all

Cochrane reviews covering the topics of therapeutic ultrasound, exercise therapy, and orthotic devices for the treatment of PFPS.

Quality Assessment Scale Validation and Methodological Quality A breakdown of scores and associated reliability statistics for all 13 final criteria, the final 13-item scale scores, and the original 15-item scale scores for each of the 10 systematic reviews are in **TABLE 3**. Application of the modifications to the original 15-item criteria did not have a significant impact on the reliability of the scale, or the order in which the reviews were rated related to their quality. The only change was that the review by Crossley et al²⁰ moved up

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TABLE 3

BREAKDOWN OF SCORES AND SUBSEQUENT RELIABILITY STATISTICS AMONG THE 3 PRIMARY REVIEWERS FOR EACH CRITERION ON EACH OF THE 10 SYSTEMATIC REVIEWS*

Review	Criteria													Total (Final 13)	Total (Original 15)
	1	2	3	4	5	6	7	8	9	10	11	12	13		
D'Hondt ²³	2	2	2	2	2	2	2	2	2	2	2	2	2	26	30
Heintjes ⁴¹	2	2	1	2	2	2	2	2	2	2	2	2	1	24	28
Brosseau ¹²	2	2	2	1	2	2	1	2	2	2	2	2	2	24	28
Bizzini ⁹	1	2	2	2	0	1	2	0	2	0	0	1	1	14	20
Crossley ²⁰	2	1	2	2	2	1	0	0	0	0	1	1	0	12	14
Aminaka ²	1	1	0	1	0	2	2	0	2	0	0	1	0	10	16
Overington ⁶⁰	2	1	0	0	0	0	0	2	2	0	0	0	0	8	13
Bolga ¹⁰	1	1	0	0	0	1	1	0	0	0	2	2	0	8	12
Harrison ³⁷	1	1	2	0	0	1	0	0	0	0	0	0	2	7	11
Selfe ⁷⁰	2	2	0	0	0	0	0	0	0	0	0	0	0	4	7
Percent agreement	80	80	70	60	100	70	80	90	100	100	90	80	80	30	20
Reliability [†]	0.73	0.73	0.67	0.58	1.00	0.58	0.72	0.86	1.00	1.00	0.88	0.80	0.71	0.96 (0.88-0.99)	0.95 (0.87-0.99)

* Scoring: yes, 2; in part, 1; no, 0.
† Weighted κ reported for each individual criteria, and ICCs (3,1) with 95% confidence intervals in brackets reported for total (final 13) and total (original 15).

to the fifth highest rank (from sixth) and Aminaka² subsequently moved down to sixth (from fifth). Percentage agreements for the final 13 criteria ranged from 60% to 100%, with an overall agreement of 83%. Kappa statistics for the final 13 criteria ranged from 0.58 to 1.00, indicating moderate to excellent agreement between the 3 primary reviewers. Full agreement regarding consensus was reached on all criteria, and disagreement was primarily a result of reading errors.

Overall score ranges for the 3 systematic reviews randomly chosen for additional scale validation across all 9 reviewers (consensus score of 3 primary reviewers and 8 additional reviewers) without the addition of criterion 5 (inclusion of non-English papers), were 21 to 24 for D'Hondt,²³ 5 to 16 for Overington,⁶⁰ and 2 to 8 for Selfe.⁷⁰ The median and mode scores from all reviewers were 24 and 24, respectively, for D'Hondt,²³ 7 and 7, respectively, for Overington,⁶⁰ and 5 and 4, respectively, for Selfe.⁷⁰ Percentage agreements of the 8 reviewers with the consensus score across the 3 papers for the 12 criteria (ie, not including item 5) ranged from 67% to 92%, with an overall percentage agreement of 82%. The average agree-

ment across the 12 criteria was 93% for D'Hondt,²³ 69% for Overington,⁶⁰ and 83% for Selfe.⁷⁰ All individual criteria median and mode scores (from the consensus score and 8 additional reviewers) for the 12 items (not including item 5) across all 3 papers were identical to the consensus scores.

Methodology Summary for Included Reviews

The following databases were used by the 10 included reviews: MEDLINE,^{2,9,12,20,23,37,41,60,70} EMBASE,^{12,41,70} SPORTDISCUS,^{2,12,70} CINAHL,^{2,9,12,20,23,37,41,70} Web of Science,⁹ Cochrane Database of Systematic Reviews,⁹ Cochrane,^{12,23,41,70} HealthSTAR,¹² PEDro,^{12,20,41,70} Current Contents,^{12,20} Biological Abstract databases,³⁷ Pubmed (clinical queries component),³⁷ AMED,^{60,70} EBSCO Health Databases (limits clinical trial),⁶⁰ Cochrane Musculoskeletal Injuries Group,⁴¹ Cochrane Rehabilitation and Related Therapies Field specialized registers,⁴¹ Cochrane Controlled Trials Register,^{41,70} Cochrane Library Reviews,⁷⁰ and Cochrane Library Protocols.⁷⁰ Inclusion/exclusion criteria used in the systematic reviews can be found in **TABLE 4**.

Five reviews reported using 2 independent reviewers during trial selection,^{2,12,32,41,60} 2 reported only 1 reviewer,^{20,70} and 3 did not report the number of reviewers used.^{9,10,37} Five out of 10 reviews reported effect sizes,^{10,12,20,23,41} and 6 of the 10 reviews used validated quality assessment scales to critique included studies.^{2,9,12,23,41,60} Quality assessment scales included versions of the Cochrane Musculoskeletal Injuries Group methodological scale,^{12,23,41} the PEDro scale,^{2,60} and a specifically developed scale related to PFPS studies.⁹

High-Quality Systematic Reviews

No homogenous systematic reviews were identified (ie, covering the same interventions for PFPS), making any pooling or meta-analysis inappropriate. Included high-quality systematic reviews covered the following areas of nonpharmacological conservative treatment: exercise therapy, therapeutic ultrasound, and foot and knee orthoses.

Exercise Therapy

From the initial 750 titles and abstracts identified in the systematic search by Heintjes et al,⁴¹ 16 studies met their initial inclusion criteria. A further 4 studies

TABLE 4

SELECTION CRITERIA USED IN THE INCLUDED SYSTEMATIC REVIEWS

Inclusion Criteria	Studies
Types of studies	
Related to patellofemoral joint taping	2
RCTs/quasi-RCTs	9,12,23,41
Controlled clinical trials	20,41
Any paper related to PFPS	37
Any paper related to patellofemoral taping and PFPS	60
Types of participants	
Participants described or diagnosed as having PFPS	2,9,10,12,41
Participants described as having anterior knee pain	2
Symptom provocation by increased patellofemoral load	23
Adolescents and adults	12,41
Types of interventions	
Conservative interventions	9
Exercise based intervention with minimum 4-wk duration	10
Exercise aimed at increasing knee extensor strength	41
Therapeutic ultrasound	12
Patellofemoral orthoses	23
Foot orthoses	23
Types of outcome measures	
Pain measures	2,12,23,41
Functional measures	12,23,41
Patient satisfaction	23,41
Complications	23
Neuromuscular control	2
Strength measures	2,12
Articular mobility	12
Electromyography	2
Proprioception	2
Patellar positioning	2
Adequately described outcome measure	20
Exclusion Criteria	Studies
Types of studies	
Non RCTs	9,12
Retrospective studies	41
Types of participants	
Studies involving only healthy participants	2
Articular pathology/osteoarthritis	2,37
Patella tendonitis/tendonopathy	2,37
Fat pad impingement/bursitis	37
Patellar subluxation/dislocation	2,41
Other knee conditions/pathology	2,41
Symptom onset related to previous trauma	23
Knee effusion	23
Surgical participants	9,23,37
Imaging studies	37
Types of interventions	
Surgical interventions	20,37
Pharmacological interventions	20
<i>Abbreviations: PFPS, patellofemoral pain syndrome; RCTs, randomized controlled trials.</i>	

were subsequently excluded from the review: Beetsma⁵ and Eburne²⁵ due to lack of description of procedures and outcomes, Kowall⁴⁸ because both treatment groups performed the same exercise and the objective of the study was to evaluate the effectiveness of additional taping, and Roush⁶⁷ due to inclusion of patients with Osgood-Schlatter disease and plica syndromes. The 12 remaining studies comprised a total of 697 patients, with equal numbers of males and females, and an age range between 11 and 65 (average, 24) years. Heterogeneity between high-quality studies for intervention comparisons, outcome measures, and assessment times was evident, making statistical pooling and meta-analysis inappropriate. The studies and results identified in the literature by Heintjes et al⁴¹ are outlined in TABLE 5. All reported conclusions and statistical analysis by the authors were validated by the crosschecking process, except for the inclusion of 1 paper (Steine⁷¹), which contained participants with a history of patellar dislocations (part of Heintjes⁴¹ exclusion criteria).

The authors concluded that there is some limited evidence that exercise reduces pain in individuals with PFPS and that such exercise may be considered for treatment.⁴¹ In regard to exercise choice, the authors concluded that weight-bearing exercises provide equivalent results to non-weight-bearing exercises in pain reduction and functional improvement.⁴¹ However, Heintjes et al⁴¹ acknowledge that the studies upon which their conclusions were based were inadequately powered due to small sample sizes. This would make it difficult to detect any differences between exercise treatment groups and increases the potential for type II error.⁴¹

Therapeutic Ultrasound

The systematic search by Brosseau et al¹² yielded 85 possible references. Of those, only 8 initially appeared to meet the inclusion criteria. However, after analysis of the full text, only the randomized controlled trial by Antich³ remained. The

LITERATURE REVIEW

TABLE 5

STUDIES AND FINDINGS IDENTIFIED IN THE LITERATURE BY HEINTJES ET AL⁴¹

Study	Quality/Type of Study	Reported Findings
Clark ¹⁷	High-quality RCT	No significant difference between exercise and no exercise groups in pain reduction at 3 mo, or 12 mo (based on means per time-point calculations). Significantly more exercise participants discharged due to treatment satisfaction (number need to treat calculated at 3)
Timm ⁷⁵	Low-quality RCT	Pain halved and functional ability drastically improved after 4 wk with a Protonics device and daily exercise compared to no intervention
McMullen ⁵⁵	Low-quality CCT	Greater functional improvement with static exercise compared to isokinetic exercise at 4 wk. Minimal significant functional improvement for both exercise forms compared to waiting list controls and no significant difference in pain levels across all groups at 4 wk
Witvrouw ⁸⁰	High-quality RCT	Significant improvements in pain and function for NWB and WB exercise, but no significant differences between the groups
Wijnen ⁷⁷	High-quality RCT	No significant difference between NWB/Couman's bandage and WB/taping (McConnell) for improvements in pain or function at 6 wk, but the WB/taping group had significantly greater patient satisfaction
Gaffney ²²	Low-quality RCT	No significant differences in pain or function between NWB and WB groups
Colon ¹⁸	Low-quality RCT	No differences in pain reduction between an NWB (isometric straight leg raises) and a WB (pogo stick) group
Stiene ⁷¹	Low-quality CCT	Significantly better function (step up test) post intervention in WB exercise compared to NWB exercise group. However, groups also had significantly different baseline measures
Harrison ³⁹	Low-quality RCT	Significant improvement in Patellar Function Scale in all 3 groups (Home exercise – stretching and education; supervised exercise – stretching and education; and extensive physiotherapy program including taping), but no difference between groups at 3, 6, and 12 mo
Thomee ⁷³	Low-quality RCT	Significant reduction in frequency of pain in isometric and eccentric exercise groups at 3 and 12 mo, but no difference between groups
Dursun ²⁴	Low-quality RCT	No significant difference in outcomes exercising with and without EMG biofeedback
Gobelet ³³	Low-quality RCT	After 4 wk a significant improvement in Arpege score in a group receiving isokinetic training and electrostimulation, but not in a group receiving isometric proprioceptive and stretching exercises

Abbreviations: CCT, controlled clinical trial; EMG, electromyography; NWB, non-weight-bearing; RCT, randomized controlled trial; WB, weight-bearing.

other 7 trials were excluded for the following reasons: Chan¹⁵ had a sample of healthy people and no clinical outcomes; Hasson,⁴⁰ Oosterveld,⁵⁹ Reed,⁶⁵ and Plaskett⁶² had samples of healthy people; the study by Meyer⁵⁶ did not use a randomized design; Bischoff⁸ did not have a sample of individuals with PFPS, and ultrasound was not used; and Thomee⁷³ did not use ultrasound. The included randomized controlled trial (Antich³) contained a total of 54 participants. Antich³ reported no significant improvements in pain reduction in a group of participants receiving ultrasound and ice massage compared to a group receiving cryotherapy (ice bags).

The crosschecking process indicated that reported conclusions and statistical analyses of Antich et al's³ paper by Brosseau et al¹² were not valid. Peto odds ratios and absolute differences were reported to support conclusions made. However, Antich et al's³ paper did not report the number of patients who improved (required to calculate an odds ratio) and, instead,

reported the average improvements. Using these averages to calculate odds ratios matches the statistics reported by Brosseau et al.¹² Absolute differences were calculated based on 13 knees in both groups. However, there were 16 knees in the cryotherapy group. Using this number produces an absolute difference of 25% between groups and not 15% as reported by Brosseau et al.¹²

In regard to the use of therapeutic ultrasound, Brosseau et al¹² concluded that there is insufficient evidence to support the recommendation of ultrasound for treating patellofemoral pain syndrome. However, the limited number of participants and the poor methodological quality in the paper by Antich et al³ raise questions as to the validity of these conclusions.

Foot and Knee Orthoses

The systematic search by D'Hondt et al²³ initially identified 15 trials. Four studies were excluded for the following reasons: Beetsma⁵ used a small study population

that prevented randomization, BenGal⁶ assessed orthoses as a preventative measure, Hoefsloot⁴⁴ did not mention the use of a randomization procedure, and Moller⁵⁸ evaluated 2 different pathologies without separate analyses. A further 6 studies were categorized as studies awaiting assessment. The studies by Arcand,⁴ Eng,²⁷ Finestone,³¹ Eburne,²⁵ and Kowall⁴⁸ were considered to have inadequate statistical data to be considered for pooling, while no reason was given to exclude the study by Handfield.³⁶ Heterogeneity between studies made statistical pooling and meta-analysis inappropriate. The studies and results identified in the literature by D'Hondt et al²³ are outlined in **TABLE 6**. Reported conclusions and statistical analysis by the authors were validated by the crosschecking process.

D'Hondt et al²³ concluded that the strength of retrieved evidence is limited, and as such it is inappropriate to make any clinical recommendation concerning the use of knee and foot orthoses in the conservative management of PFPS.²³

TABLE 6

STUDIES AND FINDINGS IDENTIFIED IN THE LITERATURE BY D'HONDT ET AL²³

Study	Type of Study	Reported Findings
Wijnen ⁷⁷	RCT	No significant difference between NWB/Couman's bandage and WB/taping (McConnell) for improvements in pain or function at 6 wk, but there was a trend towards more effective pain reduction and functional improvement in the McConnell group. McConnell group had significantly greater patient satisfaction
Miller ⁵⁷	RCT	No significant difference in pain or motivation between groups receiving a Palumbo brace, a Cho-pat strap, or no brace
Timm ⁷⁵	RCT	Significant reduction in pain, and improvement in function (Kujala scale) in a group receiving a Protonics brace and exercise compared to no treatment
Harrison ³⁹	RCT	Significant improvement in Patellar Function Scale in all 3 groups ([1] home exercise: stretching and education; [2] supervised exercise: stretching and education; and [3] extensive physiotherapy program, including taping), but no difference between groups at 3, 6, and 12 mo. Significantly better worst and usual pain reduction and functional Index Questionnaire at 4 wk in group 3 compared to group 2 (ie, addition of taping and biofeedback was superior)
Gaffney ³²	RCT	No significant difference between groups for pain or function at 6 wk

Abbreviations: NWB, non-weight-bearing; RCT, randomized controlled trial; WB, weight-bearing.

D'Hondt et al²³ reported some limited evidence for the following: a comprehensive exercise program, combined with tape, to improve worst pain, usual pain, and function questionnaire scores compared to a monitored program without taping at a 4-week follow-up; use of a Protonics brace and exercise to decrease pain and improve function at a 6-week follow-up, compared to no treatment; and no difference in outcome between using a Palumbo brace, Cho-pat strap, or no brace after 3 weeks.²³ However, D'Hondt et al²³ acknowledge this latter report of no difference lacks sufficient power to be considered conclusive due to methodological flaws and low participant numbers in the included study.²³

DISCUSSION

Quality of Methodological Design

DESPITE AN EXTENSIVE BODY OF literature on PFPS, only 3 high-quality systematic reviews related to nonpharmacological interventions were identified. All 3 reviews considered to be high quality were Cochrane reviews, scoring between 24 and 26 (out of a total possible score of 26) on the quality assessment scale. A high-quality systematic review should avoid bias in the search for original evidence, evaluate the quality and critique findings of included studies,

and assist development of evidence-based guidelines.³⁴ The developed scale for assessing quality was designed to address all these issues. While the Cochrane Collaboration systematic reviews adhered to all these principles, the remaining reviews did not. The highest score of a non-Cochrane review was 14, with the average score of the remaining 7 reviews being 9. However, we acknowledge that not all were portrayed as being systematic reviews. This does not imply that they do not provide beneficial information to the reader; however, their conclusions should be considered with caution, and it indicates that greater diligence in methodological design is required in future systematic reviews.

Search methods were generally well documented, with all reviews scoring at least an "in part" (1) score. This is not surprising because part of the inclusion criteria required the search strategies of the selected manuscripts to be "documented and reproducible." All included reviews searched at least 3 databases (scoring at least "in part"), indicating that electronic searching was adequate. However, lower-quality reviews generally scored poorly in regard to alternative searches, ranges of keywords, and inclusion of non-English papers (items 3-5). This would indicate that 1 of the key discriminating factors between high- and low-quality reviews was

the comprehensiveness of their search strategies. Reproducibility of inclusion/exclusion criteria (criterion 6) scored at least "in part" for 8 of the 10 reviews, indicating that this methodological design aspect was generally well documented. However, only 4 of the 10 reviews scored full marks for the adequacy of their inclusion and exclusion criteria (criterion 7). This would indicate the majority of the reviews did not adequately address diagnosis of PFPS or the exclusion of other sources of knee pathology, limiting the external validity of applying any reported findings to individuals with PFPS.

Only 5^{2,12,23,41,60} of 10 reviews (2 non-Cochrane reviews) reported using 2 independent reviewers during trial selection (criterion 8). Using only 1 reviewer for the selection process may lead to inclusion bias, even when applying well defined and reproducible inclusion/exclusion criteria.⁶¹ Six^{2,9,12,23,41,60} of the 10 reviews described and used validated quality assessment scales to critique included studies (criterion 9). The 4^{10,20,37,70} that did not were in the bottom 5 scoring reviews, indicating that these criteria were important in discriminating between high- and low-quality reviews. This methodological weakness found predominantly in lower-quality reviews may lead to conclusions that are insufficiently supported by the evidence.

Interestingly, only the 3 Cochrane reviews^{12,23,41} conducted meta-analysis or discussed limitations related to their findings associated with this process (criterion 10). This would indicate that this criterion could be considered an excellent indicator to distinguish between high- and low-quality reviews. Effect sizes and confidence intervals (criterion 11) were reported in only 2^{10,20} of the 7 non-Cochrane reviews. This lack of reporting/calculation limits both the authors' and readers' ability to make conclusions based on the strength of each study's findings. This may lead to conclusions that are insufficiently supported by the evidence.⁶¹

Seven^{2,9,10,12,20,23,41} of the 10 reviews used at least some statistical analysis (either their own secondary analysis or by reporting those conducted by the included studies) upon which to base their conclusions (criterion 12). This would appear to distinguish the lowest-quality reviews from the rest with 3^{37,60,70} of the 4 lowest-quality studies scoring zero for this criterion. Only 3^{12,23,37} of the 10 reviews graded their findings according to predetermined levels of evidence (criterion 13), while 2^{9,41} used their quality assessment scales to critique findings when comparing interventions. Only the 3 Cochrane reviews scored at least 1 "yes" and 1 "in part" (3/4) when criteria 12 and 13 were combined. This would indicate the combination of these 2 criteria was able to identify a high-quality review.

Validation of the Quality Assessment Scale

The current scale was similar in design to a scale previously used in systematic reviews of systematic reviews^{45,50} developed by Hoving et al.⁴⁵ However, the current scale is more comprehensive in its assessment of quality. It was intended to be more rigorous in evaluating the comprehensiveness of a review's search strategy (criteria 2-5), with 4 items in the current scale compared to 1 in the scale by Hoving et al.⁴⁵ The current scale included criteria specific to the systematic review question (criteria 4 and 7), including the

adequacy of key words and inclusion of potential studies based on their PFPS diagnosis. The current scale also included an item related specifically to the inclusion of a criterion addressing the use of predetermined levels of evidence to base conclusions on (criterion 13). These additions all exhibited an ability to differentiate between higher- and lower-quality reviews, validating their importance in a scale to assess the quality of a systematic review. Although the current scale was specifically developed for PFPS, it could be easily adapted for use in other topic areas by alterations to criteria 4 and 7.

The final 13-item developed scale was found to have moderate to excellent reliability for each individual criteria (κ between 0.58 and 1.00 and overall agreement of 83%), which was comparable to the previously developed scale by Hoving et al (κ between 0.66 and 0.94 and overall agreement of 84%).⁴⁵ These results, combined with the excellent reliability of the overall score ($ICC_{3,1} = 0.96$) from the final 13 items, indicates that the scale was appropriate for use in the current systematic review.

Median and mode scores from the 8 new reviewers were almost all identical to the original consensus scores by the 3 primary reviewers when applying the 12 criteria retained from the original 15-item scale. Only the median score for the paper by Selfe⁷⁰ differed, and this was by just 1 point (5 compared to 4). Despite this close resemblance, ranges for the total scores of the lower-quality reviews were quite wide (5-16 and 2-8). These differences may be due to differing criteria interpretations or missed information while reading the reviews, and illustrate the importance of multiple reviewers independently applying quality assessment scales and completing a consensus process to produce the most accurate scores. Individual criteria percentage agreement scores across the 3 papers ranged from 67% to 92%, with the average across all 3 papers being 80%. This would indicate that people of variable academic backgrounds were able to ap-

ply all criteria with reasonable accuracy. When evaluating the medians and modes for each item across the 3 papers, the importance of multiple reviewers is evident. Every median and mode score across all items from all 3 papers matched that of the consensus score from the 3 primary reviewers. These results indicate that the current quality assessment scale is likely to produce similar results when applied by multiple reviewers who have not received training or further instruction, regardless of professional background.

Crosschecking of High-Quality Reviews

Although all 3 Cochrane reviews were considered to be of high quality on the quality assessment scale, crosschecking identified possible weaknesses in the application of their methodological design. The paper by Steine⁷¹ included in Heintjes et al's⁴¹ Cochrane review included participants with patellar dislocation, which was part of Heintjes et al's⁴¹ exclusion criteria. Crosschecking the only paper (Antich³) included in Brosseau et al's¹² Cochrane review would indicate that patients with patellar tendonitis were included in Antich's³ study, which does not fit the PFPS diagnosis. It would also appear that statistics reported by Antich³ may have been misinterpreted by Brosseau et al,¹² or alternatively (although not mentioned), they might have received additional statistical information. Despite numerous attempts, we were unable to contact the authors of this review to seek clarification.

The crosschecking process would indicate that although a scale can be designed to evaluate the quality of each systematic review's methodological process, it is difficult to evaluate the accuracy of the reviewers in carrying out this methodological process. This poses problems for the clinician, as to identify such processing flaws takes substantial time and effort in crosschecking reported results against the original papers in the systematic review. A systematic review is designed to save the reader time, allowing the reader to efficiently find the answers without trying to decipher and critique findings from mul-

multiple research papers.⁶⁹ Thus, if clinicians are required to crosscheck for the accuracy of what they are reading, the purpose of producing a systematic review is lost.

Scope of Reviews and Overview of Evidence

Identified high-quality systematic reviews have covered therapeutic ultrasound, knee and foot orthoses, and exercise therapy for the treatment of individuals with PFPS. However, the most recent of these high-quality systematic reviews covered literature only to December 2001. According to the Cochrane handbook, "it is Collaboration policy that reviews should either be updated within 2 years or should have a commentary added to explain why this is done less frequently."⁴⁹ Around 6 to 7 years has passed since all 3 Cochrane reviews were published and an update has not yet taken place. In an area that is heavily researched, this would indicate an update in all areas of nonpharmacological conservative treatment is more than warranted.

There would appear to be no high-quality systematic reviews currently within the literature addressing 1 of the most frequently used interventions of patellar taping. Two of the 10 reviews addressed patellar taping, but their methodological design quality scores were 10 (Aminaka²) and 8 (Overington⁶⁰), meaning that they were not considered of high-quality evidence. However, there has been a recent protocol submission to Cochrane to conduct a systematic review on patellar taping.¹⁴

Research Implications

Updated high-quality systematic reviews in all areas of nonpharmacological conservative treatments for PFPS are needed. In the future, it is recommended that systematic reviews related to PFPS follow stringent standards that have been outlined in the current quality assessment scale. This will ensure that any conclusions made in future reviews will be unbiased and provide the reader confidence in any conclusions made or evidence-based guidelines developed from the reviews.³⁴

An important finding of this system-

atic review was that there was a large degree of heterogeneity among included studies and inadequately powered studies in the 3 high-quality systematic reviews. Heterogeneity and inadequate power was generally caused by methodological flaws in lower-quality studies and low participant numbers.^{23,41} Unless these issues are addressed in future clinical trials, recommending more updated high-quality systematic reviews is futile, as development of clinical guidelines based on future reviews will remain too difficult. Therefore, it is recommended that future clinical trials evaluating nonpharmacological interventions for PFPS adhere to methodological standards reflected in the CONSORT statement.¹

Adequate comparison among trials of different interventions for PFPS, and pooling for meta-analysis in the future will also require greater consistency in use of outcome measures and assessment times among trials. Therefore, it is recommended that secondary to following the CONSORT statement, future trials should also attempt to provide both short-term (eg, immediately post intervention) and long-term (eg, 12 months) follow-up of participants to ensure consistency. Furthermore, to ensure consistency in reporting of primary outcome measures it is recommended that measures with established reliability and validity for individuals with PFPS be used. Measures with these qualities include pain visual analogue scales,^{7,16,21,38} the anterior knee pain scale,^{21,49,76} and the lower extremity functional scale.⁷⁶

CONCLUSION

THE QUALITY ASSESSMENT SCALE developed in this study was validated for use on PFPS systematic reviews. The importance of using multiple assessors when applying the quality assessment scale was illustrated in the validation process. For future use of the scale for other topic areas, it is recommended that criteria 4 and 7 be modified to make them topic specific. Crosscheck-

ing results would indicate that despite having a high-quality methodological design, mistakes can still be made in applying the methodology, potentially limiting the validity of a systematic review's findings. Therefore, great care needs to be taken by those participating in future systematic reviews.

Despite such a wide body of literature on the topic of PFPS, there appears to be a limited number of high-quality systematic reviews for nonpharmacological conservative treatments. Three high-quality systematic reviews reported only limited evidence for the use of various nonpharmacological conservative treatment strategies for individuals with PFPS. A summary of evidence included in previous high-quality systematic reviews is as follows:

- There is some limited evidence that exercise reduces pain in individuals with PFPS
- The evidence indicates that non-weight-bearing and weight-bearing exercises are equally effective in the treatment of PFPS. However, previous studies in this area have been inadequately powered due to small sample sizes, and heterogeneity among studies did not allow data pooling to improve power through meta-analysis. Therefore, the current evidence should be considered inconclusive
- There is no evidence of clinically important benefits of ultrasound for treating PFPS. However, methodological flaws and the small sample size in the single study investigating ultrasound means current evidence is inconclusive
- There is no evidence for the use of foot and/or knee orthoses. However, previous studies have been inadequately powered due to small sample sizes, and heterogeneity among studies did not allow data pooling to improve power through meta-analysis. Therefore the current evidence should be considered inconclusive
- There is some limited evidence that a comprehensive exercise program, combined with tape, improves worst

pain, usual pain, and functional questionnaire scores compared to a monitored program without taping at a 4-week follow-up

- There is some limited evidence that the use of a Protonics brace and exercise compared to no treatment decreases pain, and improves function at a 6-week follow-up
- There is some limited evidence to indicate there is no difference when using a Palumbo brace or Cho-pat strap compared to no brace after 3 weeks. However, the study that evaluated these braces was inadequately powered due to small sample size, meaning this current evidence is inconclusive

Unfortunately, these review findings appear outdated, covering literature only until the year 2001. Therefore, high-quality updates of the included systematic reviews combined with high-quality systematic reviews covering various other topics, including patellar taping, are needed. ●

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