The psychological features of patellofemoral pain: a systematic review

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ABSTRACT

Background Patellofemoral pain (PFP) is prevalent in adolescence and adulthood and often persists. In contrast to other persistent musculoskeletal conditions, for which non-physical, psychological features are implicated, PFP remains largely conceptualised in mechanical terms.

Aims To (1) identify whether the psychological characteristics of individuals with PFP differs from asymptomatic controls and (2) evaluate the correlations between psychological characteristics and PFP severity.

Study design Systematic review

Methods A systematic review of the literature was conducted according to PRISMA guidelines. The Epidemiological Appraisal Instrument was used to evaluate quality. Studies measuring psychological constructs with patient-reported measures were included. Standardised mean differences were calculated and supported by narrative synthesis.

Results Twenty-five studies were eligible. Quality results ranged from 28.3% to 61.7%. Psychological constructs were reported under four groupings: mental health, cognitive factors, behavioural factors and other factors. There is limited evidence of mental health and cognitive differences in some individuals with PFP. Features demonstrating linear correlations with pain and physical function included anxiety/depression, catastrophising, praying and hoping and pain-related fear.

Conclusions Anxiety, depression, catastrophising and fear of movement may be elevated in individuals with PFP and correlate with pain and reduced physical function. These results derive from a limited number of studies. Future research should aim to evaluate if and how psychological factors contribute to PFP.

Clinical relevance Patients are likely to benefit from clinician vigilance to the presence of psychological factors.

INTRODUCTION

Patellofemoral pain (PFP) is a prevalent musculoskeletal condition[1 2] that presents as an anterior knee pain provoked by physical activities that load/stress the patellofemoral joint.[3 4] It is heterogeneous, presents throughout the lifespan[5] and is often persistent.[6] Research shows that 40% to 57% of those receiving evidence-based treatments[7] experience unfavourable long-term outcomes.[8 9] Persistent PFP and poor long-term outcomes may impact negatively on social engagement and participation in physical activities such as sports and occupational tasks.[10]

Growing evidence suggests that non-physical, psychological features play a role in persistent musculoskeletal pain. Factors such as pain-related fear, anxiety, depression, catastrophising and self-efficacy have been associated with pain[11] and disability.[12 13] They have also been identified as barriers to recovery[14] and as factors that limit the potential for improvement with rehabilitation.[15] As a result, presence of these features is often factored into treatment decision-making for other musculoskeletal conditions.[16–19]

As a persistent musculoskeletal condition that is no longer considered self-limiting,[6 9 20] PFP may also be characterised by the coexistence of physical and non-physical features. If non-physical features can influence the outcomes of physical interventions, then further investigation into the non-physical features of PFP is essential. Ultimately, a better understanding of the non-physical features of PFP stands to enhance the outcomes of currently used physical interventions and expose other features at which management may be targeted or which may influence how a treatment is applied.

The aims of this systematic review were to (1) identify whether the psychological characteristics of individuals with PFP differ from that of asymptomatic controls and (2) evaluate the correlation between psychological characteristics and measures of pain and physical function in individuals with PFP.

METHODS

The systematic review protocol was developed in accordance with the 2009 Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement[21] and prospectively registered with PROSPERO (Registration: CRD42016036379).

Search strategy and data sources

A search using 'patellofemoral pain' OR 'patellofemoral pain syndrome' OR 'anterior knee pain' OR 'chondromalacia patellae' was conducted. It was expected that this unrefined approach would yield high returns and would reduce the chance of lesser known psychological measurements being missed.

Eight electronic databases were searched (Cinahl, Cochrane library, EMBASE, MEDLINE, PubMed, PEDro, PsycINFO, Scopus). Databases were searched by the first author (LM), with the final search conducted on the 13th of January 2016. Electronic results were followed by reference list checks and author searches. Published reports, conference abstracts and reference lists were also perused.

Eligibility criteria

As an epidemiologically based review, the scope of included studies was purposefully broad. To be

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included, studies had to measure at least one psychological variable using a patient-reported format in a cohort of individuals with PFP. Studies were included that clearly defined diagnostic criteria for PFP, the diagnostician or described the condition as 'PFP'. For studies that recruited mixed (symptomatic) populations, we included those for which data pertaining solely to individuals with PFP could be extracted.

Studies were excluded if they were case studies, published abstracts, non-published studies (eg, graduate theses) or non-primary literature (eg, systematic and narrative reviews).

Study selection

Studies identified in database searches were exported to EndNote (X7.2.1). Two reviewers (LM, MM) independently evaluated titles and abstracts, and then full texts. Consensus meetings were held at each stage to determine progression to the next stage, and discrepancies were resolved by a third author (BV).

Data extraction

Data extraction was completed independently by two reviewers (LM and MM) using a standardised spreadsheet. Data of interest included: (1) participant characteristics—source, sex, age, body mass index (BMI), education level, employment status, smoking status and activity levels; (2) PFP characteristics—diagnostic criteria, pain measure used, pain duration, pain severity, location of pain; and (3) psychological factors: measures used and results.

Methodological quality assessment

The methodological quality of each study was assessed independently by two reviewers (LM, NC), one of who (NC) was blinded to journal, study title, authors and affiliations, using the Epidemiological Appraisal Instrument (EAI).[22] As a general purpose appraisal instrument, the EAI can be used to evaluate intervention, cohort, case-control and cross-sectional studies. With a total of 43 questions grouped into five sections, the EAI considers: (1) reporting; (2) participant/record selection; (3) measurement quality; (4) data analysis; and (5) generalisation of results. Items are answered 'yes' (2), 'partial' (1), 'no' (0), 'unable to determine' (0) or, depending on study design, 'not applicable'. To answer questions pertaining to covariates and cofounders, the review team selected, a priori, specific factors that the World Health Organisation has recognised as risks to mental health.[23] These factors were age, sex, BMI, pain severity and duration, smoking, employment status, education level and activity level. Summary scores were expressed as a proportion of all items that were applicable. Methodological quality criteria were graded specific to the research question for this systematic review rather than for the general quality of each study and its original purpose. Thus, methodological quality scores presented are specific to this review and should not be interpreted in different contexts. In the absence of an absolute external reference, quartiles were used to express final quality rank. The first quartile (Q1) represents the lowest scoring papers and the fourth quartile (Q4) the highest.

Data synthesis

Inter-rater reliability between methodological quality assessors was calculated in STATA V.14.0 and presented as a κ Statistic. Inter-rater reliability was considered as poor (<0.00), slight (0.00–0.2), fair (0.21–0.4), moderate (0.41–0.6), substantial (0.61–0.8) or almost perfect (0.81–1.0)[24] Psychological findings are presented under two headings that directly fulfil the review's aims: (1) psychological characteristics of people with PFP and (2) correlations between psychological factors, PFP and physical function. Standardised mean differences (SMD) and 95% CI were calculated using Review Manager (RevMan) V.5.3. The SMD results from negatively orientated measures (ones where a lower score represents poorer psychological health) were inverted so that all positive SMD meant the same thing; that is, higher positive SMD indicated poorer psychological health in the PFP group. An SMD greater or equal to 0.2 was considered small, greater or equal to 0.50, medium and greater or equal to 0.80, large.[25] Corresponding correlation coefficient indexes were 0.10, 0.30 and 0.50, respectively.[25] When only frequency data were available, risk ratios were calculated using RevMan V.5.3. The above descriptives were used where meta-analyses were not possible. Where effect sizes could not be calculated (eg, lack of control group), raw data were tabulated and presented graphically. Electronic searches were conducted to obtain normative data for comparisons.

RESULTS

Study selection and design

The search yielded 10 617 studies. After removal of duplicates, there were 6772 studies for title and abstract perusal. Fifty studies were eligible for full-text review, of which 25 met the eligibility criteria and were included (figure 1). These, by design, comprised 16 case series and nine cohort studies. Comparative data were available in five instances, correlative in nine, while the remaining 11 provided descriptive data (table 1).

Methodological quality assessment

Online supplementary file 1 contains full-quality appraisal results for all studies (itemised marking, the total percentage each study scored and an overall percentage of studies that addressed each criteria) along with a quartile table. With 879 agreed responses from 1075 items, the overall agreement between the two assessors was substantial (κ=0.75).[24] The median methodological quality percentage score was 45.2% (IQR 37.1 to 51.5) the minimum was 28.3% and the maximum was 61.7%. Seven studies, scoring between 28.3% and 37.1% fell in the 1st quartile (Q1); six studies (score 40% to 45.2%) fell in the 2nd quartile (Q2); seven studies (score 46.7% to 51.5%) fell in the 3rd quartile (Q3); and five studies (score 51.6% to 61.7%) fell in the 4th quartile (Q4]. The reliability and validity of the psychological measures used were described and referenced in 12% (3/25) and 28% (7/25) of studies, respectively. When performing data analyses, 76% (19/25) of studies did not adjust for intrinsic factors (age, gender, BMI) and 88% (22/25) did not adjust for extrinsic factors (smoking status, employment status, educational level, activity level). Five per cent (1/20) of studies reported psychological findings by PFP levels (severity and/or duration) and 4% (1/25) of studies reported psychological findings by age, sex, BMI, smoking, employment status, education level, activity level) subgroups.

Participant characteristics

Table 1 presents participant characteristics for all included studies. Across all studies, there were 1357 participants with PFP (891 women: 66%), with the mean (SD) age ranging from 14.1 (1.38) to 46.6 (10.8) years old. Participants were sourced from clinical sites,[26–42] athletics clubs and exercise programmes[43 44] and population-based cohorts.[45 46] Five studies did not report participant sources.

The 349 healthy controls (168 women: 48%) came from student cohorts[44–47] or from the local community.[48] One study

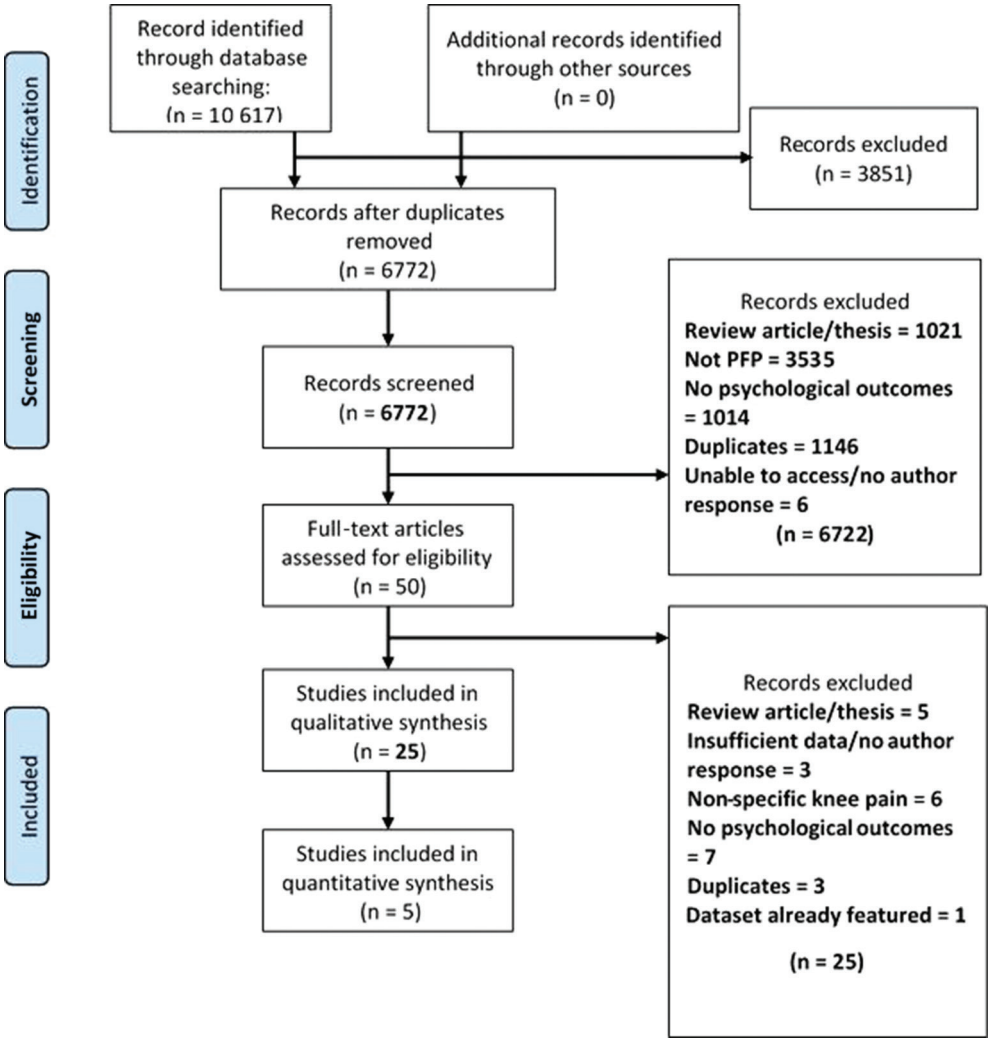

Figure 1 Eligibility flow diagram.

did not state their control source.[27] Typically, the control characteristics were matched to corresponding PFP groups and are presented in table 1.

PFP characteristics

Details relating to PFP characteristics, including duration, severity and measurement tools are presented in table 1. Criteria used to define/diagnose PFP along with the diagnosing health professional were provided in 14 studies.[27 31 34–38 41 42 44–48] In five studies, the diagnostic criteria alone were described without the diagnostician.[26 32 40 49 50] A further six studies named the diagnosing health professional but not the diagnostic criteria.[29 30 33 39 43]

Pain was most commonly measured with a Visual Analogue Scale,[29 30 42 45 46 48–50] followed by a Numerical Rating Scale,[33 36–39 41] then the Western Ontario and McMaster Universities Arthritis Index pain subscale[27 32] and the Knee Injury and Osteoarthritis Outcome Score (KOOS) pain subscale.[45 46] Pain duration ranged from a minimum of 1 month[36] to 8 years.[47]

Physical function was most commonly measured with the Kujala Patellofemoral Score,[26 28 35 43 50] Lysholm Knee Scoring Scale,[29 30 33] Activities of Daily Living Scale of the Knee Outcome Survey,[36 37] Modified Functional Index Questionnaire[34 38 40] and four subscales (symptoms, activities of daily living, function in sport and recreation) of the KOOS.[45 46]

Psychological factors

Eighteen different instruments were used to measure psychological constructs, the results of which are presented under four construct groupings; mental health, cognitive factors, behavioural factors and other psychological factors (table 2). Mental health included measures of depression, anxiety and general mental health.[51] In line with previously used cognitive and behavioural groupings,[52]

cognitive factors were coping strategies and catastrophising, whereas behavioural factors were dependency, fear of movement (kinesiophobia) and fear avoidance. Other psychological factors include measures of emotional well-being and social aspects that did not fit within the other factor groupings.

The most commonly used psychological measure was the Short Form-36 health survey Mental Health Component (SF-36 MHC).[26–28 31–35 40 43 49 50] Other instruments measuring constructs of mental health that were used more than once include the EuroQol-5 Dimensions Anxiety/Depression Subscale[38 41 45 46] and the Hospital Anxiety and Depression Scale.[29 30]

Instruments measuring cognitive factors that were used more than once were the Pain Catastrophising Scale[29 30 46] and the Coping Strategies Questionnaire.[29 30] Fear-Avoidance Beliefs Questionnaire[36 37 39] and the Tampa Scale of Kinesiophobia[29 30 33]

were the instruments measuring behavioural factors used more than once.

Psychological characteristics of people with PFP (aim 1)

Meta-analysis was not possible because of heterogeneity of the included studies. Twenty studies reported data from PFP cohorts without asymptomatic comparator groups. These data are presented in online supplementary file 3 and are supported by online supplementary files 4 and 5. The following narrative synthesis focuses on data obtained from the five case-control studies, which enables comparison between PFP and controls (aim 1). It also highlights results from single-group studies investigating correlations between PFP and psychological factors.

Mental health

General mental health, measured with the SF-36 MHC (vitality, social function, role emotional and mental health sub-scales) was significantly lower in a group of adults with PFP (SMD 1.21; 95% CI 0.81 to 1.62) (Q3).[27]

Anxiety and/or depression was compared with pain-free controls in three studies. Hopkins Symptom Checklist-25 scores revealed significantly higher levels for one adult group with PFP (SMD 1.03; 95% CI 0.43 to 1.64) (Q3)[48] but no significant differences between-group scores across the different Karolinska scales of personality in a separate study (Q1).[47] In the case where only frequency data were available, a group of adolescents with PFP had 3.00 (95% CI 0.34 to 26.45) times the risk of anxiety/depression than controls (Q4).[46]

Cognitive factors

Several coping strategies demonstrated significant between-group differences. One student cohort with PFP group found it harder to divert their attention (SMD 0.40; 95% CI 0.02 to 0.82) than those who were PFP free (Q3).[44] In a different student cohort, levels of catastrophising were significantly higher in those with PFP (SMD 1.07; 95% CI 0.41 to 1.74) (Q4).[46]

Behavioural factors

Levels of dependency, measured with Carlsson's Dependency Scale were not significantly different between those with and without PFP (SMD 0.10; 95% CI −0.57 to 0.78) (Q1).[47]

Personality and other psychosocial factors

All studies in this section had pain-free comparators. No significant differences were found between PFP and pain-free group scores of the Schalling-Sifneos Alexithymia Scale-Revised (SMD 0.24; 95% CI −0.44 to 0.91) (Q1).[47] Stress, measured with Carlsson's Stress Scale, was significantly higher in a group of adults with PFP (SMD 0.72; 95% CI 0.03 to 1.42) (Q1).[47] From the Coop Wonca Chart subscale, adults with PFP reported experiencing significantly more emotional problems (SMD 0.89; 95% CI 0.30 to 1.49) than PFP-free controls (Q3).[48]

Correlation between psychological factors, PFP and physical function (aim 2)

Mental health

Small to medium correlations (ranging from $r=0.13$ to $r=0.47$) were found between all sub-scales of the SF-36 MHC and the Thai (Q1),[26] Chinese (Q1)[28] and Persian (Q2)[35] versions of the Kujala Patellofemoral Scale. The SF-36 sub-scales of 'social function' and 'mental health' both demonstrated small correlations with the Functional Index questionnaire, r=0.23 and r=0.15, respectively (Q3).[34] All SF-36 subscales apart from role emotional (r=0.08) demonstrated small correlations with the Modified Functional Index Questionnaire (Q3).[34]

When measured with the Beck Anxiety Inventory (Q4)[36] and the Hospital Anxiety and Depression Scale (Q2),[30] anxiety was correlated with pain (r=0.34 and r=0.46, respectively) and with physical function (r=0.45 and r=0.57, respectively). Depression was also correlated with pain (r=0.44) and physical function (r=−0.61) (Q2).[30] When measured over a 6-month period, improvement change scores in pain and physical function were associated with changes in anxiety (r=0.41 and r=0.43, respectively) and depression (r=0.54 and r=0.59, respectively) (Q2).[29]

Cognitive factors

Catastrophising and the coping strategy of 'praying and hoping' both correlated to pain (r=0.43 and r=0.35, respectively) and physical function (r=−0.53 and r=−0.38, respectively) (Q2).[30] When measured over a 6-month period, improvement change scores in pain and physical function were correlated with reduced catastrophising (r=0.59 and r=0.57, respectively) (Q2).[29]

Behavioural factors

Fear of movement (Q2)[30] and the fear-avoidance beliefs relating to physical activity (FABQ-PA) and work (FABQ-W) (Q4)[36] were all associated with pain (r=0.26, r=0.31 and r=0.37, respectively) and physical function (r=0.26, r=0.31 and r=0.37, respectively). When measured over a 2-month follow-up period, pain reductions and physical functional improvements were associated with reduced FABQ-PA scores (r=0.51 and r=0.57, respectively). But only pain reductions were associated with reduced FABQ-W scores ($r=0.30$) (Q4).[37]

DISCUSSION

This systematic review identified psychological characteristics that differed between individuals with PFP and asymptomatic controls in several cohorts. Further, according to our second aim, we found linear correlations between some psychological characteristics and measures of pain and physical function in individuals with PFP.

Psychological characteristics in individuals with PFP

Four case-control studies report evidence of abnormal psychological features in those with PFP. Specifically, general mental health was worse;[27 48] adolescents catastrophised more that PFP-free counterparts;[46] and an active group employed different coping strategies.[44] Other results suggestive of elevated scores on tests of psychological features were: high levels of fear avoidance in 26% of an adolescent cohort;[39] levels of anxiety/depression in Danish adolescents (12%–15%)[46] above that reported in normative data for Danish school-aged children (8.8%);[53] and a study from the UK[38] reporting a greater prevalence of anxiety/depressive symptoms (26%) than that recorded for the general population by the Office of National Statistics (19%).[54]

Several studies reported no evidence of elevated non-physical characteristics in PFP. One case-control study found no difference in levels of anxiety/depression between groups with and without PFP.[47] Single-group studies also reported mean anxiety and depression levels that were not abnormal;[42] mean anxiety and depression levels[41] below that of a national normative dataset;[55] and SF-36 MHC results that, when compared with normative equivalents, demonstrate normal mental health in individuals with PFP.[26 28 34 35]

Table 1 Participant characteristics: studies presented in order of those with only psychosocial measurements; those with PFP-free controls; those examining the relationship between psychosocial factors and other PFP-related symptoms; and those exploring the predictive capabilities of psychosocial factors

		PFP group									PFP-free control group				
Author (date)	Study design/Data provided (descriptive, comparative, correlative)	Source	Number (women)	Age: mean (SD)	BMI: mean (SD)	Occupation/Education/ Activity	PFP diagnosis information	Pain duration (months): mean (SD)	Pain severity: mean (SD)	Patient-reported functional measures related to PFP: mean (SD)	Source	Number (females)	Age (mean ± SD)	BMI: mean (SD)	Occupation/ Education/ activity
Akkurt *et al* (2010)[49]	Case series/ descriptive	NR	22 (22)	34.7 (8.4)	NR	NR	Clinical criteria described	NR	VAS: 4.5 (1.9)	SF-36 PHC: 39.9 (19.6)	No control				
Apivatgaroon *et al*[26]	Case series/ Correlative	University hospital	49 (39)	46.59 (10.83)	25.19 (4.51)	NR	Clinical criteria described	Median (range): 10 (0.5–120)	NR	Kujala: 47.61 (21.11) SF-36 PHC: NR	No control				
Cheung *et al* (2012)[28]	Case series/ Correlative	Hospitals and physiotherapy clinics	64 (26)	30.2 (6.1)	22.3	NR	No criteria but practitioner named	32.2 (38.8)	NR	Kujala: 86.4 (11.2) SF-36 PHC: NR	No control				
Cheung *et al* (2013)[43]	Case series/ Correlative	Athletics clubs	38 (24)	21.9 (1.9)	20.6	19.4 (17.2) hours training per week	No criteria but practitioner named	18.1 (21.1)	NR	Kujala: 79.87 (13.1) SF-36 PF: 81.5 (17.2) SF-36 RP: 59.9 (42.6) SF-36 BP: 56.9 (20.8) SF-36 GH: 65.2 (19.5)	No control				
Doménech *et al* (2013)[30]	Case series/ Correlative	Orthopaedic outpatients clinics	97 (80)	32 (10.0)	NR	NR	No criteria but practitioner named	Mean (range): 12 (6–22)	VAS: 6.9 (1.8)	Lysholm: 47.7 (20.4)	No control				
Doménech *et al* (2014)[29]	Cohort/ Correlative	Orthopaedic outpatients clinics	47 (42)	32.1 (10.9)	NR	Education: University: 17 Secondary studies: 19 Basic studies: 11	No criteria but practitioner named	NR	VAS: 7.7 (1.6)	Lysholm: 43.9 (20.9)	No control				
Eapen *et al* (2011)[31]	Case series/ Descriptive	In-and-outpatient hospital departments	20 (12)	27.5 (6.6)	NR	NR	Clinical criteria described and practitioner named	NR	NR	PFP severity score: 57.94 (11.07)	No control				
Haim *et al* (2013)[31]	Case series/ Descriptive	Therapy centre database	48 (21)	31.2 (8.7)	24 (4.0)	NR	Clinical criteria described and practitioner named	NR	VAS: 30.9 (18.5)	WOMAC: Pain: 30.9 (18.5) stiffness: 19.3 (20.2) function: 20.6 (17.4) SF-36 PHC: 52.6 (18.5)	No control				

Kastelein *et al* (2014)[33]	Case series/ Descriptive	General practitioners	74 (35)	23.7 (7.9)	23.4 (4.3)	Mixed level of education and working hours	No criteria but practitioner named	Half of sample under 3 months	NPRS: 3.6 (2.3)	Lysholm: 73.7 (14.0) WOMAC: Pain: 2.4 (16.9); stiffness: 23.6 (22.3); function: 18.4 (15.8)	No control
Kuru *et al* (2012)[50]	Cohort/ Descriptive	NR	30 (26)	36.9 (11.9)	25.3 (1.6)	Years in education: 12.4 (3.2)	No criteria but practitioner named	NR	VAS: 6.4 (1.6)	Kujala: 76 (9) SF-36 PF: 40.2 (9.4) SF-36 RP: 38.2 (11.8) SF-36 BP: 41.6 (8.6) SF-36 GH: 41.8 (9.4)	No control
Negahban *et al* (2012; 2013)[34 35]	Case series/ Correlative	Physiotherapy clinics	100 (71)	25.28 (7.0)	Mean: 23.0	Years of education: 6–8: 2 9–12: 15 >12: 83	Clinical criteria described and practitioner named	Median (IQR): 12 (6, 24)	NR	Kujala: 67.6 (13.5) SF-36 PF: 65 (24) SF-36 RP: 47.8 (36.9) SF-36 BP: 51.2 (19.3) SF-36 GH: 53.6 (17.2) FIQ: 10.4 (2.9) MFIQ: 31.3 (18.0)	No control
Piva *et al* (2009a)[36]	Case series/ Correlative	Clinical sites on military bases	74 (39)	29 (9.0)	Mean: 26.3	Employment type: mostly sedentary: 18; sedentary, walking: 13; moderately active: 34; demanding: 9	Clinical criteria described and practitioner named	Range: 1 ->25	NPRS: 3.8 (1.9)	KOS-ADLS: 66 (17)	No control
Piva *et al* (2009b)[37]	Cohort/ Correlative	Clinical sites on military bases	51 (27)	Median (IQR): 26: 22–38	Mean: 25.9	Employment type: mostly sedentary: 11; sedentary, walking: 9; moderately active: 25; Demanding: 6	Clinical criteria described	Range: 1 ->25	Median (IQR): NPRS: 3.7 (2.3–5.0)	Median (IQR): KOS-ADLS: 71.4 (55.7–78.6)	No control
Rathleff *et al* (2015)[45]	Cohort/ Descriptive	Secondary school cohort	121 (97)	17.2 (1.0)	21.7 (2.9)	Education: secondary school students. Activity: participating in sport=40	Clinical criteria described and practitioner named	Median (IQR): 39 (21–60)	Median (IQR): VAS: with activity: 50.0 (35.0–64.0). At rest=13.0 (327)	NR	No control
Selfe *et al* (2016)[38]	Case series/ Descriptive	Hospital-based physiotherapy clinics	127 (84)	26 (5.7)	25.4 (5.8)	Number (%) with low physical activity level (IPAQ): 19 (15)	Clinical criteria described and practitioner named	Median (IQR): 24 (7–60)	4.7 (1.95)	MFIQ: 34.1 (16.97)	No control
Selhorst *et al* (2015)[39]	Cohort/ Descriptive	Children's hospital physiotherapy clinic	21 (14)	14.1 (1.4)	NR	NR	No criteria but practitioner named	NR	NPRS: 2.2 (0.9)	AKPS: 77.90 (8.99)	No control

Continued

Table 1 Continued

		PFP group									PFP-free control group				
Author (date)	Study design/Data provided (descriptive, comparative, correlative)	Source	Number (women)	Age: mean (SD)	BMI: mean (SD)	Occupation/Education/ Activity	PFP diagnosis information	Pain duration (months): mean (SD)	Pain severity: mean (SD)	Patient-reported functional measures related to PFP: mean (SD)	Source	Number (females)	Age (mean ± SD)	BMI: mean (SD)	Occupation/ Education/ activity
Syme et al (2009)[40]	Cohort/ Descriptive	Orthopaedic knee clinic	69 (41)	28.2 (7.4)	25.7 (1.3)	NR	Clinical criteria described	48.3 (37)	NPRS: 52.9 (27.2)	MFIQ: 33.6 (15.4) SF-36 PHC: 46 (8)	No control				
Tan *et al* (2010)[41]	Cohort/ Descriptive	GP's and sports physicians	131 (84)	24 (8.2)	23.1 (3.6)	Primary occupation: in education: 56 paid work: 61 other: 14 Activity: sports participation: 100 5 (3.5) hours per week	Clinical criteria described and practitioner named	NR	NR	NR	No control				
Thomee *et al* (2002)[42]	Case series/ Descriptive	Orthopaedic surgeons, doctors, nurses and physiotherapists	50 (gender balance unknown)	24.9 (9.7)	NR	NR	Clinical criteria described and practitioner named	67.2 (68.4)	Mean (range): VAS: 32 (20–55)	MPI general activity score: 2.5 (0.9)	No control				
Assa *et al* (2013)[27]	Case series/ Comparative	Therapy centre database	157 (66)	30.3 (5.0)	23.6 (3.3)	NR	Clinical criteria described and practitioner named	NR	VAS: 30.1 (22.6)	WOMAC: Pain: 30.1 (22.6); Stiffness: 19.5 (24.0); Function: 17.7 (17.9) SF-36 PHC: 54.8 (16.3)	NR	31 (14)	31.9 (3.8)	22.5 (2.9)	NR
Carlsson *et al* (1993)[47]	Case series/ Comparative	NR	17 (8)	27.5 (5.0)	NR	'mixed'	Clinical criteria described	Range: 9–96	NR	NR	Physiotherapy students	17 (8)	27.7 (5.2)	NR	NR
Jensen *et al* (2005)[48]	Case series/ Comparative	Orthopaedic outpatients clinics	25 (16)	32.2 (7.1)	23.8 (3.2)	NR	Clinical criteria described	Mean (range): 74 (12–260)	VAS: 24 (0–77)	CKRS: 57.6 (15.5)	Advertisements	23 (12)	29.1 (8.7)	23.4 (2.3)	NR
Rathleff *et al* (2013)[46]	Cohort/ Comparative	Population-based secondary school cohort	20 (16)	14.6 (1.1)	Median (IQR): 19.5 (18.2–20.7)	Education: secondary school students	Clinical criteria described and practitioner named	Median (IQR): 28.5 (24–36)	Median (IQR): VAS: With activity: 55.5 (40.5–71.0). At rest=5.5 (129)	Median (IQR) PAS=42.0 (39.449.8)	Population-based secondary school cohort	20 (16)	14.8 (1.0)	Median (IQR): 19.3 (17.4–21.7)	Education: secondary school students
Witvrouw *et al* (2000)[44]	Cohort/ Comparative	Physical education classes	24 (13)	NR	Mean: 21.2	Activity: 12–14 hours various sports per week+2.8 hours external sports	Clinical criteria described and practitioner named	NR	NR	NR	Physical education classes	258 (118)	NR	Mean: 21.6	Activity: 12–14 hours various sports per week+2.5 hours external sports

AKPS, Anterior Knee Pain Scale; BP, bodily pain; CKRS, Cincinnati Knee Rating System; Knee Outcome Survey-Activities of Daily Living; GH, general health; KOOS, Knee injury and Osteoarthritis Outcome Score; MFIQ, Modified Functional Index Questionnaire; NR, not reported; PAS, Physical Activity Scale; PFP, patellofemoral pain; RP, role physical; SF-36 PF, Physical Function; SF-36 PHC, Short Form-36 Physical Health Component; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

Table 2 Outcome measures presented within their allocated construct groupings. Information about the measure and who it was used by. Further information is provided in online supplementary file 2.

Instrument	Constructs evaluated	Number of items; subscales	Score interpretation	Used by
Mental health measures				
36-Item Short Form Health Survey Mental Health Component[72]	Generic mental health measure	14 items; four subscales (vitality; social functioning; role emotional; mental health)	Each subscale 0–100. Higher score = better mental health	24, 46, 23, 25, 40, 28, 29, 30, 47, 31, 32, 37
EuroQol—5 Dimensions 3 Level[73]	Generic quality of life measure	Five items; five subscales (only one related to mental health; anxiety/ depression) Three-level version: no problems; moderate problems; extreme problems. Five-level version: no problems; slight problems; moderate problems; severe problems; extreme problems.		43, 42, 35, 38
Hospital Anxiety and Depression Scale[74]	Anxiety and depression	14 items; two subscales (anxiety and depression)	Each subscale 0–21. 0–7 = non-case 8–10 = possible case >10 = probable case	27, 26
Modified Karolinska Scales of Personality[75]	Version featured in this review focused on anxiety	10 scales (psychic anxiety; psychasthenia; low assertiveness; somatic anxiety; muscular tension; indirect aggression; verbal aggression; irritability; suspicion; guilt	Unable to determine	44
Hopkins Symptom Checklist – 25 items[76]	Mental distress	25 items; two = anxiety and depression	Each item 1 = not at all, to 4 = extremely Average score (1.00–4.00) calculated	45
Beck Anxiety Inventory[77]	Anxiety	21 items	Each item 0–3 giving overall score 0–63 Higher scores mean more anxiety	33
Spielberger State Trait Anxiety Inventory[78]	Anxiety	40 items; two = current state of anxiety (S-anxiety). Stable, trait aspect of anxiety (T-anxiety)	Each item 1–4 Scores added with higher scores indicating greater anxiety	39
Cognitive measures				
Pain Catastrophising Scale[79]	Catastrophising	13 items; three subscales (rumination, magnification and helplessness)	Each item 0 = not at all, to 4 = all the time Higher overall score means higher levels of catastrophising	27, 26, 43
Coping Strategies Questionnaire[80]	Coping strategies	48 items; eight subscales (diverting attention, reinterpreting pain sensations, catastrophising, ignoring sensations, praying and hoping, coping self-statements, increased behaviour activities)	Each item 0 = no control, to 6 = complete control	27, 26, 39
Utrecht Coping List[81]	Coping strategies	44 items; seven subscales (active tackling, seeking social support, palliative reacting, avoiding, passive reacting, reassuring thoughts, expression of emotions	Unable to determine	41
Amsterdam Biographic Questionnaire[82]	Unable to determine	Unable to determine	Unable to determine	41
Behavioural measures				
Tampa Scale of Kinesiophobia[71]	Fear of movement	17 items	Each item 0 to 4 Higher net score = increased fear of movement	27, 26, 30
Fear-Avoidance Beliefs Questionnaire[83]	Fear-avoidance beliefs	16 items; two subscales (physical activity and work)	Each item 0 to 6 Higher net score = increased fear-avoidance beliefs	33, 34, 36
Carlsson's Dependency Scale[47]	Dependency	No instrument information available		44
Other related measures				
Coop-Wonca Chart[84]	Generic quality of life measure	Six items; only one related to psychological function (feelings)	1 to 5 Higher score = more emotional problems	45, 30
Schalling-Sifneos Alexithymia Scale[85]	Alexithymia	20 items	Each item answered yes or no	44
Carlsson's Stress Scale[47]	Stress	No instrument information available		44
WHO Disability Assessment Schedule 2.0[86]	Overall function (psychological and physical)	12 items; 6 domains. 1 directly related to psychological function (cognition)	Each item 0 to 4 Higher score = more difficulty	35

In summary, there were four case-control studies that found psychological differences between PFP and control participants, compared with one that did not. The four studies that found differences were in the higher quality rating (Q3;[27 44 48] Q4[46]) while the one that found no change rated poorly (Q1[47]). Supporting comparative data were three high-rating single-group studies (Q3;[37 38] Q4[45]),demonstrating elevated psychological factors compared with six single-group studies that found no difference in measures. Of the latter, four rated poorly (Q1;[26 28 42] Q2[35]) and two rated highly Q3;[34] Q4[41]). Thus, many of these findings suggest that coping strategies including catastrophising may differ in those with PFP, though the clinical relevance of the size of this difference is yet to be determined. Findings also suggest that anxiety/depression and fear avoidance may be elevated, especially in adolescents. These results derive from a disparate group of studies that use a wide variety of psychological measures. Sample sizes were, for the most part, small, which may explain why some studies failed to find evidence of abnormal non-physical features. The small samples also prevent accurate estimation of the prevalence of non-physical features in PFP.

Correlation between psychological factors, PFP and physical function

This review revealed several non-physical features that are correlated with PFP in a linear manner. As single mental health constructs, anxiety and depression demonstrated moderate-to-large correlation with pain and physical function.[29 30 36 37] All studies that used the SF-36 MHC only evaluated relationships with physical function and all found small-to-moderate correlations at best.[26 28 34 35]

Beyond mental health, catastrophising[29 30] and pain-related fear[29 30 36 37] were the cognitive and behavioural factors, respectively, that demonstrated the strongest and most consistent correlation with both pain and physical function. Catastrophising and fear avoidance beliefs have previously been described as the cognitive and behavioural determinants of the pain experience.[56] It remains unknown whether the experience of pain and the inability to perform physical tasks lead to the development of psychological problems, or whether psychological features influence pain and function through mechanisms such as effects on endogenous pain modulation, individual resilience and the motivation needed to cope with the symptoms of PFP. Longitudinal research is required to study these potential temporal relationships.

Comparison with non-physical characteristics in other knee conditions

A number of systematic reviews have explored the relationship between psychological factors and short-, medium- and long-term postoperative pain following total knee arthroplasty. The psychological factors identified therein included catastrophising,[57–61] depression[58–60] and anxiety.[60] In other knee conditions, psychological factors also seem to share a relationship with function. Higher levels of exercise adherence, higher perceived rehabilitation effort and greater rates of home exercise completion have been found in patients with greater general self-efficacy following ACL reconstruction.[62] Recognising the similarities in psychological factors between these knee conditions and PFP provide support for consideration of non-physical factors in addition to mechanically focused PFP management strategies.

Implications for clinicians who are managing PFP

PFP and low back pain (LBP) are similar from several perspectives. Both conditions can stem from insidious roots, limit physical function and persist. In both instances, the cause of pain can be hard to define and the pathway from acute pain to chronicity poorly understood. They differ in terms of structure, anatomical region and depth of investigation of involvement of psychological features of the conditions. Drawing from LBP research, subgroups that demonstrate the highest levels of psychological impairment are those with the highest pain intensities, the greatest disability and the longest pain duration.[63–65] Psychological factors also act as significant barriers to home exercise programme adherence,[66] influence the transition from persistent to chronic widespread pain[67] and increase healthcare usage.[68 69]

Facing a growing literature base implicating non-physical features in the development and maintenance of persistent musculoskeletal pain, clinicians who assess and treat PFP should screen for their presence. Generic instruments, such as the short-form Orebro Musculoskeletal Pain Questionnaire,[70] are simple to implement and can be completed early in the consultation process. If further investigation is merited, concise assessment of individual psychological constructs can be conducted using the instruments highlighted in this review (eg, fear of movement with the Tampa Scale of Kinesiophobia).[71]

Future research

The identification of differences in psychological factors between individuals with PFP and controls, as well as relationships with pain and physical function, suggests that there might be subgroups of PFP that require different treatment approaches. Three studies in this review attempted to subgroup participants. One took a cross-sectional approach to identify physical phenotypes[38] and one identified a range of physical measures that may be potential risk factors for PFP development.[44] The third applied a treatment algorithm that first identified and directed treatment according to the results of a fear-avoidance beliefs assessment.[39] In the latter, a comparator group receiving usual care was lacking, but tailored treatment produced clinically significant physical functional improvements (Anterior Knee Pain Scale scores) for 100% of participants and clinically significant reductions in pain severity for 33%. Although the potential benefits of subgrouping people with PFP to guide treatment remain relatively unknown, these results provide a stimulus for further studies. This includes further comparison of psychological factors between those with and without PFP, psychometric evaluation of psychological measures used in PFP groups and consistent use of recommended measures.

Strengths and limitations

This review has attempted to address the complex topic of non-physical features of PFP. The overall results are derived, in many cases, from a disparate group of studies without PFP-free comparators that were too diverse for data pooling. The wide range of psychological measures used also made the compiling and comparing of the results challenging. For most studies, investigation of psychological factors was not a primary aim, and this reflects in the generally low EAI quality ratings. The wide range of study designs made selection of an appropriate quality appraisal tool difficult. While comprehensive enough to evaluate the range of studies in this review (cohort and case series), the EAI did not evaluate the quality of specific study design analyses. The potential to define, classify and select

psychological measures for analysis also proved challenging and needs consideration when drawing inferences from the findings.

Key messages

What is already known on this subject?

- Patellofemoral pain (PFP) is a highly prevalent musculoskeletal condition that can be challenging to manage.
- PFP is usually considered in a biomechanical paradigm.
- Non-physical, psychological factors are increasingly recognised for their role in other persistent musculoskeletal pain conditions.

What are the new findings?

- Some mental health and cognitive profiles were different in those with PFP compared with asymptomatic controls.
- A range of mental health, cognitive and behavioural factors were correlated with pain and physical function.
- Few studies have compared psychological profiles between those with and without PFP, and none have used the same measure.

CONCLUSION

This systematic review has demonstrated that anxiety, depression, catastrophising and pain-related fear may be elevated in individuals with PFP. It has also identified linear correlation between PFP-related symptoms and psychological factors such as catastrophising and pain-related fear. These findings are derived from studies with relatively small sample sizes, few of which included healthy control groups for comparison. Large case-control studies are needed to confirm the presence and prevalence of non-physical features.

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