*Journal of Athletic Training* 2025;60(9):675–689
doi: 10.4085/1062-6050-0353.24

www.natajournals.org



# Individuals With Patellofemoral Pain Have Impaired Self-Reported and Performance-Based Function: Systematic Review With Meta-Analysis and Meta-Regression

**Ana Flavia Balotari Botta, MS, PT*; Marina Cabral Waiteman, PhD, PT*; Júlia de Cássia Pinto da Silva, PT*; Fábio Mícolis de Azevedo, PhD, PT*; Michelle C. Boling, PhD, ATC†; David Matthew Bazett-Jones, PhD, ATC‡; Ronaldo Valdir Briani, PhD, PT***

*School of Science and Technology, São Paulo State University, Presidente Prudente, Brazil; †Brooks College of Health, University of North Florida, Jacksonville; ‡Congdon School of Health Sciences, High Point University, NC

***Objectives:*** To determine impairments in self-reported and performance-based function in individuals with patellofemoral pain (PFP) and determine physical and nonphysical factors potentially related to these impairments.

***Data Sources:*** We searched MEDLINE, Embase, CINAHL, Web of Science, and SPORTDiscus databases between inception and January 2024.

***Study Selection:*** Included studies compared self-reported and performance-based measures of function between PFP-affected and pain-free limbs in individuals with unilateral PFP or between individuals with PFP and pain-free individuals.

***Data Extraction:*** The key information from each study was extracted by 1 independent researcher and reviewed by another researcher.

***Data Synthesis:*** We performed meta-analyses for each self-reported and performance-based measure of function and meta-regressions to identify factors that might explain outcomes of meta-analyses. We assessed the certainty of evidence using the Grading of Recommendations Assessment, Development, and Evaluation. We included 83 studies (2807 individuals with PFP and 2518 pain-free individuals). We identified very-low– to high-certainty evidence that individuals with PFP have reduced self-reported (large effect sizes; standardized mean difference [SMD] = −1.99; 95% CI = −2.41, −1.57 to SMD = −4.87; 95% CI = −6.97, −2.77) and performance-based (small to large effect sizes; SMD = −0.30; 95% CI = −0.58, −0.02 to SMD = −0.80; 95% CI = −1.11, −0.50) measures of function compared with pain-free individuals, but no differences were found between limbs in individuals with unilateral PFP for most performance-based measures of function (small to moderate effect sizes; SMD = −0.20; 95% CI = −0.68, 0.27 to SMD = −0.49; 95% CI = −1.02, 0.03). Age, body mass index, duration of symptoms, and self-reported pain did not explain self-reported function, and age did not explain performance-based function ($R^2$ range, <0.01–0.02; *P* range, .15–.91).

***Conclusions:*** Our results highlight the negative effect of PFP on self-reported and performance-based function, which seems to also affect the pain-free limb. Self-reported and performance-based measures of function should be considered when assessing individuals with PFP. None of the factors investigated explained impaired self-reported and performance-based function.

***Key Words:*** clinical tests, functional capacity, patient-reported outcome measures, physical function, subjective function

**Key Points**

- Individuals with patellofemoral pain (PFP) had impaired function compared with pain-free individuals; thus, function measures should be considered primary outcomes in the management of PFP.
- No function differences were observed between limbs in individuals with unilateral PFP; therefore, caution is warranted when comparing function between PFP and pain-free limbs.
- Age, body mass index, duration of symptoms, and self-reported pain did not explain function.

Individuals with patellofemoral pain (PFP) frequently present to orthopaedic and sports clinics given the high prevalence of PFP in active adolescents and young adults.[1] These individuals report diffuse anterior knee pain during daily living or sporting activities such as stair ascent and descent, squatting, and hopping.[2] Reductions in health-related quality of life,[3–5] psychological well-being,[6,7] and physical activity and sport participation,[8] as well as impairments in self-reported and performance-based function,[9,10] have been reported in individuals with PFP. Self-reported measures (eg, patient-reported outcome measures) indicate how individuals with PFP perceive their functional limitations, whereas performance-based measures of function (eg, single-leg hop test [SLHT]) represent the actual objectively measured functional limitation.[9] Both provide clinically relevant and complementary information that can help guide the development of effective interventions.

Measures of function have been considered one of the key determinants of PFP and its prognosis.[11,12] Self-reported function has been related to pain severity, kinesiophobia, and psychological well-being,[7,13] and poor self-reported function has predicted unfavorable recovery 5 to 8 years after treatment.[11] Performance-based measures of function, such as hopping and stepping tasks, have been related to hip and knee strength,[9,14] which are key targets of PFP management.[12] A greater understanding of the potential magnitude of functional impairments may help inform preferable outcome measures for decision-making processes.[9] Despite the importance of measures of function for PFP, no researchers have systematically synthesized the literature to compare self-reported function between individuals with PFP and pain-free individuals and performance-based function between individuals with PFP and pain-free individuals or the PFP-affected and pain-free limbs of individuals with unilateral PFP. In addition, no systematic review has been conducted to identify factors that may explain poor self-reported and performance-based function in individuals with PFP. Determining which measures of function are impaired as well as which physical and nonphysical factors may underline these deficits is important given that function improvement is a common target of PFP rehabilitation.[15]

The purposes of our systematic review were to (1) systematically review and meta-analyze the literature comparing self-reported and performance-based function between individuals with PFP and pain-free individuals or the PFP-affected and pain-free limbs of individuals with unilateral PFP and (2) investigate physical and nonphysical factors that might explain poor self-reported and performance-based function in individuals with PFP via meta-regression.

## METHODS

We conducted this systematic review in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines[16] and registered it in the International Prospective Register of Systematic Reviews database (CRD42021234911).[17] Protocol deviations are summarized in Supplemental Material 1.

### Search Strategy

We conducted the initial electronic search in MEDLINE, Embase, CINAHL, Web of Science, and SPORTDiscus between inception and February 2021 and updated it in January 2024. We combined the keywords and medical subject headings related to PFP and self-reported and performance-based measures of function with search filters to develop the search strategy. We created the primary search for MEDLINE and adapted it to the other databases through pilot searches (Supplemental Table 1). We did not search the gray literature.

### Selection Criteria

One author (A.F.B.B.) imported identified studies into Covidence (Veritas Health Innovation), and duplicates were removed.[18] Two authors (A.F.B.B. and J.C.P.S.) independently screened titles and abstracts for eligibility using the criteria presented in Table 1. We retrieved full-text articles of potentially relevant abstracts for further review. When the full text was not available, we requested it from the corresponding authors via email. If authors were unable to provide the full text, we excluded the study. When studies from the same author groups presented similar descriptive values of measures of function, we included only the first study published after confirmation with the corresponding author that both publications included the same cohort. Disagreements were resolved by consulting a senior author (R.V.B.).

### Data Extraction

One author (R.V.B.) extracted study and participant characteristics (eg, lead author, year of publication, sample size, sex, and participant age), self-reported and performance-based measures of function (eg, Anterior Knee Pain Scale [AKPS], Lower Extremity Functional Scale [LEFS], Knee injury and Osteoarthritis Outcome Score [KOOS], KOOS for PFP and osteoarthritis [KOOS-PF], forward step-down test [FSDT], and hop or balance tests), and predictors of interest to be included in the meta-regression. We selected physical (eg, body mass index [BMI] and strength) and nonphysical (eg, kinesiophobia and pain catastrophizing) predictors of interest based on recommended items from Reporting of Quantitative Patellofemoral Pain (REPORT-PFP), the biomechanical and psychological consensus of PFP.[6,19,20] A second author (J.C.P.S.) reviewed all extracted data. We extracted means, SDs, and sample sizes for all outcomes and used them for data analysis. When data were missing, we contacted corresponding authors for further information via email up to 3 times. If authors were unable to provide the data or did not respond to the requests and missing data could not be calculated using Review Manager 5.4 (The Cochrane Collaboration), we did not enter the study in the meta-analyses. For these studies, we only performed an individual study analysis by calculating the standardized mean differences (SMDs) and discussing them. We provide details on data-extraction management in Supplemental Material 2.

### Methodologic Quality Assessment and Risk of Bias

We assessed internal and external validity of observational and nonrandomized interventional studies with a domain-based evaluation using the modified Downs and Black checklist, as performed by Hart et al.[21] We assessed internal validity across the following 5 domains: performance bias (items 14, 15, and 19), reporting bias (item 16), detection bias (items 17, 18, and 20), selection bias (items 21–25), and attrition bias (item 26). We assessed external validity using items 11 through 13. Items were scored as *yes*, *no*, or *unable to determine*. Overall quality classification for each study was based on concerns across all applicable items and domains rather than the numeric summary score. Studies were classified across domains and external validity as *low*, *moderate*, or *high quality* based on item evaluation. A similar classification was performed for internal validity based on domain evaluation. We assessed the methodologic quality of the only randomized clinical trial[22]

Table 1. Inclusion and Exclusion Criteria for Studies

| | Criteria |
|---|---|
| Inclusion | |
| Design | Observational prospective or cross-sectional/case-control studies, pretest-posttest studies, and randomized or nonrandomized clinical trials written in English, Portuguese, or Spanish. |
| Participants | Individuals with insidious unilateral or bilateral PFP of both sexes, age < 50 y, without any other previous or concomitant knee or lower limb condition reported. |
| Comparisons | Pain-free control group or pain-free contralateral limb of individuals with unilateral PFP. |
| Outcomes | Self-reported function as measured using questionnaires or scales. |
| | Physical performance during clinical tests. |
| Exclusion | Retrospective comparative cohort studies, review papers, theses, editorials, abstracts, and letters. |
| | Studies without a comparator (pain-free group or limb). |

Abbreviation: PFP, patellofemoral pain.

included using the Physiotherapy Evidence Database (PEDro) scale[23] and its risk of bias using the Cochrane Risk of Bias for Randomized Trials 2 (RoB2) following *Cochrane Handbook for Systematic Reviews of Interventions* recommendations.[24] The 10-item PEDro scale consists of a score ranging from 0 to 10 and is used to rate trials according to the presence or absence of some methodologic quality criteria.[23] The score classifications are *high quality* (≥7 of 10), *moderate quality* (4–6 of 10), and *low quality* (≤3 of 10). The RoB2 comprises the following 5 domains: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported study. For each domain, the tool comprises a series of signaling questions scored as *yes*, *probably yes*, *probably no*, *no*, and *no information*. We classified each domain as *low*, *high*, or *some concerns of risk of bias* based on the tool's algorithm.[25] We determined the overall risk of bias using the worst-score-counts method, which takes the lowest rating across all the domains.[26] Further details regarding study-quality assessment and risk of bias are provided in Supplemental Material 3 and Supplemental Tables 2 and 3. Two authors (A.F.B.B. and M.C.W.) independently assessed all studies, and disagreements were resolved by consulting a senior author (R.V.B.).

## Data Synthesis and Analysis

One author (R.V.B.) performed meta-analyses using Review Manager 5.4 and random-effects models when ≥2 studies investigated the same outcome and comparator (pain-free individuals or pain-free limb of individuals with unilateral PFP). Another author (A.F.B.B.) reviewed all meta-analyses. We calculated SMDs with 95% CIs (Hedges *g*) once different scales or units of measurement were reported across studies, even in those using the same questionnaire or test (eg, Goharpey et al,[27] Peeler and Anderson,[28] and Guimaraes Araujo et al[29]). We classified SMDs as *small* (≥0.2), *moderate* (0.5–0.79), and *large* (≥0.80) *effects*.[30] We quantified statistical heterogeneity for pooled results using the $I^2$ statistic and defined it as *not important* (<50%), *moderate* (50%–75%), or *high* (>75%).[31] We estimated publication bias using the Egger regression test. For data that were not included in the meta-analyses, we calculated the SMDs with 95% CIs for individual comparisons and discussed them. Confidence intervals excluding zero were considered statistically significant.

We performed meta-regressions to identify predictors that could explain the SMDs (Hedges *g*) of function outcomes. Random-effects meta-regressions were performed using Comprehensive Meta-Analysis software (BioSTAT Consultants, Inc) when at least 10 studies included in a meta-analysis presented data for the same predictor.[25]

## Certainty of Evidence

Two authors (A.F.B.B. and M.C.W.) assessed the certainty of evidence using a modified Grading of Recommendations Assessment, Development, and Evaluation approach.[32,33] Given the observational nature of the research question of our systematic review, certainty of evidence started as high and was downgraded or upgraded according to Grading of Recommendations Assessment, Development, and Evaluation Handbook recommendations, which are described in Table 2.[32,34] We defined levels of certainty of evidence as follows: *high* when further research is very unlikely to change confidence in the estimate of the effect; *moderate* when further research is likely to have an important effect on confidence in the estimate of the effect and may change the estimate; *low* when further research is very likely to have an important effect on confidence in the estimate of the effect and is likely to change the estimate; and *very low* when there is very little confidence in the effect estimate.[32]

# RESULTS

Our systematic search identified 28 797 titles and abstracts for screening (Figure 1). After duplicates were removed, 21 648 studies underwent title and abstract screening, then 475 studies underwent full-text screening. We included 83 studies in the review: 73 observational studies,[8–10,27,29,35–102] 8 pretest-posttest studies,[28,103–109] 1 randomized clinical trial,[22] and 1 crossover study.[110] We grouped studies with cross-sectional and case-control designs because, despite being similar, they did not consistently report the design and most exhibited characteristics of both designs.

## Study and Participant Characteristics

Study and participant characteristics are summarized in Supplemental Material 4. A total of 2807 individuals with

Table 2. Outcome Level of Certainty of Meta-Analyses (GRADE Approach)

| Outcome | No. of Individuals (Studies) | SMD (95% CI) | $I^2$, % | Downgrading Domain[a] | | | | Upgrading Domain | Level of Certainty |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Risk of Bias[b] | Inconsistency[c] | Imprecision[d] | Publication Bias[e] | Large Effect[f] | |
| Self-reported function: PFP × pain-free groups | | | | | | | | | |
| AKPS | 2414 (40) | −3.45 (−3.84, −3.06) | 88 | −1 | −1 | 0 | 0 | +1 | Moderate |
| LEFS | 593 (9) | −3.83 (−5.10, −2.55) | 95 | −1 | −1 | 0 | NA | +1 | Moderate |
| FIQ | 337 (7) | −4.87 (−6.97, −2.77) | 96 | −1 | −1 | 0 | NA | +1 | Moderate |
| KOOS | 255 (5) | −1.99 (−2.41, −1.57) | 43 | −1 | 0 | 0 | NA | +1 | High |
| ADLS | 375 (5) | −2.79 (−3.49, −2.08) | 83 | −1 | −1 | 0 | NA | +1 | Moderate |
| KOOS-PF | 124 (4) | −2.66 (−3.47, −1.86) | 60 | −1 | −1 | 0 | NA | +1 | Moderate |
| Lysholm | 102 (3) | −2.23 (−3.51, −0.96) | 82 | −1 | −1 | 0 | NA | +1 | Moderate |
| Performance-based function: PFP × pain-free groups | | | | | | | | | |
| Balance tests | 789 (12) | −0.66 (−1.12, −0.19) | 88 | −1 | −1 | 0 | 0 | 0 | Low |
| FSDT | 737 (9) | −0.80 (−1.11, −0.50) | 68 | −1 | −1 | 0 | NA | +1 | Moderate |
| SLHT | 711 (7) | −0.42 (−0.57, −0.27) | 0 | −1 | 0 | 0 | NA | 0 | Moderate |
| SLTHT | 196 (2) | −0.30 (−0.58, −0.02) | 0 | −1 | 0 | 0 | NA | 0 | Moderate |
| Bilateral squat test | 70 (2) | −1.21 (−2.71, 0.29) | 86 | −1 | −1 | 0 | NA | +1 | Moderate |
| Performance-based function: painful limb × contralateral pain-free limb | | | | | | | | | |
| Balance tests | 70 (2) | −0.20 (−0.68, 0.27) | 0 | −1 | 0 | −1 | NA | 0 | Low |
| FSDT | 106 (2) | −0.36 (−1.11, 0.38) | 72 | −1 | −1 | −1 | NA | 0 | Very low |

Abbreviations: ADLS, Activities of Daily Living Questionnaire; AKPS, Anterior Knee Pain Scale; FIQ, Functional Index Questionnaire; FSDT, forward step-down test; GRADE, Grading of Recommendations Assessment, Development, and Evaluation; KOOS, Knee Injury and Osteoarthritis Outcome Score; KOOS-PF, KOOS for PFP and osteoarthritis; LEFS, Lower Extremity Functional Scale; Lysholm, Lysholm Knee Scoring Scale; NA, not applicable; PFP, patellofemoral pain; SLHT, single-leg hop test; SLTHT, single-leg triple hop test; SMD, standardized mean difference.

[a] As the inclusion and exclusion criteria were rigorous and only studies with populations and outcomes that exactly fit the review question were included, the indirectness domain was not applied.

[b] The domain was downgraded 1 level when >25% of participants from studies were judged as having one-half or a majority of domains with high risk of bias in the assessment tool.

[c] The domain was downgraded 1 level when $I^2 > 50\%$.

[d] The domain was downgraded 1 level when the difference of the effect on the patient would differ depending on use of the upper vs lower boundary of the CI.

[e] The domain was downgraded 1 level when $P < .05$ in the Egger regression test.

[f] The domain was upgraded 1 level when pooled results had large effects (≥0.80).

PFP and 2518 pain-free individuals were included. Mean ± SD ages for PFP and pain-free individuals were 22.91 ± 6.55 years and 23.24 ± 6.23 years, respectively. Mean ± SD BMIs for PFP and pain-free individuals were 23.04 ± 3.58 and 22.30 ± 3.05, respectively. The most common self-reported measures of function were the AKPS (42 studies*), LEFS (9 studies[37,60,65,68–73]), Functional Index Questionnaire (7 studies[28,74–77,105,106]), KOOS (7 studies[78–83,110]), Activities of Daily Living Questionnaire (5 studies[29,84–87]), KOOS-PF (5 studies[9,79,88,89,110]), and Lysholm Knee Scoring Scale (5 studies[60,85,90,91,107]). The most common performance-based measures of function were balance tests, including the Star Excursion Balance Test (5 studies[60,92,93,108,109]), Y-Balance Test (YBT; 8 studies[22,29,42,88,89,94–96]), FSDT (11 studies†), and SLHT (8 studies[9,42,45,61,62,93,99,101]).

## Methodologic Quality and Risk of Bias

Methodologic quality and risk-of-bias assessment of the included studies is provided in Supplemental Material 3 and Supplemental Tables 2 and 3. We rated nearly 76% (63 studies‡) of the studies as low quality for performance bias, 20% (17 studies§) as low quality for reporting bias, 2% (2 studies[27,51]) as low quality for detection bias, 53% (44 studies‖) as low quality for selection bias, and 5% (4 studies[28,62,94,105]) as low quality for attrition bias. Overall, we judged most studies to have low quality for internal (87%, 72 studies¶) and external (98%, 81 studies[8–10,27–29,35–68,70–110]) validity. A single study was assessed using the PEDro scale and RoB2 and was classified as *moderate quality* (6 of 10) and high risk of bias, respectively.[22]

## Publication Bias

We could only assess risk of publication bias for the AKPS and balance tests meta-analyses. No publication bias was detected (Supplemental Figure 1).

* *References 8–10, 27, 29, 35–67, 103–105, 110.*

† *References 9, 27, 45, 61, 62, 93, 97–100, 105.*

‡ *References 8, 10, 27, 29, 35–40, 46, 48, 49, 51–53, 55, 57–72, 74–77, 79, 80, 82, 84–88, 90–92, 94–107, 110.*

§ *References 27, 42, 53, 62, 66, 85, 89, 94–98, 100, 104–107.*

‖ *References 10, 27, 37, 38, 40, 42, 45, 46, 50–52, 57, 58, 60, 64–66, 68, 69, 71, 73–79, 82, 85, 87, 89–91, 95–98, 100, 101, 104, 105, 107–109.*

¶ *References 8, 10, 27–29, 35–40, 42, 45, 46, 48–53, 55, 57–80, 82,84–92, 94–110.*

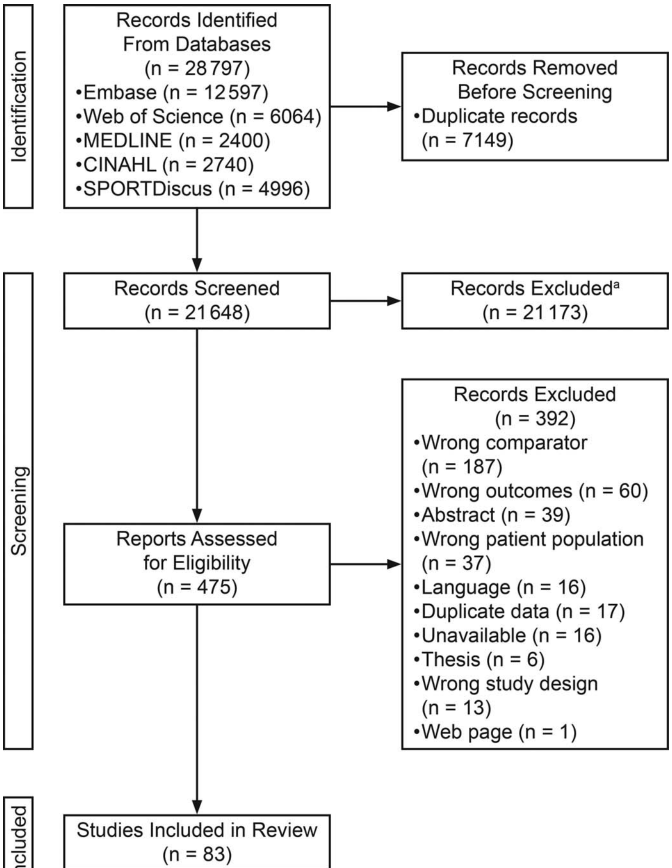



**Figure 1. Flow of studies through the review.**

## Data Findings

We pooled 78 studies# in meta-analyses and presented their level of certainty outcomes in Table 2. We could not pool 5 studies[82,91,100,102,107] due to missing descriptive or parametric data[82,91,100,102,107] or lack of sufficient studies.[100,102] We pooled only part of the outcomes of 11 studies** that reported multiple function measures due to missing descriptive or parametric data,[62,110] lack of sufficient studies,[9,10,29,59,66,67,97,99] or duplicate data.[61] We present a synthesis of unpooled studies with SMDs and 95% CIs in Supplemental Material 5, except for the between-limbs comparisons of performance-based measures of function that are presented in the Performance-Based Measures of Function subsection. We were unable to synthesize the AKPS and KOOS data from 2 studies[62,110] due to missing descriptive or parametric data or both, and we did not synthesize the AKPS data of 1 study[61] to avoid duplication of information, as it presented the same data as the study by Ferreira et al.[47]

## Self-Reported Function

**Anterior Knee Pain Scale.** Moderate certainty of evidence from 40 studies (2414 individuals) showed that individuals with PFP have reduced self-reported function measured with the AKPS compared with pain-free individuals (large effect size, SMD = −3.45; 95% CI = −3.84, −3.06; $I^2 = 88\%$; $P < .001$; Figure 2A).††

**Lower Extremity Function Scale.** Moderate certainty of evidence from 9 studies (593 individuals) showed that individuals with PFP have reduced self-reported function measured with the LEFS compared with pain-free individuals (large effect size, SMD = −3.83; 95% CI = −5.10, −2.55; $I^2 = 95\%$; $P < .001$; Figure 2B).[37,60,65,68–73]

**Functional Index Questionnaire.** Moderate certainty of evidence from 7 studies (337 individuals) showed that individuals with PFP have reduced self-reported function measured using the Functional Index Questionnaire compared with pain-free individuals (large effect size, SMD = −4.87; 95% CI = −6.97, −2.77; $I^2 = 96\%$; $P < .001$; Figure 2C).[28,74–77,105,106]

**Knee injury and Osteoarthritis Outcome Score.** High certainty of evidence from 5 studies (255 individuals) showed that individuals with PFP have reduced self-reported function measured using the KOOS compared with pain-free individuals (large effect size, SMD = −1.99; 95% CI = −2.41, −1.57; $I^2 = 43\%$; $P < .001$; Figure 2D).[78–81,83]

**Activities of Daily Living Questionnaire.** Moderate certainty of evidence from 5 studies (375 individuals) showed that individuals with PFP have reduced self-reported function measured using the Activities of Daily Living Questionnaire compared with pain-free individuals (large effect size, SMD = −2.79; 95% CI = −3.49, −2.08; $I^2 = 83\%$; $P < .001$; Figure 2E).[29,84–87]

**KOOS for PFP and Osteoarthritis.** Moderate certainty of evidence from 4 studies (124 individuals) showed that individuals with PFP have reduced self-reported function measured using the KOOS-PF compared with pain-free individuals (large effect size, SMD = −2.66; 95% CI = −3.47, −1.86; $I^2 = 60\%$; $P < .001$; Figure 2F).[9,79,88,110]

**Lysholm Knee Scoring Scale.** Moderate certainty of evidence from 3 studies (102 individuals) showed that individuals with PFP have reduced self-reported function measured using the Lysholm Knee Scoring Scale compared with pain-free individuals (large effect size, SMD = −2.23; 95% CI = −3.51, −0.96; $I^2 = 82\%$; $P < .001$; Figure 2G).[60,85,90]

## Performance-Based Measures of Function

**Balance Tests.** Low certainty of evidence from 12 studies (789 individuals) showed that individuals with PFP have reduced reach distance in balance tests compared with pain-free individuals (large effect size, SMD = −0.66; 95% CI = −1.12, −0.19; $I^2 = 88\%$; $P = .005$; Figure 3).‡‡ Low certainty of evidence from 2 studies (70 individuals) showed no differences between limbs for the YBT in individuals with unilateral PFP (small effect size, SMD = −0.20; 95% CI = −0.68, 0.27; $I^2 = 0\%$; $P = .39$; Figure 4).[22,88]

**Forward Step-Down Test.** Moderate certainty of evidence from 9 studies (737 individuals) showed that individuals with PFP have fewer repetitions in the FSDT

# *References 8–10, 22, 27–29, 35–81, 83–90, 92–99, 101, 103–106, 108–110.*

** *References 9, 10, 29, 59, 61, 62, 66, 67, 97, 99, 110.*

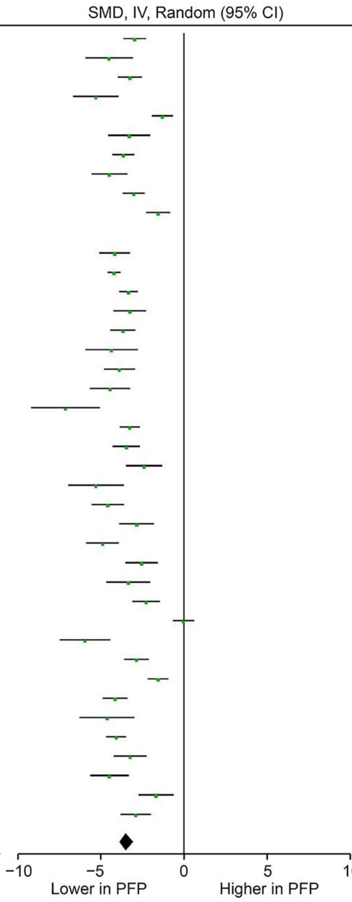
†† *References 8–10, 27, 29, 35–60, 63–67, 103–105, 110.*

‡‡ *References 29, 42, 60, 88, 89, 92–96, 108, 109.*

A

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Antunez et al[63] (2023) | 78.17 ± 8.12 | 75 | 100 ± 0.1 | 18 | 2.7 | −2.96 (−3.63, −2.28) |
| Baellow et al[37] (2020) | 74.47 ± 7.8 | 15 | 100 ± 0.1 | 15 | 2.1 | −4.50 (−5.92, −3.09) |
| Baellow et al[38] (2022) | 77.26 ± 9.8 | 35 | 100 ± 0.1 | 35 | 2.7 | −3.25 (−3.97, −2.52) |
| Bley et al[39] (2014) | 80.2 ± 4.9 | 20 | 99.5 ± 1.2 | 20 | 2.2 | −5.30 (−6.67, −3.93) |
| Branco et al[67] (2023) | 83.77 ± 10.41 | 26 | 95.08 ± 6.06 | 24 | 2.8 | −1.29 (−1.91, −0.68) |
| Carlson et al[40] (2017) | 61.1 ± 16.5 | 12 | 100 ± 0.1 | 13 | 2.3 | −3.30 (−4.56, −2.03) |
| Coelho et al[42] (2021) | 76.1 ± 9.2 | 48 | 100 ± 0.1 | 48 | 2.8 | −3.64 (−4.31, −2.98) |
| de Albuquerque et al[35] (2021) | 74.04 ± 7.2 | 26 | 98.96 ± 2.48 | 24 | 2.4 | −4.48 (−5.55, −3.41) |
| de Albuquerque et al[36] (2022) | 74.8 ± 11.7 | 40 | 100 ± 0.1 | 40 | 2.8 | −3.02 (−3.67, −2.37) |
| de Moura Campos Carvalho E Silva et al[41] (2014) | 78.9 ± 17.2 | 20 | 98.4 ± 2.3 | 20 | 2.7 | −1.56 (−2.27, −0.84) |
| de Oliveira Silva et al[43] (2015) | 72.6 ± 9.2 | 31 | 100 ± 0.1 | 31 | 2.6 | −4.16 (−5.06, −3.25) |
| de Oliveira Silva et al[44] (2018) | 71.96 ± 9.53 | 158 | 100 ± 0.1 | 165 | 2.9 | −4.20 (−4.59, −3.81) |
| de Oliveira Silva et al[45] (2018) | 72.9 ± 10 | 65 | 98.4 ± 2.5 | 53 | 2.8 | −3.33 (−3.89, −2.76) |
| Felicio et al[46] (2012) | 77.9 ± 8.8 | 19 | 99 ± 2.3 | 20 | 2.5 | −3.25 (−4.24, −2.27) |
| Ferreira et al[47] (2021) | 69.34 ± 11.7 | 38 | 100 ± 0.1 | 38 | 2.7 | −3.67 (−4.42, −2.92) |
| Ferreira et al[64] (2023) | 75.27 ± 7.98 | 11 | 99.69 ± 0.76 | 13 | 2.0 | −4.36 (−5.93, −2.79) |
| Gallina et al[48] (2018) | 74.3 ± 8.1 | 36 | 100 ± 0.1 | 20 | 2.6 | −3.89 (−4.81, −2.96) |
| Glaviano et al[8] (2017) | 75.3 ± 7.7 | 20 | 100 ± 0.1 | 20 | 2.3 | −4.45 (−5.64, −3.25) |
| Goharpey et al[27] (2007) | 78.26 ± 4.43 | 15 | 103 ± 1.79 | 15 | 1.6 | −7.12 (−9.19, −5.06) |
| Guimaraes Araujo et al[29] (2023) | 74.5 ± 10.5 | 50 | 99.2 ± 1.7 | 50 | 2.8 | −3.26 (−3.86, −2.65) |
| Jaffri and Baellow[65] (2023) | 77.22 ± 9.2 | 30 | 100 ± 0.1 | 30 | 2.6 | −3.46 (−4.27, −2.64) |
| Jeon et al[110] (2023) | 76.3 ± 12.8 | 12 | 99.2 ± 2.5 | 12 | 2.4 | −2.40 (−3.49, −1.31) |
| Kalytczak et al[49] (2016) | 80.43 ± 4.78 | 14 | 99.5 ± 1.29 | 14 | 1.9 | −5.29 (−6.96, −3.62) |
| Kızılkaya and Ecesoy[50] (2019) | 70.57 ± 8.37 | 30 | 98.58 ± 2.05 | 31 | 2.5 | −4.57 (−5.55, −3.59) |
| Muniz et al[51] (2023) | 86.8 ± 6.8 | 13 | 99.7 ± 0.8 | 18 | 2.5 | −2.84 (−3.89, −1.80) |
| Novello et al[52] (2018) | 67.35 ± 9.33 | 34 | 100 ± 0.1 | 34 | 2.5 | −4.89 (−5.86, −3.92) |
| Nunes et al[9] (2019) | 76.3 ± 12.5 | 16 | 99.5 ± 1.1 | 16 | 2.5 | −2.55 (−3.51, −1.59) |
| O'Sullivan et al[103] (2012) | 78 ± 9 | 12 | 100 ± 0.1 | 12 | 2.2 | −3.34 (−4.64, −2.03) |
| Ott et al[104] (2011) | 82.8 ± 9.98 | 20 | 99.4 ± 1.85 | 20 | 2.6 | −2.27 (−3.08, −1.46) |
| Pavone et al[53] (2022) | 98.47 ± 12.96 | 38 | 98.9 ± 15.3 | 13 | 2.8 | −0.03 (−0.66, 0.60) |
| Pazzinatto et al[54] (2017) | 80.45 ± 4.55 | 20 | 100 ± 0.1 | 20 | 2.1 | −5.95 (−7.46, −4.45) |
| Pazzinatto et al[55] (2019) | 70.3 ± 11.84 | 30 | 97.7 ± 6.27 | 30 | 2.7 | −2.85 (−3.59, −2.12) |
| Plastaras et al[56] (2016) | 85.7 ± 10.1 | 21 | 97.6 ± 5.7 | 36 | 2.8 | −1.54 (−2.16, −0.93) |
| Sanchis-Alfonso et al[66] (2023) | 49.2 ± 17 | 44 | 98.4 ± 2.7 | 50 | 2.7 | −4.14 (−4.87, −3.41) |
| Souza et al[105] (2017) | 72.3 ± 7.14 | 14 | 99.2 ± 1.92 | 10 | 2.0 | −4.62 (−6.26, −2.97) |
| van der Heijden et al[57] (2018) | 66.3 ± 11.6 | 64 | 99.5 ± 1.7 | 70 | 2.8 | −4.07 (−4.67, −3.47) |
| Willson and Davis[58] (2008) | 80.2 ± 8.5 | 20 | 100 ± 0.2 | 20 | 2.5 | −3.23 (−4.20, −2.26) |
| Yilmaz Yelvar et al[59] (2017) | 49.09 ± 15.78 | 22 | 100 ± 0.1 | 22 | 2.4 | −4.48 (−5.63, −3.34) |
| Zamboti et al[60] (2017) | 78.4 ± 16.5 | 10 | 98.9 ± 2.02 | 10 | 2.5 | −1.67 (−2.72, −0.62) |
| Zamboti et al[10] (2021) | 70.5 ± 11.61 | 20 | 96.7 ± 4.8 | 20 | 2.6 | −2.89 (−3.80, −1.98) |
| Total | | 1244 | | 1170 | 100.0 | −3.45 (−3.84, −3.06) |

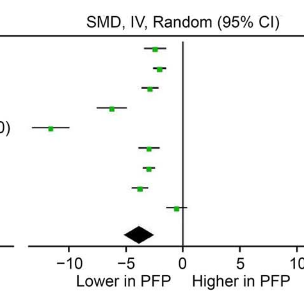
Heterogeneity: $\tau^2 = 1.33$, $\chi^2_{39} = 335.46$, $P < .001$, $I^2 = 88\%$
Test for overall effect: $Z = 17.30$, $P < .001$




B

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Baellow et al[37] (2020) | 80.66 ± 10.92 | 15 | 100 ± 0.1 | 15 | 11.1 | −2.44 (−3.41, −1.46) |
| Hoglund et al[68] (2018) | 68.17 ± 7.82 | 36 | 79.72 ± 0.78 | 36 | 11.6 | −2.06 (−2.63, −1.48) |
| Jaffri and Baellow[65] (2023) | 63.03 ± 8.17 | 30 | 80 ± 0.1 | 30 | 11.4 | −2.90 (−3.64, −2.16) |
| Kim et al[69] (2020) | 60 ± 4.3 | 26 | 78.9 ± 0.8 | 30 | 10.5 | −6.25 (−7.56, −4.94) |
| Kim and Park[70] (2022) | 55.2 ± 2.7 | 60 | 79.1 ± 0.5 | 48 | 9.9 | −11.62 (−13.25, −10.00) |
| Kim et al[73] (2023) | 58.8 ± 9.1 | 22 | 79.2 ± 1.3 | 19 | 11.2 | −2.97 (−3.88, −2.06) |
| Kim et al[72] (2024) | 55.44 ± 11.06 | 55 | 79.3 ± 1.83 | 55 | 11.6 | −2.99 (−3.54, −2.44) |
| Van Cant et al[71] (2017) | 58.6 ± 11.1 | 20 | 78.7 ± 1.9 | 76 | 11.4 | −3.78 (−4.52, −3.05) |
| Zamboti et al[60] (2017) | 74.7 ± 11.32 | 10 | 79.4 ± 0.7 | 10 | 11.2 | −0.56 (−1.46, 0.34) |
| Total | | 274 | | 319 | 100.0 | −3.83 (−5.10, −2.55) |

Heterogeneity: $\tau^2 = 3.56$, $\chi^2_8 = 176.23$, $P < .001$, $I^2 = 95\%$
Test for overall effect: $Z = 5.89$, $P < .001$




C

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Biabanimoghadam et al[75] (2016) | 12.3 ± 0.89 | 30 | 16 ± 0.1 | 30 | 14.5 | −5.77 (−6.95, −4.59) |
| Boling et al[106] (2006) | 10.2 ± 2.3 | 14 | 15.7 ± 0.7 | 14 | 14.5 | −3.14 (−4.30, −1.99) |
| Heydari Armaki et al[74] (2020) | 12.1 ± 0.78 | 20 | 16 ± 0.1 | 20 | 13.8 | −6.87 (−8.58, −5.17) |
| Kordi Yoosefinejad et al[77] (2022) | 11.58 ± 0.77 | 24 | 16 ± 0.1 | 24 | 13.7 | −7.92 (−9.67, −6.17) |
| Peeler and Anderson[28] (2007) | 79 ± 16.6 | 43 | 96 ± 10.3 | 40 | 15.0 | −1.21 (−1.68, −0.74) |
| Rojhani Shirazi et al[76] (2014) | 12.03 ± 0.89 | 27 | 16 ± 0.1 | 27 | 14.3 | −6.18 (−7.50, −4.86) |
| Souza et al[105] (2017) | 11.35 ± 1.72 | 14 | 16 ± 0.1 | 10 | 14.3 | −3.39 (−4.72, −2.07) |
| Total | | 172 | | 165 | 100.0 | −4.87 (−6.97, −2.77) |

Heterogeneity: $\tau^2 = 7.56$, $\chi^2_6 = 149.19$, $P < .001$, $I^2 = 96\%$
Test for overall effect: $Z = 4.55$, $P < .001$

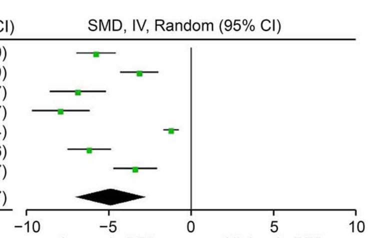
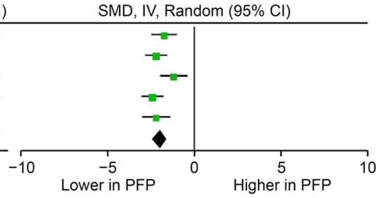



**Figure 2. Forest plots for self-reported function meta-analyses comparing individuals with patellofemoral pain and pain-free individuals. A, Anterior Knee Pain Scale. B, Lower Extremity Functional Scale. C, Functional Index Questionnaire. D, Knee injury and Osteoarthritis Outcome Score. E, Activities of Daily Living Questionnaire. F, Knee injury and Osteoarthritis Outcome Score for PFP and osteoarthritis. G, Lysholm Knee Scoring Scale. Abbreviations: IV, inverse variance; SMD, standardized mean difference.** **Continued on next page.**

D

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Crouzier et al[83] (2023) | 80.7 ± 14 | 20 | 98.8 ± 2.9 | 20 | 19.0 | −1.75 (−2.50, −1.01) |
| Holden et al[78] (2018) | 78 ± 13 | 36 | 100 ± 2 | 29 | 22.8 | −2.22 (−2.85, −1.59) |
| Liew et al[79] (2020) | 85.29 ± 17.83 | 14 | 100 ± 0.1 | 17 | 18.0 | −1.20 (−1.98, −0.42) |
| Rathleff et al[80] (2013) | 78 ± 10.5 | 57 | 99.9 ± 0.3 | 22 | 22.9 | −2.42 (−3.05, −1.80) |
| Rathleff et al[81] (2016) | 84 ± 10 | 20 | 100 ± 1 | 20 | 17.2 | −2.21 (−3.01, −1.40) |
| Total | | 147 | | 108 | 100.0 | −1.99 (−2.41, −1.57) |

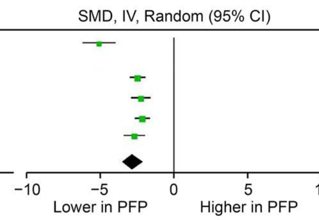
Heterogeneity: $\tau^2 = 0.10$, $\chi^2_4 = 6.96$, $P = .14$, $I^2 = 43\%$
Test for overall effect: $Z = 9.34$, $P < .001$




E

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| de Moura Campos Carvalho E Silva et al[84] (2016) | 74.4 ± 7.2 | 25 | 99.5 ± 0.8 | 30 | 15.3 | −5.07 (−6.19, −3.95) |
| Guimaraes Araujo et al[29] (2023) | 76.8 ± 12.8 | 50 | 99.5 ± 1.8 | 50 | 21.9 | −2.46 (−2.99, −1.94) |
| Kiliç et al[85] (2021) | 61.4 ± 11.5 | 30 | 79.8 ± 0.6 | 30 | 20.6 | −2.23 (−2.88, −1.58) |
| Magalhães et al[86] (2010) | 73.6 ± 17.16 | 50 | 99.8 ± 0.8 | 50 | 22.2 | −2.14 (−2.64, −1.65) |
| Piva et al[87] (2005) | 64.5 ± 18.4 | 30 | 99.8 ± 0.08 | 30 | 19.9 | −2.68 (−3.39, −1.97) |
| Total | | 185 | | 190 | 100.0 | −2.79 (−3.49, −2.08) |

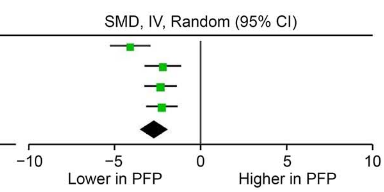
Heterogeneity: $\tau^2 = 0.51$, $\chi^2_4 = 23.24$, $P < .001$, $I^2 = 83\%$
Test for overall effect: $Z = 7.77$, $P < .001$




F

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Eckenrode et al[88] (2023) | 76.79 ± 7.62 | 17 | 98.89 ± 1.73 | 20 | 22.0 | −4.09 (−5.27, −2.91) |
| Jeon et al[110] (2023) | 65.8 ± 17.3 | 12 | 96.3 ± 7.8 | 12 | 24.4 | −2.19 (−3.24, −1.15) |
| Liew et al[79] (2020) | 68.99 ± 18.9 | 14 | 99.47 ± 1.71 | 17 | 26.5 | −2.33 (−3.28, −1.39) |
| Nunes et al[9] (2019) | 67.3 ± 19.3 | 16 | 98.9 ± 1.7 | 16 | 27.2 | −2.25 (−3.16, −1.34) |
| Total | | 59 | | 65 | 100.0 | −2.66 (−3.47, −1.86) |

Heterogeneity: $\tau^2 = 0.41$, $\chi^2_3 = 7.59$, $P = .06$, $I^2 = 60\%$
Test for overall effect: $Z = 6.48$, $P < .001$




G

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Ingram et al[90] (2016) | 73.3 ± 13.7 | 12 | 98 ± 6.3 | 10 | 31.4 | −2.16 (−3.25, −1.06) |
| Kiliç et al[85] (2021) | 70.4 ± 11.5 | 30 | 98.6 ± 3.5 | 30 | 35.4 | −3.27 (−4.06, −2.48) |
| Zamboti et al[60] (2017) | 82.7 ± 18.42 | 10 | 99 ± 2.11 | 10 | 33.1 | −1.19 (−2.16, −0.22) |
| Total | | 52 | | 50 | 100.0 | −2.23 (−3.51, −0.96) |

Heterogeneity: $\tau^2 = 1.03$, $\chi^2_2 = 10.88$, $P = .004$, $I^2 = 82\%$
Test for overall effect: $Z = 3.44$, $P < .001$

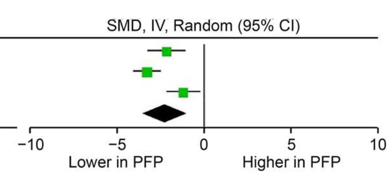



**Figure 2. Continued from previous page.**

compared with pain-free individuals (large effect size, SMD = −0.80; 95% CI = −1.11, −0.50; $I^2 = 68\%$; $P < .001$; Figure 3).§§ Very low certainty of evidence from 2 studies (106 individuals) showed no differences between limbs for repetitions in the FSDT in individuals with unilateral PFP (small effect size, SMD = −0.36, 95% CI = −1.11, 0.38; $I^2 = 73\%$; $P = .34$; Figure 4).[97,99]

**Single-Leg Hop Test.** Moderate certainty of evidence from 7 studies (711 individuals) indicated a shorter distance in the SLHT for individuals with PFP than for pain-free individuals (small effect size, SMD = −0.42; 95% CI = −0.57, −0.27; $I^2 = 0\%$; $P < .001$; Figure 3).[9,42,45,61,62,93,101] Evidence from 1 high-quality study showed a shorter distance in the SLHT for the PFP limb compared with the pain-free limb of individuals with unilateral PFP, but this result was not confirmed via the calculated SMD and 95% CI (small effect size, SMD = −0.29; 95% CI = −0.86, 0.28; $P = .32$; Figure 4).[99]

**Single-Leg Triple-Hop Test.** Moderate certainty of evidence from 2 studies (196 individuals) showed a shorter distance in the single-leg triple-hop test (SLTHT) in individuals with PFP than pain-free individuals (small effect size, SMD = −0.30, 95% CI = −0.58, −0.02; $I^2 = 0\%$; $P = .04$; Figure 3).[29,42]

**Bilateral Squat Test.** Moderate certainty of evidence from 2 pooled studies (70 individuals) showed no difference in the number of repetitions in the bilateral squat test between individuals with PFP and pain-free individuals (large effect size, SMD = −1.21; 95% CI = −2.71, 0.29; $I^2 = 86\%$; $P = .11$; Figure 3).[27,97]

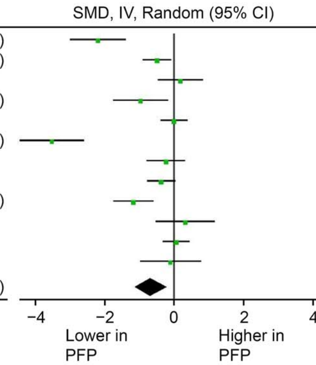
**Between-Limbs Comparisons for Other Performance-Based Measures.** Evidence from 1 study showed fewer repetitions for the anteromedial lunge in the PFP limb compared with the pain-free limb of individuals with unilateral PFP (moderate effect size, SMD = −0.64; 95% CI = −1.17, −0.11; $P = .02$) (Figure 4).[97] The same study showed fewer repetitions for the balance-and-reach test and lower scores in the single-leg press test in the PFP limb compared with the pain-free limb of individuals with unilateral PFP; however, this result

§§ *References 9, 27, 45, 61, 62, 93, 97, 98, 105.*

A

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight,[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Aminaka and Gribble et al[108] (2008) | 62.8 ± 1.2 | 20 | 65.6 ± 1.3 | 20 | 7.7 | −2.19 (−2.99, −1.39) |
| Coelho et al[42] (2021) | 58.6 ± 6.6 | 48 | 61.7 ± 5.9 | 48 | 9.2 | −0.49 (−0.90, −0.08) |
| Eckenrode et al[88] (2023) | 98.68 ± 8.34 | 17 | 97.07 ± 8.69 | 20 | 8.3 | 0.18 (−0.46, 0.83) |
| Goto et al[92] (2018) | 66.17 ± 4.99 | 14 | 70.84 ± 4.39 | 14 | 7.7 | −0.96 (−1.75, −0.18) |
| Guimaraes Araujo et al[29] (2023) | 0.6 ± 0.1 | 50 | 0.6 ± 0.1 | 50 | 9.3 | 0.00 (−0.39, 0.39) |
| Nafez et al[95] (2023) | 64.76 ± 3.32 | 26 | 76.42 ± 3.18 | 23 | 7.1 | −3.52 (−4.44, −2.61) |
| Nakagawa et al[94] (2020) | 64.19 ± 5.2 | 14 | 65.49 ± 5.62 | 121 | 8.7 | −0.23 (−0.79, 0.32) |
| Priore et al[93] (2019) | 76 ± 8 | 55 | 79 ± 8 | 40 | 9.2 | −0.37 (−0.78, 0.04) |
| Shallan et al[89] (2023) | 56.05 ± 6.56 | 40 | 62.9 ± 3.7 | 20 | 8.6 | −1.17 (−1.75, −0.59) |
| Song et al[109] (2017) | 65.57 ± 4.83 | 16 | 63.54 ± 8.1 | 8 | 7.4 | 0.32 (−0.53, 1.18) |
| Steinberg et al[96] (2020) | 56.98 ± 6.07 | 56 | 56.62 ± 5.16 | 49 | 9.3 | 0.06 (−0.32, 0.45) |
| Zamboti et al[60] (2017) | 80.55 ± 4.72 | 10 | 81.05 ± 4.58 | 10 | 7.3 | −0.10 (−0.98, 0.77) |
| Total | | 366 | | 423 | 100.0 | −0.66 (−1.12, −0.19) |

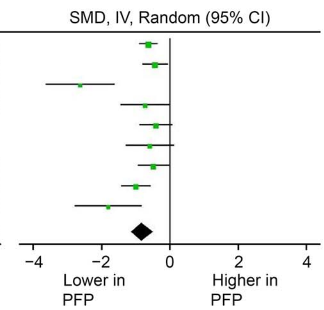
Heterogeneity: $\tau^2 = 0.56$, $\chi^2_{11} = 88.86$, $P < .001$, $I^2 = 88\%$
Test for overall effect: $Z = 2.78$, $P = .005$




B

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight,[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Botta et al[61] (2021) | 16.76 ± 7.12 | 148 | 21 ± 6.07 | 92 | 16.0 | −0.63 (−0.89, −0.36) |
| de Oliveira Silva et al[45] (2018) | 17.7 ± 5.6 | 65 | 20.2 ± 6 | 53 | 14.4 | −0.43 (−0.80, −0.06) |
| Goharpey et al[27] (2007) | 14.06 ± 1.9 | 15 | 18.93 ± 1.7 | 15 | 6.1 | −2.63 (−3.64, −1.62) |
| Loudon et al[97] (2002) | 13.93 ± 5.49 | 29 | 17.75 ± 4.03 | 11 | 9.1 | −0.73 (−1.44, −0.01) |
| Naserpour et al[98] (2018) | 20.84 ± 4.23 | 34 | 22.29 ± 2.71 | 34 | 12.6 | −0.40 (−0.88, 0.08) |
| Nunes et al[9] (2019) | 25 ± 5 | 16 | 28 ± 5 | 16 | 9.2 | −0.58 (−1.29, 0.12) |
| Pazzinatto et al[62] (2023) | 15.2 ± 5.9 | 27 | 17.9 ± 5.4 | 63 | 13.0 | −0.48 (−0.94, −0.03) |
| Priore et al[93] (2019) | 18 ± 5 | 55 | 23 ± 5 | 40 | 13.4 | −0.99 (−1.42, −0.56) |
| Souza et al[105] (2017) | 9.42 ± 1.3 | 14 | 12.88 ± 2.43 | 10 | 6.3 | −1.81 (−2.79, −0.82) |
| Total | | 403 | | 334 | 100.0 | −0.80 (−1.11, −0.50) |

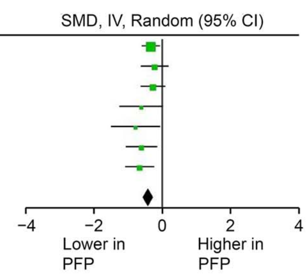
Heterogeneity: $\tau^2 = 0.13$, $\chi^2_8 = 25.33$, $P = .001$, $I^2 = 68\%$
Test for overall effect: $Z = 5.15$, $P < .001$




C

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight,[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Botta et al[61] (2021) | 90.06 ± 24.76 | 148 | 98.26 ± 23.41 | 92 | 33.8 | −0.34 (−0.60, −0.08) |
| Coelho et al[42] (2021) | 4.2 ± 0.9 | 48 | 4.4 ± 0.9 | 48 | 14.4 | −0.22 (−0.62, 0.18) |
| de Oliveira Silva et al[45] (2018) | 88.1 ± 19.5 | 65 | 93.5 ± 19.5 | 53 | 17.5 | −0.28 (−0.64, 0.09) |
| dos Reis et al[101] (2015) | 0.96 ± 0.11 | 20 | 1.05 ± 0.17 | 20 | 5.7 | −0.62 (−1.25, 0.02) |
| Nunes et al[9] (2019) | 90 ± 29 | 16 | 113 ± 28 | 16 | 4.4 | −0.79 (−1.51, −0.06) |
| Pazzinatto et al[62] (2023) | 73.4 ± 15.5 | 27 | 83.5 ± 16.8 | 63 | 11.0 | −0.61 (−1.07, −0.15) |
| Priore et al[93] (2019) | 84.4 ± 16.18 | 55 | 95.81 ± 18.14 | 40 | 13.2 | −0.66 (−1.08, −0.25) |
| Total | | 379 | | 332 | 100.0 | −0.42 (−0.57, −0.27) |

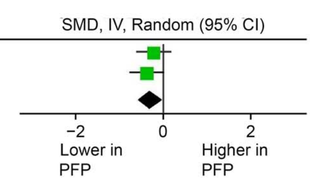
Heterogeneity: $\tau^2 = 0.00$, $\chi^2_6 = 5.26$, $P = .51$, $I^2 = 0\%$
Test for overall effect: $Z = 5.39$, $P < .001$




D

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight,[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Coelho et al[42] (2021) | 4.2 ± 0.9 | 48 | 4.4 ± 0.9 | 48 | 49.3 | −0.22 (−0.62, 0.18) |
| Guimaraes Araujo et al[29] (2023) | 290.6 ± 59.8 | 50 | 312.4 ± 54.4 | 50 | 50.7 | −0.38 (−0.77, 0.02) |
| Total | | 98 | | 98 | 100.0 | −0.30 (−0.58, −0.02) |

Heterogeneity: $\tau^2 = 0.00$, $\chi^2_1 = 0.30$, $P = .58$, $I^2 = 0\%$
Test for overall effect: $Z = 2.09$, $P = .04$




E

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Total, No. | Pain-Free Group Mean ± SD | Total, No. | Weight,[a] % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| Goharpey et al[27] (2007) | 14.06 ± 2.28 | 15 | 19.4 ± 2.87 | 15 | 48.2 | −2.00 (−2.90, −1.11) |
| Loudon et al[97] (2002) | 16.51 ± 7.21 | 29 | 19.6 ± 3.01 | 11 | 51.8 | −0.47 (−1.18, 0.23) |
| Total | | 44 | | 26 | 100.0 | −1.21 (−2.71, 0.29) |

Heterogeneity: $\tau^2 = 1.00$, $\chi^2_1 = 6.90$, $P = .009$, $I^2 = 86\%$
Test for overall effect: $Z = 1.59$, $P = .11$

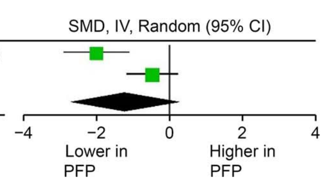



**Figure 3. Forest plots for performance-based measures of function meta-analyses comparing individuals with patellofemoral pain and pain-free individuals. A, Balance tests. B, Forward step-down test. C, Single-legged hop test. D, Single-legged triple-hop test. E, Bilateral squat test. Abbreviations: IV, inverse variance; SMD, standardized mean difference.**

| Study or Subgroup (Year) | Patellofemoral Pain Group Mean ± SD | Patellofemoral Pain Group Total, No. | Pain-Free Group Mean ± SD | Pain-Free Group Total, No. | Weight, % | SMD, IV, Random (95% CI) |
|---|---|---|---|---|---|---|
| **A** | | | | | | |
| Eckenrode et al[88] (2023) | 98.68 ± 8.34 | 17 | 98.94 ± 9.19 | 17 | 49.1 | −0.03 (−0.70, 0.64) |
| Miller et al[22] (2013) | 91.08 ± 9.47 | 18 | 94.84 ± 10.16 | 18 | 50.9 | −0.37 (−1.03, 0.29) |
| Subtotal | | 35 | | 35 | 100.0 | −0.20 (−0.68, 0.27) |
| Heterogeneity: τ$^2$ = 0.00, $\chi^2_1$ = 0.52, *P* = .47, $I^2$ = 0% | | | | | | |
| Test for overall effect: *Z* = 0.85, *P* = .39 | | | | | | |
| **B** | | | | | | |
| Kaya et al[99] (2011) | 9.9 ± 24 | 24 | 9.5 ± 2.3 | 24 | 49.2 | 0.02 (−0.54, 0.59) |
| Loudon et al[97] (2002) | 13.93 ± 5.49 | 29 | 17.31 ± 3.28 | 29 | 50.8 | −0.74 (−1.27, −0.20) |
| Subtotal | | 53 | | 53 | 100.0 | −0.36 (−1.11, 0.38) |
| Heterogeneity: τ$^2$ = 0.21, $\chi^2_1$ = 3.68, *P* = .06, $I^2$ = 73% | | | | | | |
| Test for overall effect: *Z* = 0.96, *P* = .34 | | | | | | |
| **C** | | | | | | |
| Kaya et al[99] (2011) | 86.4 ± 15.9 | 24 | 91.1 ± 16.1 | 24 | 100.0 | −0.29 (−0.86, 0.28) |
| Subtotal | | 24 | | 24 | 100.0 | −0.29 (−0.86, 0.28) |
| Heterogeneity: not applicable | | | | | | |
| Test for overall effect: *Z* = 1.00, *P* = .32 | | | | | | |
| **D** | | | | | | |
| Loudon et al[97] (2002) | 17.93 ± 5.55 | 29 | 19.9 ± 5.6 | 29 | 100.0 | −0.35 (−0.87, 0.17) |
| Subtotal | | 29 | | 29 | 100.0 | −0.35 (−0.87, 0.17) |
| Heterogeneity: not applicable | | | | | | |
| Test for overall effect: *Z* = 1.32, *P* = .19 | | | | | | |
| **E** | | | | | | |
| Loudon et al[97] (2002) | 11.72 ± 3.07 | 29 | 13.56 ± 2.58 | 29 | 100.0 | −0.64 (−1.17, −0.11) |
| Subtotal | | 29 | | 29 | 100.0 | −0.64 (−1.17, −0.11) |
| Heterogeneity: not applicable | | | | | | |
| Test for overall effect: *Z* = 2.37, *P* = .02 | | | | | | |
| **F** | | | | | | |
| Loudon et al[97] (2002) | 13.69 ± 4.69 | 29 | 16 ± 4.52 | 29 | 100.0 | −0.49 (−1.02, 0.03) |
| Subtotal | | 29 | | 29 | 100.0 | −0.49 (−1.02, 0.03) |
| Heterogeneity: not applicable | | | | | | |
| Test for overall effect: *Z* = 1.85, *P* = .06 | | | | | | |
| Test for subgroup differences: $\chi^2_5$ = 1.76, *P* = .88, $I^2$ = 0% | | | | | | |

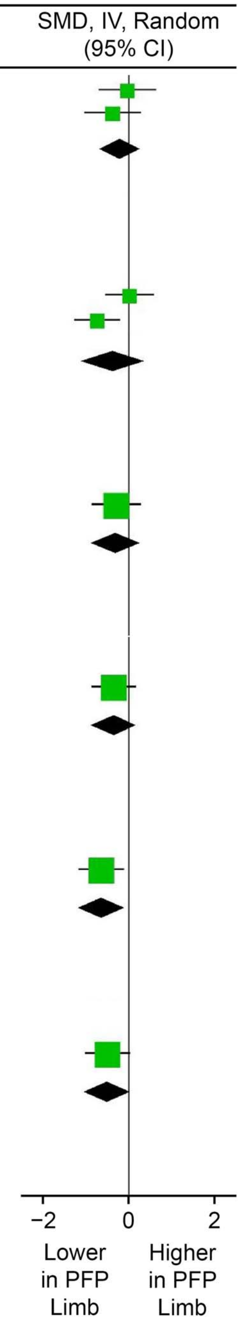



**Figure 4. Forest plots for performance-based measures of function meta-analyses comparing patellofemoral pain and contralateral pain-free limbs of individuals with unilateral patellofemoral pain. A, Balance tests. B, Forward step-down test. C, Single-legged hop test. D, Balance-and-reach test. E, Anterior lunge. F, Single-legged press test. Abbreviations: IV, inverse variance; SMD, standardized mean difference.**

was not confirmed by the SMDs and 95% CIs (small effect sizes, SMD = −0.35; 95% CI = −0.87, 0.17; *P* = .19 and SMD = −0.49; 95% CI = −1.02, 0.03; *P* = .06, respectively) (Figure 4).[97]

## Meta-Regressions

We could only perform meta-regressions for self-reported function measured using the AKPS and the following predictors: age (in years), BMI, duration of symptoms (in months), and self-reported pain (score). Meta-regressions could be performed only for performance-based function measured using balance tests and age (in years) (Supplemental Figure 2).

Meta-regression results indicated no relationship between self-reported function and age (40 studies[‖‖]; $R^2 < .01$, $P = .54$); BMI (20 studies[¶¶]; $R^2 < .01$, $P = .18$); duration of

[‖‖] *References 8–10, 27, 29, 35–60, 63–67, 103–105, 110.*

[¶¶] *References 10, 27, 35, 36, 39, 40, 44, 45, 47–50, 52, 55, 57, 59, 60, 64, 103, 104.*

symptoms (21 studies##; $R^2 < .01$, $P = .86$); and worst level of pain in the last month, week, or 24 to 72 hours (15 studies***; $R^2 = .02$, $P = .15$) (Supplemental Figure 2). No relationship was observed between performance-based function and age (12 studies; $R^2 < .01$, $P = .91$; Supplemental Figure 2).†††

## DISCUSSION

We identified 83 studies investigating self-reported or performance-based measures of function in individuals with PFP. Moderate to high certainty of evidence demonstrated that individuals with PFP have impaired self-reported function compared with pain-free individuals, regardless of instrumentation. Very low to moderate certainty of evidence also demonstrated between-groups (ie, individuals with PFP vs pain-free individuals) but not between-limbs (ie, painful vs pain-free limb of individuals with PFP) differences for most of the performance-based measures of function. Reduced performance between individuals with PFP and pain-free individuals was observed in tasks simulating dynamic balance (eg, YBT), stepping (eg, FSDT), or hopping (eg, SLHT). Our results highlight the negative effect of PFP on self-reported and performance-based measures of function. However, none of the predictors investigated in our study (ie, age, BMI, duration of symptoms, and self-reported pain) could explain impaired self-reported or performance-based function in individuals with PFP.

### Self-Reported Function

We identified that individuals with PFP have impaired self-reported function compared with pain-free individuals. This finding is based on large effects across 7 different questionnaires/scales and supports previous evidence considering self-reported measures of function as determinants of treatment success or patient recovery after nonoperative management of PFP.[12,15] Impaired self-reported function as a consequence of having PFP not only affects individuals' perception and perspectives about their physical function[5,111] but also can predict persistent or recurrent PFP (ie, poor prognosis) in the medium and long term.[11,112,113] Along with previous evidence, our results highlight the need to consider self-reported function as one of the primary condition-specific outcome measures during rehabilitation of individuals with PFP.

The assessment of self-reported function is clinician friendly and strongly recommended by the REPORT-PFP.[19] Recommended questionnaires include the AKPS (also known as the *Kujala scale*) and the KOOS-PF.[19] Although the AKPS is by far the most commonly used questionnaire (42 studies‡‡‡ included in our review), the recently developed KOOS-PF[114] seems to have better content validity, reliability, construct validity, and responsiveness.[115,116] The KOOS-PF is also more feasible for clinical use due to the its ease of administration and scoring, smaller number of items, and short time to complete.[116] Changes in KOOS-PF ranging from 16 to 17.2 have been suggested to detect meaningful differences postintervention.[116] However, only 5 studies included in our review used the KOOS-PF.[9,79,88,89,110] More studies using the KOOS-PF to assess self-reported function of individuals with PFP are needed to further support the recommendation for using this tool instead of the AKPS.

### Physical Performance

Performance-based measures of function can complement information from self-reported measures by objectively quantifying functional impairments using physical performance tests that are clinically accessible, low-cost, and time efficient.[117,118] We identified that individuals with PFP have impaired physical performance compared with pain-free individuals during balance tests FSDT, SLHT, and SLTHT. These tests are easily measured in clinical settings, and they represent aspects of daily function or sport and simulate common pain-provoking tasks (eg, stepping, jumping, and landing).[93,94,119] Given that self-reported function does not fully reflect the magnitude of performance deficits, we recommend using performance-based measures of function when assessing individuals with PFP. Whereas balance tests and FSDT may be more useful for evaluating sedentary or lower-functioning individuals due to their reduced physical demand, the SLHT may be used for athletic populations as it is more challenging. In a recent review, Berg et al also recommended the use of the SLHT for assessing performance deficits of youth and young adults, given its sufficient intrarater reliability, construct validity, and responsiveness.[117]

Although we observed that performance during balance tests FSDT, SLHT, and SLTHT was impaired when compared with that of controls, we found no differences between the painful and pain-free limbs of individuals with unilateral PFP. This suggested that the functional performance of the pain-free limb may be also compromised in individuals with PFP, as recently reported by Waiteman et al.[120] Individuals with PFP have reduced physical activity, which may result in reduced bilateral lower limb muscle strength and physical performance, regardless of pain laterality.[8,121] Reduced pain-free limb performance may also be a consequence of fear-avoidance belief, a commonly reported trait in this population.[7,93] Caution is warranted when comparing limbs using performance-based measures of function in clinical practice, as the pain-free limb of individuals with unilateral PFP may not be an accurate comparator.[122] In the absence of reference values of performance-based measures of function for individuals with PFP, we encourage pretest and posttest bilateral assessments to aid clinicians in their decision-making processes because changes may occur bilaterally.[123,124] Future research is needed to provide reference values from age- and sex-matched pain-free samples, as the use of the contralateral limb does not seem appropriate.

### Predictors of Self-Reported or Performance-Based Function

We performed meta-regressions to investigate physical and nonphysical factors that might explain poor self-reported and

## *References 8–10, 35, 37, 38, 41, 42, 46, 47, 50, 51, 53–55, 57, 59, 60, 63, 64, 110.*

*** *References 8, 9, 36–39, 43, 44, 47, 49, 52, 54, 55, 65, 105.*

††† *References 29, 42, 60, 88, 89, 92–96, 108, 109.*

‡‡‡ *References 8–10, 27, 29, 35–67, 103–105.*

performance-based function in individuals with PFP. We observed no relationships between self-reported function and age, BMI, or duration of symptoms. Similarly, no relationship between performance-based function and age was observed. Although researchers have reported a direct relationship between these factors and clinical outcomes in PFP (eg, higher BMI was related to lower functional capacity), our findings showed that this relationship does not explain differences between groups.[125,126] This means that individuals with PFP have lower self-reported and performance-based function compared with pain-free controls regardless of age, BMI, or duration of symptoms. Another reason that we did not observe relationships between function and these variables is that, as commonly reported in PFP, most individuals from the studies included in this review had normal BMI (mean ± SD BMI of individuals with PFP = 23.04 ± 3.58 kg/m$^2$ and of pain-free individuals = 22.30 ± 3.05 kg/m$^2$) and were young adults (mean ± SD age of individuals with PFP = 22.91 ± 6.55 years and of pain-free individuals = 23.24 ± 6.23 years).[125] This results in a constrained range of age and BMI across studies and may have influenced statistical analysis. Other factors, such as quadriceps strength, kinesiophobia, or both, may be more associated with impaired self-reported or performance-based function, as previously reported.[13,127,128] Quadriceps strength and kinesiophobia have been reported to be associated with pain intensity in individuals with PFP, which plays an important role in the perception of disability and function.[7,129,130] These uncontrolled factors may also be the source of potential heterogeneity between the studies. More studies are needed to better understand what physical and nonphysical factors might explain impaired self-reported and performance-based function in individuals with PFP. Furthermore, more longitudinal studies are necessary to investigate how function changes across time in individuals with PFP.

We also did not observe a relationship between self-reported function and self-reported pain. Glaviano et al reported high pain variability in individuals with PFP over 10 days, which explained almost 60% of the variance in self-reported function.[131] One should assume that traditional methods of assessing pain (eg, worst levels of pain in the last month or week) used in the studies included in our review may not be sensitive to pain variation and are also more susceptible to recall bias.[132] Longitudinal pain assessments of daily pain variability over a period may be better suited to investigate the relationship between self-reported pain and function in individuals with PFP versus isolated pain observations.

### Limitations

The design of studies included in the review did not allow us to infer causality of self-reported and performance-based measures of function in individuals with PFP. We did not review the gray literature; thus, relevant but unpublished studies may have been excluded from our findings. In addition, the limited number of studies did not allow us to investigate whether other important physical and nonphysical predictors (eg, hip and knee strength, physical activity level, and psychological factors) may be more associated with self-reported and performance-based measures of function. More studies following the REPORT-PFP guidelines are needed to fill this gap in the literature.

## CONCLUSIONS

Individuals with PFP have impaired self-reported and performance-based function compared with pain-free individuals. Our results also suggest a negative effect of PFP on performance-based measures of function on the pain-free limb of individuals with unilateral PFP. No physical or nonphysical factors explain impaired self-reported function in individuals with PFP. Both self-reported and performance-based measures of function should be clinically assessed when treating individuals with PFP.

## ACKNOWLEDGMENTS

This work was supported by grants 2022/06403-9 (Dr Briani) and 2023/15990-8 (Ms Botta) from the Sao Paulo Research Foundation (FAPESP) and by the Coordination for the Improvement of Higher Education Personnel (CAPES) (Ms Botta). The funders played no role in the design, conduct, or reporting.

## REFERENCES

1. Smith BE, Selfe J, Thacker D, et al. Incidence and prevalence of patellofemoral pain: a systematic review and meta-analysis. *PLoS One*. 2018;13(1):e0190892. doi:10.1371/journal.pone.0190892
2. Crossley KM, Stefanik JJ, Selfe J, et al. 2016 Patellofemoral pain consensus statement from the 4th International Patellofemoral Pain Research Retreat, Manchester, part 1: terminology, definitions, clinical examination, natural history, patellofemoral osteoarthritis and patient-reported outcome. *Br J Sports Med*. 2016;50(14):839–843. doi:10.1136/bjsports-2016-096384
3. Djurtoft C, Yona T, Roos EM, et al. Quality of life in adolescents with longstanding non-traumatic knee pain: an analysis of 316 adolescents with patellofemoral pain and Osgood-Schlatter disease. *Phys Ther Sport*. 2023;61:156–164. doi:10.1016/j.ptsp.2023.04.001
4. Coburn SL, Barton CJ, Filbay SR, Hart HF, Rathleff MS, Crossley KM. Quality of life in individuals with patellofemoral pain: a systematic review including meta-analysis. *Phys Ther Sport*. 2018;33:96–108. doi:10.1016/j.ptsp.2018.06.006
5. Glaviano NR, Holden S, Bazett-Jones DM, Singe SM, Rathleff MS. Living well (or not) with patellofemoral pain: a qualitative study. *Phys Ther Sport*. 2022;56:1–7. doi:10.1016/j.ptsp.2022.05.011
6. Vicenzino BT, Rathleff MS, Holden S, et al. Developing clinical and research priorities for pain and psychological features in people with patellofemoral pain: an international consensus process with health care professionals. *J Orthop Sport Phys Ther*. 2022;52(1):29–39. doi:10.2519/jospt.2022.10647
7. Botta AFB, de Cássia Pinto da Silva J, Dos Santos Lopes H, Boling MC, Briani RV, de Azevedo FM. Group- and sex-related differences in psychological and pain processing factors in people with and without patellofemoral pain: correlation with clinical outcomes. *BMC Musculoskelet Disord*. 2023;24(1):397. doi:10.1186/s12891-023-06513-8
8. Glaviano NR, Baellow A, Saliba S. Physical activity levels in individuals with and without patellofemoral pain. *Phys Ther Sport*. 2017;27:12–16. doi:10.1016/j.ptsp.2017.07.002
9. Nunes GS, de Oliveira Silva D, Crossley KM, Serrão FV, Pizzari T, Barton CJ. People with patellofemoral pain have impaired functional performance, that is correlated to hip muscle capacity. *Phys Ther Sport*. 2019;40:85–90. doi:10.1016/j.ptsp.2019.08.010
10. Zamboti CL, Marçal Camillo CA, Ricardo Rodrigues da Cunha AP, Ferreira TM, Macedo CSG. Impaired performance of women with patellofemoral pain during functional tests. *Braz J Phys Ther*. 2021;25(2):156–161. doi:10.1016/j.bjpt.2020.05.002
11. Lankhorst NE, van Middelkoop M, Crossley KM, et al. Factors that predict a poor outcome 5–8 years after the diagnosis of

patellofemoral pain: a multicentre observational analysis. *Br J Sports Med*. 2016;50(14):881–886. doi:10.1136/bjsports-2015-094664
12. Willy RW, Hoglund LT, Barton CJ, et al. Patellofemoral pain. *J Orthop Sports Phys Ther*. 2019;49(9):CPG1–CPG95. doi:10.2519/jospt.2019.0302
13. Rethman KK, Mansfield CJ, Moeller J, et al. Kinesiophobia is associated with poor function and modifiable through interventions in people with patellofemoral pain: a systematic review with individual participant data correlation meta-analysis. *Phys Ther*. 2023;103(9): pzad074. doi:10.1093/ptj/pzad074
14. Briani RV, de Oliveira Silva D, Ducatti MHM, et al. Knee flexor strength and rate of torque development deficits in women with patellofemoral pain are related to poor objective function. *Gait Posture*. 2021;83:100–106. doi:10.1016/j.gaitpost.2020.10.011
15. Neal BS, Bartholomew C, Barton CJ, Morrissey D, Lack SD. Six treatments have positive effects at 3 months for people with patellofemoral pain: a systematic review with meta-analysis. *J Orthop Sports Phys Ther*. 2022;52(11):750–768. doi:10.2519/jospt.2022.11359
16. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71. doi:10.1136/bmj.n71
17. Oliveira CB, Elkins MR, Lemes ÍR, et al. A low proportion of systematic reviews in physical therapy are registered: a survey of 150 published systematic reviews. *Braz J Phys Ther*. 2018;22(3):177–183. doi:10.1016/j.bjpt.2017.09.009
18. Babineau J. Product review: Covidence (systematic review software). *J Can Health Libr Assoc*. 2014;35(2):68–71. doi:10.5596/c14-016
19. Barton CJ, De Oliveira Silva D, Morton S, et al. REPORT-PFP: a consensus from the International Patellofemoral Research Network to improve REPORTing of quantitative PatelloFemoral Pain studies. *Br J Sports Med*. 2021;55(20):1135–1143. doi:10.1136/bjsports-2020-103700
20. Powers CM, Witvrouw E, Davis IS, Crossley KM. Evidence-based framework for a pathomechanical model of patellofemoral pain: 2017 patellofemoral pain consensus statement from the 4th International Patellofemoral Pain Research Retreat, Manchester, UK, part 3. *Br J Sports Med*. 2017;51(24):1713–1723. doi:10.1136/bjsports-2017-098717
21. Hart HF, Crossley KM, Culvenor AG, et al. Knee confidence, fear of movement, and psychological readiness for sport in individuals with knee conditions: a systematic review and meta-analysis. *J Orthop Sports Phys Ther*. 2024;54(4):234–247. doi:10.2519/jospt.2024.12070
22. Miller J, Westrick R, Diebal A, Marks C, Gerber JP. Immediate effects of lumbopelvic manipulation and lateral gluteal kinesio taping on unilateral patellofemoral pain syndrome: a pilot study. *Sports Health*. 2013;5(3):214–219. doi:10.1177/1941738112473561
23. Maher CG, Sherrington C, Herbert RD, Moseley AM, Elkins M. Reliability of the PEDro scale for rating quality of randomized controlled trials. *Phys Ther*. 2003;83(8):713–721. doi:10.1093/ptj/83.8.713
24. Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JA. Assessing risk of bias in a randomized trial. In: Higgins JPT, Thomas J, Chandler J, et al, eds. *Cochrane Handbook for Systematic Reviews of Interventions*. Version 6.3. Cochrane; 2022.
25. Higgins JP, Green S, eds. *Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0*. The Cochrane Collaboration; 2011.
26. Sterne JA, Hernán MA, Reeves BC, et al. ROBINS-I: a tool for assessing risk of bias in non-randomised studies of interventions. *BMJ*. 2016;355:i4919. doi:10.1136/bmj.i4919
27. Goharpey S, Shaterzadeh MJ, Emrani A, Khalesi V. Relationship between functional tests and knee muscular isokinetic parameters in patients with patellofemoral pain syndrome. *J Med Sci*. 2007;7(8):1315–1319. doi:10.3923/jms.2007.1315.1319
28. Peeler J, Anderson JE. Effectiveness of static quadriceps stretching in individuals with patellofemoral joint pain. *Clin J Sport Med*. 2007;17(4):234–241. doi:10.1097/JSM.0b013e3180f60afc
29. Guimaraes Araujo S, Rocha Nascimento L, Ramiro Felício L. Functional tests in women with patellofemoral pain: which tests make a difference in physical therapy evaluation. *Knee*. 2023;42:347–356. doi:10.1016/j.knee.2023.04.012
30. Cohen J. *Statistical Power Analysis for the Behavioral Sciences*. 2nd ed. Lawrence Erlbaum Associates; 1988.
31. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *BMJ*. 2003;327(7414):557–560. doi:10.1136/bmj.327.7414.557
32. Schünemann H, Brożek J, Guyatt G, Oxman A. *GRADE Handbook.* The GRADE Working Group; 2013.
33. Oliveira CB, Maher CG, Franco MR, et al. Co-occurrence of chronic musculoskeletal pain and cardiovascular diseases: a systematic review with meta-analysis. *Pain Med*. 2020;21(6):1106–1121. doi:10.1093/pm/pnz217
34. Guyatt GH, Oxman AD, Sultan S, et al; GRADE Working Group. GRADE guidelines, IX: rating up the quality of evidence. *J Clin Epidemiol*. 2011;64(12):1311–1316. doi:10.1016/j.jclinepi.2011.06.004
35. de Albuquerque TAB, Liebano RE, Biasotto-Gonzalez DA, Lopes Ferreira C, Lucareli PRG. Correlation of pain sensitization with muscle strength and angular kinematics in women with patellofemoral pain. *Clin Biomech* (*Bristol, Avon*). 2021;81:105217. doi:10.1016/j.clinbiomech.2020.105217
36. de Albuquerque CE, Bibin F, Bussarolo JM, Dalmolin EB, Ricardo Flor Bertolini G, Nuñez SC. The influence of iliotibial tract thickness on clinical outcomes in women with patellofemoral pain. *Knee*. 2022;39:319–324. doi:10.1016/j.knee.2022.10.007
37. Baellow A, Glaviano NR, Hertel J, Saliba SA. Lower extremity biomechanics during a drop-vertical jump and muscle strength in women with patellofemoral pain. *J Athl Train*. 2020;55(6):615–622. doi:10.4085/1062-6050-476-18
38. Baellow A, Jaffri AH, Hertel J, et al. Intrinsic foot muscle size and quality in a single leg weight bearing position across foot posture types in individuals with patellofemoral pain compared to healthy. *Phys Ther Sport*. 2022;54:58–64. doi:10.1016/j.ptsp.2022.01.002
39. Bley AS, Correa JC, Dos Reis AC, Rabelo ND, Marchetti PH, Lucareli PR. Propulsion phase of the single leg triple hop test in women with patellofemoral pain syndrome: a biomechanical study. *PLoS One*. 2014;9(5):e97606. doi:10.1371/journal.pone.0097606
40. Carlson VR, Boden BP, Sheehan FT. Patellofemoral kinematics and tibial tuberosity-trochlear groove distances in female adolescents with patellofemoral pain. *Am J Sports Med*. 2017;45(5):1102–1109. doi:10.1177/0363546516679139.
41. de Moura Campos Carvalho E Silva AP, Magalhães E, Bryk FF, Fukuda TY. Comparison of isometric ankle strength between females with and without patellofemoral pain syndrome. *Int J Sports Phys Ther*. 2014;9(5):628–634.
42. Coelho VK, Gomes BSQ, Lopes TJA, Corrêa LA, Telles GF, Nogueira LAC. Knee proprioceptive function and physical performance of patients with patellofemoral pain: a matched case-control study. *Knee*. 2021;33:49–57. doi:10.1016/j.knee.2021.08.031
43. de Oliveira Silva D, Briani R, Pazzinatto M, Ferrari D, Aragão F, De Azevedo F. Vertical ground reaction forces are associated with pain and self-reported functional status in recreational athletes with patellofemoral pain. *J Appl Biomech*. 2015;31(6):409–414. doi:10.1123/jab.2015-0048
44. de Oliveira Silva D, Pazzinatto MF, Priore LBD, et al. Knee crepitus is prevalent in women with patellofemoral pain, but is not related with function, physical activity and pain. *Phys Ther Sport*. 2018;33:7–11. doi:10.1016/j.ptsp.2018.06.002
45. de Oliveira Silva D, Barton C, Crossley K, et al. Implications of knee crepitus to the overall clinical presentation of women with and without patellofemoral pain. *Phys Ther Sport*. 2018;33:89–95. doi:10.1016/j.ptsp.2018.07.007
46. Felicio LR, Saad MC, Liporaci RF, Baffa Ado P, dos Santos AC, Bevilaqua-Grossi D. Correlation between trochlear groove depth and

patellar position during open and closed kinetic chain exercises in subjects with anterior knee pain. *J Appl Biomech*. 2012;28(3):335–342. doi:10.1123/jab.28.3.335
47. Ferreira AS, de Oliveira Silva D, Barton CJ, et al. Impaired isometric, concentric, and eccentric rate of torque development at the hip and knee in patellofemoral pain. *J Strength Cond Res*. 2021;35(9):2492–2497. doi:10.1519/JSC.0000000000003179
48. Gallina A, Hunt MA, Hodges PW, Garland SJ. Vastus lateralis motor unit firing rate is higher in women with patellofemoral pain. *Arch Phys Med Rehabil*. 2018;99(5):907–913. doi:10.1016/j.apmr.2018.01.019
49. Kalytczak MM, Lucareli PRG, Dos Reis AC, et al. Kinematic and electromyographic analysis in patients with patellofemoral pain syndrome during single leg triple hop test. *Gait Posture*. 2016;49:246–251. doi:10.1016/j.gaitpost.2016.07.020
50. Kızılkaya AÖ, Ecesoy H. Ultrasonographic assessment of quadriceps and patellar tendon thicknesses in patients with patellofemoral pain syndrome. *Acta Orthop Traumatol Turc*. 2019;53(4):272–277. doi:10.1016/j.aott.2019.04.009
51. Muniz AMS, Zeitoune G, Alvim F, Grassi GBA, Britto PAA, Nadal J. Exist differences in kinematics and EMG of the hip and knee between male runners with and without patellofemoral pain in different running speeds? *Phys Ther Sport*. 2023;59:122–129. doi:10.1016/j.ptsp.2022.12.006
52. Novello AA, Garbelotti S II, Rabelo NDDA, et al. Descending stairs: good or bad task to discriminate women with patellofemoral pain? *Gait Posture*. 2018;65:26–32. doi:10.1016/j.gaitpost.2018.06.170
53. Pavone V, Vescio A, Panvini FMC, et al. Patellofemoral pain syndrome in young female athletes: a case-control study. *Adv Orthop*. 2022;2022:1907975. doi:10.1155/2022/1907975
54. Pazzinatto MF, de Oliveira Silva D, Pradela J, Coura MB, Barton C, de Azevedo FM. Local and widespread hyperalgesia in female runners with patellofemoral pain are influenced by running volume. *J Sci Med Sport*. 2017;20(4):362–367. doi:10.1016/j.jsams.2016.09.004
55. Pazzinatto MF, de Oliveira Silva D, Ferreira AS, et al. Patellar tendon reflex and vastus medialis Hoffmann reflex are down regulated and correlated in women with patellofemoral pain. *Arch Phys Med Rehabil*. 2019;100(3):514–519. doi:10.1016/j.apmr.2018.06.024
56. Plastaras C, McCormick Z, Nguyen C, et al. Is hip abduction strength asymmetry present in female runners in the early stages of patellofemoral pain syndrome? *Am J Sports Med*. 2016;44(1):105–112. doi:10.1177/0363546515611632
57. van der Heijden RA, Rijndertse MM, Bierma-Zeinstra SMA, van Middelkoop M. Lower pressure pain thresholds in patellofemoral pain patients, especially in female patients: a cross-sectional case-control study. *Pain Med*. 2018;19(1):184–192. doi:10.1093/pm/pnx059
58. Willson JD, Davis IS. Lower extremity mechanics of females with and without patellofemoral pain across activities with progressively greater task demands. *Clin Biomech (Bristol, Avon)*. 2008;23(2):203–211. doi:10.1016/j.clinbiomech.2007.08.025
59. Yilmaz Yelvar GD, Çirak Y, Dalkilinç M, et al. Impairments of postural stability, core endurance, fall index and functional mobility skills in patients with patello femoral pain syndrome. *J Back Musculoskelet Rehabil*. 2017;30(1):163–170. doi:10.3233/BMR-160729
60. Zamboti CL, da Silva R, Gobbi C, Shigaki L, Macedo C. Analysis of pain, functional capacity, muscular strength and balance in young women with patellofemoral pain syndrome. *Fisioter Mov*. 2017;30(3):433–441. doi:10.1590/1980-5918.030.003.ao01
61. Botta AFB, Waiteman MC, Perez VO, et al. Trunk muscle endurance in individuals with and without patellofemoral pain: sex differences and correlations with performance tests. *Phys Ther Sport*. 2021;52:248–255. doi:10.1016/j.ptsp.2021.09.012
62. Pazzinatto MF, Barton CJ, Willy RW, Ferreira AS, Azevedo FM, de Oliveira Silva D. Are physical function and fear of movement risk factors for patellofemoral pain? A 2-year prospective study. *J Sport Rehabil*. 2023;32(1):24–30. doi:10.1123/jsr.2021-0392
63. Antunez J, Malone ZC, Glaviano NR. Influence of self-perceived disability on squatting kinematics in individuals with patellofemoral pain. *Clin Biomech (Bristol, Avon)*. 2023;109:106089. doi:10.1016/j.clinbiomech.2023.106089
64. Ferreira CL, Oliveira Barroso F, Torricelli D, Pons JL, Politti F, Lucareli PRG. Muscle synergies analysis shows altered neural strategies in women with patellofemoral pain during walking. *PLoS One*. 2023;18(10):e0292464. doi:10.1371/journal.pone.0292464
65. Jaffri A, Baellow A. Poor mental health indicators in individuals with patellofemoral pain. *J Athl Train*. 2023;58(10):849–854. doi:10.4085/1062-6050-0584.22
66. Sanchis-Alfonso V, Beser-Robles M, Navarro-Calvo A, López-Company L, Roselló-Añón A, Domenech-Fernández J. Central sensitization negatively influences the level of disability in female patients with anterior knee pain. *Knee Surg Sports Traumatol Arthrosc*. 2023;31(12):5381–5387. doi:10.1007/s00167-023-07591-w
67. Branco GR, Resende RA, Carpes FP, Mendonça LD. Association of cycling kinematics with anterior knee pain in mountain bike cyclists. *J Sport Rehabil*. 2023;32(1):40–45. doi:10.1123/jsr.2021-0233
68. Hoglund LT, Burns RO, Stepney AL II. Do males with patellofemoral pain have posterolateral hip muscle weakness? *Int J Sports Phys Ther*. 2018;13(2):160–170. doi:10.26603/ijspt20180160
69. Kim S, Kim D, Park J. Knee joint and quadriceps dysfunction in individuals with anterior knee pain, anterior cruciate ligament reconstruction, and meniscus surgery: a cross-sectional study. *J Sport Rehabil*. 2020;30(1):112–119. doi:10.1123/jsr.2018-0482
70. Kim S, Park J. Impact of severity and duration of anterior knee pain on quadriceps function and self-reported function. *J Athl Train*. 2022;57(8):771–779. doi:10.4085/1062-6050-0647.21
71. Van Cant J, Pitance L, Feipel V. Hip abductor, trunk extensor and ankle plantar flexor endurance in females with and without patellofemoral pain. *J Back Musculoskelet Rehabil*. 2017;30(2):299–307. doi:10.3233/BMR-150505
72. Kim S, Glaviano NR, Park J. Sex differences in knee extensor neuromuscular function in individuals with and without patellofemoral pain. *Sports Health*. 2024;16(6):1000–1008. doi:10.1177/19417381231209318
73. Kim S, Roh Y, Glaviano NR, Park J. Quadriceps neuromuscular function during and after exercise-induced fatigue in patients with patellofemoral pain. *J Athl Train*. 2023;58(6):554–562. doi:10.4085/1062-6050-0348.22
74. Heydari Armaki R, Abbasnia K, Motealleh A. Comparison of trunk flexion proprioception between healthy athletes and athletes with patellofemoral pain. *J Sport Rehabil*. 2020;30(3):430–436. doi:10.1123/JSR.2019-0369
75. Biabanimoghadam M, Motealleh A, Cowan SM. Core muscle recruitment pattern during voluntary heel raises is different between patients with patellofemoral pain and healthy individuals. *Knee*. 2016;23(3):382–386. doi:10.1016/j.knee.2016.01.008
76. Rojhani Shirazi Z, Biabani Moghaddam M, Motealleh A. Comparative evaluation of core muscle recruitment pattern in response to sudden external perturbations in patients with patellofemoral pain syndrome and healthy subjects. *Arch Phys Med Rehabil*. 2014;95(7):1383–1389. doi:10.1016/j.apmr.2014.01.025
77. Kordi Yoosefinejad A, Mazaheri M, Sobhani S, Motealleh A. Electromyographic onset and activity level of medial and lateral hamstrings, vastus medialis obliquus, and vastus lateralis in women with patellofemoral pain during stair descent. *J Rehabil Sci Res*. 2022;9(3):128–133. doi:10.30476/JRSR.2022.93861.1249
78. Holden S, Straszek CL, Rathleff MS, Petersen KK, Roos EM, Graven-Nielsen T. Young females with long-standing patellofemoral pain display impaired conditioned pain modulation, increased temporal summation of pain, and widespread hyperalgesia. *Pain*. 2018;159(12):2530–2537. doi:10.1097/j.pain.0000000000001356
79. Liew BXW, Abichandani D, De Nunzio AM. Individuals with patellofemoral pain syndrome have altered inter-leg force coordination. *Gait Posture*. 2020;79:65–70. doi:10.1016/j.gaitpost.2020.04.006

80. Rathleff MS, Roos EM, Olesen JL, Rasmussen S, Arendt-Nielsen L. Lower mechanical pressure pain thresholds in female adolescents with patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2013;43(6):414–421. doi:10.2519/jospt.2013.4383
81. Rathleff MS, Petersen KK, Arendt-Nielsen L, Thorborg K, Graven-Nielsen T. Impaired conditioned pain modulation in young female adults with long-standing patellofemoral pain: a single blinded cross-sectional study. *Pain Med*. 2016;17(5):980–988. doi:10.1093/pm/pnv017
82. Rathleff MS, Winiarski L, Krommes K, et al. Pain, sports participation, and physical function in adolescents with patellofemoral pain and Osgood-Schlatter disease: a matched cross-sectional study. *J Orthop Sports Phys Ther*. 2020;50(3):149–157. doi:10.2519/jospt.2020.8770
83. Crouzier M, Hug F, Sheehan FT, Collins NJ, Crossley K, Tucker K. Neuromechanical properties of the vastus medialis and vastus lateralis in adolescents with patellofemoral pain. *Orthop J Sports Med*. 2023;11(6):23259671231155894. doi:10.1177/23259671231155894
84. de Moura Campos Carvalho-e-Silva AP, Peixoto Leão Almeida G, Oliveira Magalhães M, et al. Dynamic postural stability and muscle strength in patellofemoral pain: is there a correlation? *Knee*. 2016;23(4):616–621. doi:10.1016/j.knee.2016.04.013
85. Kiliç GÇ, Kunduracilar Z, Demirel M, Alaca R. Relationship between physical activity, cardiorespiratory endurance, functıonal disability, participation limitations, and quality of life in patients with anterior knee pain. *Sports Med J*. 2021;17(2):3362–3369.
86. Magalhães E, Fukuda TY, Sacramento SN, Forgas A, Cohen M, Abdalla RJ. A comparison of hip strength between sedentary females with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2010;40(10):641–647. doi:10.2519/jospt.2010.3120
87. Piva SR, Goodnite EA, Childs JD. Strength around the hip and flexibility of soft tissues in individuals with and without patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2005;35(12):793–801. doi:10.2519/jospt.2005.35.12.793
88. Eckenrode BJ, Kietrys DM, Brown A, Parrott JS, Noehren B. Signs of nervous system sensitization in female runners with chronic patellofemoral pain. *Int J Sports Phys Ther*. 2023;18(1):132–144. doi:10.26603/001c.57603
89. Shallan A, Hawamdeh M, Gaowgzeh RAM, et al. The association between kinesiophobia and dynamic balance in patients with patellofemoral pain syndrome. *Eur Rev Med Pharmacol Sci*. 2023;27(6):2216–2221. doi:10.26355/eurrev_202303_31755
90. Ingram TG, Roddick JM, Byrne JM. Is gamma loop dysfunction related to bilateral inhibition in anterior knee pain? *Muscle Nerve*. 2016;53(2):280–286. doi:10.1002/mus.24705
91. Aliberti S, Costa MS, Passaro AC, Arnone AC, Sacco IC. Medial contact and smaller plantar loads characterize individuals with patellofemoral pain syndrome during stair descent. *Phys Ther Sport*. 2010;11(1):30–34. doi:10.1016/j.ptsp.2009.11.001
92. Goto S, Aminaka N, Gribble PA. Lower-extremity muscle activity, kinematics, and dynamic postural control in individuals with patellofemoral pain. *J Sport Rehabil*. 2018;27(6):505–512. doi:10.1123/jsr.2016-0100
93. Priore LB, Azevedo FM, Pazzinatto MF, et al. Influence of kinesiophobia and pain catastrophism on objective function in women with patellofemoral pain. *Phys Ther Sport*. 2019;35:116–121. doi:10.1016/j.ptsp.2018.11.013
94. Nakagawa TH, Dos Santos AF, Lessi GC, Petersen RS, Scattone Silva RS. Y-Balance test asymmetry and frontal plane knee projection angle during single-leg squat as predictors of patellofemoral pain in male military recruits. *Phys Ther Sport*. 2020;44:121–127. doi:10.1016/j.ptsp.2020.05.011
95. Nafez S, Ghanavati T, Akbari M, Khalilian-Ekrami N, Salahzadeh Z. Relationship between functional and laboratory balance assessment in females with patellofemoral pain syndrome. *Muscles Ligaments Tendons J*. 2023;13(3):368–375. doi:10.32098/mltj.03.2023.03
96. Steinberg N, Tenenbaum S, Waddington G, et al. Unilateral and bilateral patellofemoral pain in young female dancers: associated factors. *J Sports Sci*. 2020;38(7):719–730. doi:10.1080/02640414.2020.1727822
97. Loudon JK, Wiesner D, Goist-Foley HL, Asjes C, Loudon KL. Intrarater reliability of functional performance tests for subjects with patellofemoral pain syndrome. *J Athl Train*. 2002;37(3):256–261.
98. Naserpour M, Goharpey S, Saki A, Mohammadi Z. Dynamic postural control during step down task in patients with patellofemoral pain syndrome. *J Phys Ther Sci*. 2018;30(10):1289–1292. doi:10.1589/jpts.30.1289
99. Kaya D, Citaker S, Kerimoglu U, et al. Women with patellofemoral pain syndrome have quadriceps femoris volume and strength deficiency. *Knee Surg Sport Traumatol Arthrosc*. 2011;19(2):242–247. doi:10.1007/s00167-010-1290-2
100. Jensen R, Kvale A, Baerheim A. Is pain in patellofemoral pain syndrome neuropathic? *Clin J Pain*. 2008;24(5):384–394. doi:10.1097/AJP.0b013e3181658170
101. dos Reis AC, Correa JC, Bley AS, Rabelo ND, Fukuda TY, Lucareli PR. Kinematic and kinetic analysis of the single-leg triple hop test in women with and without patellofemoral pain. *J Orthop Sports Phys Ther*. 2015;45(10):799–807. doi:10.2519/jospt.2015.5011
102. Jensen R, Hystad T, Baerheim A. Knee function and pain related to psychological variables in patients with long-term patellofemoral pain syndrome. *J Orthop Sports Phys Ther*. 2005;35(9):594–600. doi:10.2519/jospt.2005.35.9.594
103. O'Sullivan K, Herbert E, Sainsbury D, McCreesh K, Clifford A. No difference in gluteus medius activation in women with mild patellofemoral pain. *J Sport Rehabil*. 2012;21(2):110–118. doi:10.1123/jsr.21.2.110
104. Ott B, Cosby NL, Grindstaff TL, Hart JM. Hip and knee muscle function following aerobic exercise in individuals with patellofemoral pain syndrome. *J Electromyogr Kinesiol*. 2011;21(4):631–637. doi:10.1016/j.jelekin.2011.04.006
105. dos Santos de Souza G, Schwanck AA, Barbosa RI, Marcolino AM, Kuriki HU. Eficácia de um protocolo de exercícios em cadeia cinética fechada para indivíduos com dor femoropatelar. *Conscientiae Saúde*. 2017;16(4):393–401. doi:10.5585/conssaude.v16n4.7458
106. Boling MC, Bolgla LA, Mattacola CG, Uhl TL, Hosey RG. Outcomes of a weight-bearing rehabilitation program for patients diagnosed with patellofemoral pain syndrome. *Arch Phys Med Rehabil*. 2006;87(11):1428–1435. doi:10.1016/j.apmr.2006.07.264
107. Sacco I de CN, Konno GK, Rojas GB, et al. Functional and EMG responses to a physical therapy treatment in patellofemoral syndrome patients. *J Electromyogr Kinesiol*. 2006;16(2):167–174. doi:10.1016/j.jelekin.2004.06.010
108. Aminaka N, Gribble PA. Patellar taping, patellofemoral pain syndrome, lower extremity kinematics, and dynamic postural control. *J Athl Train*. 2008;43(1):21–28. doi:10.4085/1062-6050-43.1.21
109. Song CY, Lin JJ, Chang AH. Effects of femoral rotational taping on dynamic postural stability in female patients with patellofemoral pain. *Clin J Sport Med*. 2017;27(5):438–443. doi:10.1097/JSM.0000000000000392
110. Jeon H, Donovan L, Thomas AC. Exercise-induced changes in femoral cartilage thickness in patients with patellofemoral pain. *J Athl Train*. 2023;58(2):128–135. doi:10.4085/1062-6050-0602.21
111. Del Priore LB, Briani RV, Waiteman MC, et al. "I believe it will not get worse": a mixed-methods longitudinal study about patient's perspective of recently developed patellofemoral pain. *Phys Ther Sport*. 2024;70:29–35. doi:10.1016/j.ptsp.2024.08.007
112. Collins NJ, Bierma-Zeinstra SM, Crossley KM, van Linschoten RL, Vicenzino B, van Middelkoop M. Prognostic factors for patellofemoral pain: a multicentre observational analysis. *Br J Sports Med*. 2013;47(4):227–233. doi:10.1136/bjsports-2012-091696
113. Matthews M, Rathleff MS, Claus A, et al. Can we predict the outcome for people with patellofemoral pain? A systematic review on

prognostic factors and treatment effect modifiers. *Br J Sports Med*. 2017;51(23):1650–1660. doi:10.1136/bjsports-2016-096545
114. Crossley KM, Macri EM, Cowan SM, Collins NJ, Roos EM. The patellofemoral pain and osteoarthritis subscale of the KOOS (KOOS-PF): development and validation using the COSMIN checklist. *Br J Sports Med*. 2018;52(17):1130–1136. doi:10.1136/bjsports-2016-096776
115. Hoglund LT, Scalzitti DA, Jayaseelan DJ, Bolgla LA, Wainwright SF. Patient-reported outcome measures for adults and adolescents with patellofemoral pain: a systematic review of construct validity, reliability, responsiveness, and interpretability using the COSMIN methodology. *J Orthop Sports Phys Ther*. 2023;53(8):460–479. doi:10.2519/jospt.2023.11730
116. Hoglund LT, Scalzitti DA, Jayaseelan DJ, Bolgla LA, Wainwright SF. Patient-reported outcome measures for adults and adolescents with patellofemoral pain: a systematic review of content validity and feasibility using the COSMIN methodology. *J Orthop Sports Phys Ther*. 2023;53(1):23–39. doi:10.2519/jospt.2022.11317
117. Berg B, Urhausen AP, Øiestad BE, et al. What tests should be used to assess functional performance in youth and young adults following anterior cruciate ligament or meniscal injury? A systematic review of measurement properties for the OPTIKNEE consensus. *Br J Sports Med*. 2022;56(24):1454–1464. doi:10.1136/bjsports-2022-105510
118. Reiman MP, Manske RC. The assessment of function: how is it measured? A clinical perspective. *J Man Manip Ther*. 2011;19(2):91–99. doi:10.1179/106698111X12973307659546
119. Glaviano NR, Bazett-Jones DM, Boling MC. Pain severity during functional activities in individuals with patellofemoral pain: a systematic review with meta-analysis. *J Sci Med Sport*. 2022;25(5):399–406. doi:10.1016/j.jsams.2022.01.004
120. Waiteman MC, Briani RV, Lopes HS, et al. People with patellofemoral pain have bilateral deficits in physical performance regardless of pain laterality. *J Athl Train*. 2024;59(11):1110–1117. doi:10.4085/1062-6050-0649.23
121. Lopes HS, Waiteman MC, Priore LB, et al. There is more to the knee joint than just the quadriceps: a systematic review with meta-analysis and evidence gap map of hamstring strength, flexibility, and morphology in individuals with gradual-onset knee disorders. *J Sport Health Sci*. 2024;13(4):521–536. doi:10.1016/j.jshs.2023.08.004
122. Wellsandt E, Failla MJ, Snyder-Mackler L. Limb symmetry indexes can overestimate knee function after anterior cruciate ligament injury. *J Orthop Sports Phys Ther*. 2017;47(5):334–338. doi:10.2519/jospt.2017.7285
123. Dolak KL, Silkman C, McKeon JM, Hosey RG, Lattermann C, Uhl TL. Hip strengthening prior to functional exercises reduces pain sooner than quadriceps strengthening in females with patellofemoral pain syndrome: a randomized clinical trial. *J Orthop Sports Phys Ther*. 2011;41(8):560–570. doi:10.2519/jospt.2011.3499
124. Fukuda TY, Melo WP, Zaffalon BM, et al. Hip posterolateral musculature strengthening in sedentary women with patellofemoral pain syndrome: a randomized controlled clinical trial with 1-year follow-up. *J Orthop Sport Phys Ther*. 2012;42(10):823–830. doi:10.2519/jospt.2012.4184
125. Hart HF, Barton CJ, Khan KM, Riel H, Crossley KM. Is body mass index associated with patellofemoral pain and patellofemoral osteoarthritis? A systematic review and meta-regression and analysis. *Br J Sport Med*. 2017;51(10):781–790. doi:10.1136/bjsports-2016-096768
126. Ferreira AS, Mentiplay BF, Taborda B, Pazzinatto MF, de Azevedo FM, de Oliveira Silva D. Overweight and obesity in young adults with patellofemoral pain: impact on functional capacity and strength. *J Sport Health Sci*. 2023;12(2):202–211. doi:10.1016/j.jshs.2020.12.002
127. Glaviano NR, Saliba S. Relationship between lower-extremity strength and subjective function in individuals with patellofemoral pain. *J Sport Rehabil*. 2018;27(4):327–333. doi:10.1123/jsr.2016-0177
128. Ducatti MHM, Waiteman MC, Botta AFB, et al. Knee flexor strength, rate of torque development and flexibility in women and men with patellofemoral pain: relationship with pain and the performance in the single leg bridge test. *Phys Ther Sport*. 2021;50:166–172. doi:10.1016/j.ptsp.2021.05.006
129. Domenech J, Sanchis-Alfonso V, López L, Espejo B. Influence of kinesiophobia and catastrophizing on pain and disability in anterior knee pain patients. *Knee Surg Sports Traumatol Arthrosc*. 2013;21(7):1562–1568. doi:10.1007/s00167-012-2238-5
130. Guney H, Yuksel I, Kaya D, Doral MN. The relationship between quadriceps strength and joint position sense, functional outcome and painful activities in patellofemoral pain syndrome. *Knee Surg Sports Traumatol Arthrosc*. 2016;24(9):2966–2972. doi:10.1007/s00167-015-3599-3
131. Glaviano NR, Simon MM, Bazett-Jones DM. Pain variability and subjective function in individuals with patellofemoral pain: a short report. *J Athl Train*. 2022;57(2):165–169. doi:10.4085/1062-6050-0261.21
132. Schmier J, Halpern MT. Patient recall and recall bias of health state and health status. *Expert Rev Pharmacoecon Outcomes Res*. 2004;4(2):159–163. doi:10.1586/14737167.4.2.159

## SUPPLEMENTAL MATERIAL

**Supplemental Figure 1.** Funnel plots assessing publication bias in studies included in meta-analyses of A, Anterior Knee Pain Scale of individuals with patellofemoral pain compared with pain-free individuals, and B, balance tests of individuals with patellofemoral pain compared with pain-free individuals.
**Supplemental Figure 2.** Meta-regressions for self-reported function measured using A, Anterior Knee Pain Scale and age, B, Anterior Knee Pain Scale and body mass index, C, Anterior Knee Pain Scale and duration of symptoms, and D, Anterior Knee Pain Scale and self-reported pain. E, Meta-regression for performance-based function measured using balance tests and age.
**Supplemental Material 1.** Protocol deviations.
**Supplemental Material 2.** Data-extraction management.
**Supplemental Material 3.** Internal and external validity of studies assessed using the modified Downs and Black checklist.
**Supplemental Material 4.** Summary of included studies.
**Supplemental Material 5.** Synthesis of unpooled data.
**Supplemental Table 1.** Search strategy.
**Supplemental Table 2.** Study quality of Miller et al[1] assessed using Physiotherapy Evidence Database scale.
**Supplemental Table 3.** Risk of bias of Miller et al[22] assessed using Cochrane Risk of Bias in Randomized Trials 2.

*Address correspondence to Ana Flavia Balotari Botta, MS, PT, Physical Therapy Department, School of Science and Technology, São Paulo State University, 305 Roberto Simonsen Street, Presidente Prudente, SP, 9060-900, Brazil. Address email to anafbbotta@hotmail.com.*