Observational study

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The psychological features of patellofemoral pain: a cross-sectional study

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Abstract

Background and aims: Patellofemoral pain (PFP) is a prevalent and debilitating musculoskeletal condition, considered to have a mechanical aetiology. As such, the physical impairments associated with PFP are well documented and have helped characterise different physical phenotypes. But little is known about the relationship between PFP and psychological well-being. In this study, we aimed to: (1) compare psychological profiles between groups with and without PFP; (2) compare psychological profiles and condition severity between PFP subgroups; and (3) explore relationships between psychological factors and their contribution to disability. We expected to find higher levels of psychological impairment, especially kinesiophobia and catastrophizing in the PFP group. We also expected to identify a sub-group for who worsening levels of disability correspond with worsening psychological well-being.

Methods: One hundred participants with PFP (72 females, mean ± SD age 27 ± 5 years, BMI 25.3 ± 4.8 kg/m^2) completed measures of pain, disability, and psychological features (kinesiophobia, catastrophizing, anxiety and depression). Fifty controls, matched by sex, age and activity level (36 females, age 27 ± 5 years, BMI 22.9 ± 4.5 kg/m^2) also completed psychological measures. The Knee injury and Osteoarthritis Outcome Score (KOOS) was used to cluster PFP participants (K-means cluster analysis) into more and less severe sub-groups. Differences between the control and PFP groups were analysed using *t*-tests, analysis of variance, Mann-Whitney *U*-tests or χ^2 tests as appropriate ($p < 0.05$). Pearson correlations were used to explore relationships between psychological measures. Backward stepwise regression (p out >0.05) evaluated how the psychological factors potentially relate to disability.

Results: Psychological features did not differ between PFP and pain-free groups. But differences were apparent when the PFP cohort was subgrouped. Compared to controls, the more-severe group had significantly higher levels of depression (MD 1.8, 95% CI 0.8–2.8; $p \leq 0.001$) and catastrophizing (MD 5.7, 95% CI 2.4–9; $p \leq 0.001$). When compared to less-severe cases, the more-severe group also demonstrated significantly higher levels of kinesiophobia (MD 4.3, 95% CI 2.1–6.5; $p \leq 0.001$), depression (MD 1.5 95% CI 0.5–2.6; $p = 0.01$) and catastrophizing (MD 4.9, 95% CI 1–8.8; $p = 0.01$). The weakest relationship between psychological factors was found between kinesiophobia and anxiety ($r = 0.29$; $p = 0.02$). While the strongest relationship existed between depression and anxiety ($r = 0.52$; $p \leq 0.001$). Both kinesiophobia (β −0.27, 95% CI −0.265 to −0.274) and depression (β −0.22, 95% CI −0.211 to −0.228) were associated with disability as defined by the KOOS in the regression model ($R^2 = 0.17$, $p \leq 0.001$).

Conclusions: Those with more-severe PFP-related disability have higher levels of psychological impairment than less-severe cases. Kinesiophobia seems to stand as an important factor in the experience of PFP, because it was elevated in the PFP group, significantly differed between the PFP sub-groups and contributed to explaining disability. Contrary to our hypothesis, levels of catastrophizing in the PFP group and severe sub-group were low and seemingly not important.

Implications: These findings draw attention to psychological factors to which clinicians assessing PFP should show vigilance. They also highlight psychological impairments that might be worthwhile targets in optimising PFP management.

Keywords: disability; anxiety; depression; kinesiophobia; catastrophizing; sub-grouping.

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1 Introduction

Patellofemoral pain (PFP) is a common and frequently persistent condition that presents as pain behind or around the patella [1, 2]. It is typically considered to have a mechanical aetiology, aggravated when the knee is loaded in a flexed position [3], with ensuing functional limitations in daily physical tasks and sporting activities [4]. Exploration of physical features has exposed condition heterogeniety [5, 6]. It has also prompted the need for subgroup analyses to optimise management. To date nearly all subgrouping research has been based around the physical features of the condition.

Increasingly, psychological factors have been considered alongside physical factors in musculoskeletal pain [7–10]. Currently there exists limited evidence to indicate that some with PFP have higher levels of catastrophising and poorer patient-reported general mental health than controls [11]. Qualitative research has also found that catastrophic thinking and anxiety related to joint crepitus, a frequent symptom of PFP, may lead to avoidance or modification of activity [12]. These findings indicate that PFP may be more than just a mechanical problem.

The majority of studies investigating psychological factors in PFP have done so with small samples and lack pain-free control groups [11]. Thus, whether those with PFP have different psychological profiles from similar societal groups without pain remains unclear. Furthermore, psychological evaluation in PFP lacks uniformity due to the application of a wide range of patient-reported measures used for similar constructs. Using common patient-reported measures, the aims of this study were to: (1) compare psychological features between groups with and without PFP; (2) compare psychological profiles, disability and pain between subgroups with different severity of PFP symptoms; and (3) explore linear correlations between psychological factors and how these factors contribute to disability. We hypothesised that, when compared to controls, psychological factors, especially kinesiophobia and catastrophizing would be elevated in those with PFP. We also expected to find higher levels of psychological impairment in those with higher levels of disability.

2 Materials and methods

We conducted a cross-sectional study in three parts. First, we compared psychological factors between the PFP group and a pain-free group of similar age, sex and activity level. Then, in order to improve our understanding of severity-related differences in psychological well-being, we partitioned the PFP cohort into two subgroups determined by the Knee injury and Osteoarthritis Outcome Score (KOOS). Finally, we explored relationships between psychological factors and their contribution to PFP-related disability. Ethical approval for this study was granted by the Institutional Medical Research Ethics Committee (approval number: 2013000981) and all participants provided written informed consent prior to data collection.

2.1 Participants

The PFP participants were a subset of those included in the Foot Orthoses versus Hip eXercises (FOHX) trial [13]. They were recruited across the greater Brisbane region through advertising in physiotherapy clinics, posters in public areas, and social media outlets. In accordance with the FOHX trial's recruitment process, volunteers were assessed through a two-part screening process conducted by a registered physiotherapist with post-graduate qualifications. Volunteers were first screened by a phone assessment, and then underwent a physical examination. Inclusion criteria for the PFP group were: (1) aged 18–40 years; (2) 6 weeks or more of PFP symptoms that were provoked by at least two of squatting, jogging, running, hopping, jumping or stair ambulation; (3) worst pain over the last week ≥3/10 on a numerical pain rating scale (0 = no pain, 10 = worst pain imaginable); (4) pain on palpation around the patella; and (5) none of the following: concomitant knee injuries, pathologies or surgery; patellar instability or evidence of knee swelling; hip, pelvis or lower back pain; current use of anti-inflammatory medication; or treatment in the last 12 months [13].

Pain-free control volunteers were recruited through the same method as the PFP group minus the clinical advertisements. They were aged 18–40 years and had been pain-free for the past 3 months. Controls were excluded if they had been unable to complete normal daily duties due to body pain in the past 3 months, or had any chronic conditions affecting their physical function.

2.2 Psychological measures

Patellofemoral pain and pain-free groups completed self-rated questionnaires pertaining to anxiety, depression and pain catastrophizing, with only the PFP group completing a fear of movement or re-injury questionnaire.

The Hospital Anxiety and Depression Scale (HADS) is a 14-item questionnaire (two 7-item subscales) developed to detect states of anxiety and depressive symptoms in clinical settings [14]. Participants are instructed to answer

each item in response to how they have felt over the last 7 days. Each item is scored on a 4-point scale, and summed to give a total score from 0 to 21. Although the developers of the scale recommended categorising a score of 8–10 as a potential case and 11–21 as a definite case, a literature review of over 700 studies concluded that a subscale score of ≥8 identifies cases of anxiety and depression [15].

The Pain Catastrophizing Scale (PCS) was used to measure pain-related catastrophizing [16]. It has 13 items that yield an overall score and three subscale scores (rumination, magnification and helplessness). Scores greater than 24 have been associated with higher pain ratings following multi-disciplinary intervention [17]. Reliability and validity of the PCS have been established and confirmed [16, 18, 19].

The Tampa Scale for Kinesiophobia (TSK) is a 17-item questionnaire designed to assess fear of movement or (re)injury [20]. Items are scored on a 4-point Likert scale, and responses summed to yield a net score between 17 and 68, with higher values indicating a greater fear of movement. As an operational definition, 37 has been proposed as the cut-off between individuals with high- and low-fear [21]. The TSK was intended for use in patients with chronic pain, and thus was not completed by the control group. The TSK demonstrates excellent test-retest reliability and correlates significantly with other fear-avoidance measures [22], although its construct validity has previously been questioned [23].

2.3 Measures of symptoms and function

Patient-reported measures of symptoms and function were completed by the PFP group only. Pain severity was measured using a numerical rating scale (NRS). Participants were asked to rate their worst knee pain experienced during the previous week across 11 points, where 0 = "no pain" and 10 = "worst pain imaginable".

The Kujala Patellofemoral Score (KPS) was used to measure symptoms and function [24]. The KPS comprises 13 questions related to PFP. Participants are asked to answer each question by selecting a response that best corresponds to their level of activity and symptoms. A final score is calculated as the sum of all items (0–100), where lower scores indicate worse symptoms and disability.

The KOOS was used to characterise the cohort and subgroup PFP participants into high and low severity groups [25]. The original KOOS comprises 42 questions across five subscales that relate to symptoms, pain, function in activities of daily living, sport and recreation function, and knee-related quality of life. We also included the 11-item patellofemoral pain and osteoarthritis subscale (KOOS-PF), which was recently developed for use in PFP conditions [26]. Items are scored from 0 to 4, each of the six subscale scores are calculated independently, and transformed to give a score from 0 (extreme problems) to 100 (no problems).

2.4 Statistical analysis

Group data were reported in tables as mean and standard deviations or median and inter-quartile ranges. Differences between groups were reported as the relevant point estimate of effect and 95% confidence interval. All analyses were performed using Stata 14.0 (Statacorp, College station, TX, USA).

For aim 1, the PFP and pain-free groups were compared using two methods. First, *t*-tests were employed for between-group mean comparisons. Second, recommended measure cut-offs were applied to the psychological measures, dichotomizing both groups. The prevalence of impairment was then presented as a percentage of cases for each group. Once obtained, prevalence rates were used to calculate relative risks with 95% confidence intervals. Relative risks were considered to be either small = 2, medium = 3 or large = 4 [27].

For aim 2, PFP data were analysed in subgroups, determined by k-means cluster analysis, conducted using all six KOOS subscales as multiple variables. Numbers of subgroups, ranging from 1 to 5 were considered, with the Calinski-Harabasz pseudo-*F* index used to determine the optimal clustering solution. The two-cluster solution produced the highest index score (94.4). Thus, the PFP cohort was partitioned into two groups; less-severe or more-severe PFP. Pain severity, KPS, KOOS, TKS, PCS and HADS were compared between less-severe and more-severe PFP subgroups and the control group using one-way analysis of variance (ANOVA). Bonferroni corrected post-hoc analyses were conducted where main effects were statistically significant ($p < 0.05$).

For aim 3, relationships between psychological factors were assessed using Pearson correlations and Sidak adjustment methods, and were reported as *r*-values. Effect sizes of correlations were considered as follows: 0.0 = trivial; ≥0.1 = small; ≥0.3 = medium; ≥0.5 = large; ≥0.7 = very large; ≥0.9 = nearly perfect [28]. Multivariate backward stepwise linear regression was conducted (p-out >0.05) to explore how psychological factors, as independent variables, were contributing to disability as defined by the KOOS subgroups (dependent variable). The F statistic and R^2 value for the model were reported along with standardised coefficients (β) and *p*-values for each psychological variable.

3 Results

One hundred participants with PFP were deemed eligible (Fig. 1) and completed all pain, disability and psychological measures. This group was 76% female with a mean (SD) age of 27 (5) years, BMI of 25.3 (4.8) weekly activity levels (expressed in MET-minutes) of 3564.9 (3681.2). Worst pain over the last week for the PFP group was 6.1 (2). All appropriate psychological measures were completed by 50 pain-free controls. The control group was comparable on sex, age and activity levels, but had a significantly smaller BMI ($p = 0.01$) (Table 1).

3.1 PFP versus controls

No between-group mean differences were found for the HADS-A, HADS-D or PCS (Table 1). When explored as percentages, the prevalence of anxiety and depression were, respectively, 8% and 6%, higher in the PFP group. The prevalence of pain catastrophizing did not differ between groups (Table 2).

3.2 Subgroups of PFP severity

Individuals with PFP were partitioned into a less-severe group ($n = 57$) and a more-severe group ($n = 43$) (Table 1). Significantly higher pain severity ($p \leq 0.001$) and consistently worse symptoms and disability (KPS and all KOOS scales; $p \leq 0.001$) seen in the more-severe group helped validate the group split. Both groups were comparable in terms of demographic features (Table 3).

Although there were no significant differences in TKS, PCS or HADS between those with less-severe PFP and controls, those with more-severe PFP had significantly higher HADS-D ($p = 0.01$) and PCS ($p = 0.01$) scores than the controls (Table 3). The more-severe group also had significantly worse scores for the TSK ($p \leq 0.001$), HADS-D ($p \leq 0.001$) and PCS ($p \leq 0.001$) than the less-severe group. The largest difference in prevalence was observed for kinesiophobia, which was 27% more prevalent in the more-severe PFP group.

3.3 Relationships between psychological factors and their contribution to disability

A range of effect sizes for psychological factor correlations were seen. Anxiety and depression were the only constructs to hold a large correlation ($r = 0.52$). Catastrophizing held medium correlations to all other psychological constructs (ranging from $r = 0.37$ to $r = 0.47$). The only small correlation was between anxiety and kinesiophobia ($r = 0.29$). All results in Table 4.

The multivariate regression revealed that kinesiophobia [β (95% CI), −0.27 (−0.265 to −0.274)] and depression [−0.22 (−0.211 to −0.228)] were the only psychological constructs significantly contributing to the overall KOOS

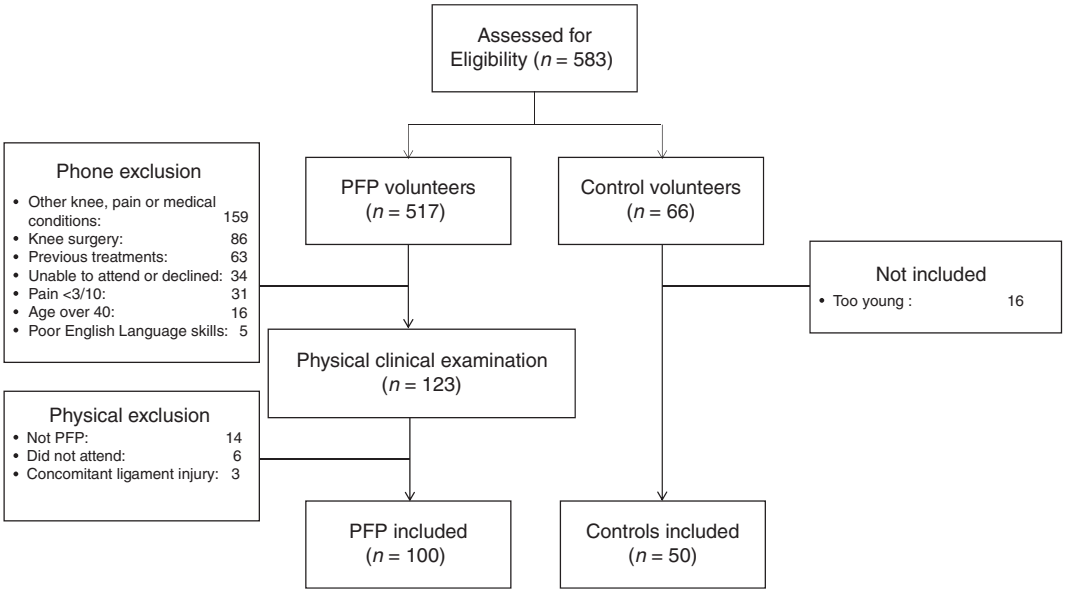

Figure 1: Participant flow diagram.

Table 1: Participant demographics, psychological measures and results pertaining to pain and physical function.

	PFP group ($n=100$)		Pain-free group ($n=50$)		MD (95% CI)
	Mean (SD)	Min–max	Mean (SD)	Min–max	
Demographics					
Age[a]	27 (8)	18–37	25.5 (7)	19–39	1.5 (–1.41 to 4.41)
Number of females (%)	72 (72)		36 (72)		NS
BMI[a]	24.2 (6.2)	19.1–43	22.9 (3.9)	18.8 – 32.5	1.3 (–0.13 to 2.63)
Weekly activity level (IPAQ)[a]	2,391 (3039.75)	0–17,208	2,606 (2095.5)	258–14,670	–206 (–867.8 to 455.8)
Psychological measures					
Kinesiophobia (TSK)	39.3 (5.92)	24–54			
Anxiety (HADS-A)[a]	6 (5)	0–19	6 (4)	0–17	0 (–1.31 to 1.31)
Depressive symptoms (HADS-D)[a]	2 (3)	0–13	2 (3)	0–8	0 (–1.03 to 1.03)
Catastrophizing (PCS)[a]	10 (12.5)	0–49	6.5 (14)	0–33	3.5 (–1.46 to 8.46)
Pain and physical function					
Worst pain past week (NRS)	6.1 (1.96)	0–9			
Kujala Patellofemoral Score	71.1 (9.55)	43–90			
KOOS – symptoms	76.8 (11.64)	42.8–100			
KOOS – pain	71 (12.42)	44.4–97.2			
KOOS – activities of daily living[a]	85.3 (19.85)	45.6–100			
KOOS – sports and recreation	49.2 (22.26)	0–100			
KOOS – quality of life	47.6 (16.61)	0–87.5			
KOOS – patellofemoral	56.3 (15.85)	22.7–88.6			

[a] = Median (interquartile range); IPAQ = International Physical activity Scale (MET/minutes); TSK = Tampa Scale for Kinesiophobia; HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; PCS = Pain Catastrophizing Scale; NRS = Numerical Rating Scale; KOOS = Knee injury and Osteoarthritis Outcome Score; sports/rec = sports and recreational function; MD = median difference.

Table 2: Prevalence and relative risk of psychological impairments across groups.

	Cases (%)				Relative risk (confidence interval)			
	Control	PFP	Less-severe	More-severe	PFP vs. control	Less-severe vs. control	More-severe vs. control	Less- vs. more-severe
Anxiety	13 (26)	34 (34)	17 (30)	17 (40)	1.3 (0.8–2.2)	1.2 (0.6–2.1)	1.5 (0.8–2.8)	1.3 (0.8–2.3)
Depression	1 (2)	8 (8)	2 (4)	6 (14)	4 (0.5–31.1)	1.8 (0.2–18.8)	7 (0.9–55.7)	4 (0.8–18.7)
Catastrophizing	4 (8)	8 (8)	3 (5)	5 (12)	1 (0.3–3.2)	0.7 (0.2–2.8)	1.5 (0.4–5.1)	2.2 (0.6–8.7)
Kinesiophobia	NA	73 (73)	35 (61)	38 (88)	NA	NA	NA	1.4 (1.1–1.8)

Prevalence rates have been determined according to previously recommended measure cut-off points. These are ≥8 for the HADS-A and -D (15), >24 for the PCS (17) and the ≥37 for TSK (21).

results. The model [F(2,97) 10.07, $p \leq 0.001$] explained 17% of the total variance (Table 5).

4 Discussion

Our study yields several important findings. The first is that there was no difference in the measures of interest between our PFP and control groups. Another is the discovery of a subgroup of individuals with more-severe PFP group who had significantly higher levels of psychological impairment. In the more-severe group, levels of depression and catastrophizing were significantly higher than those identified for the less-severe and the control group. When compared to the less-severe group, the more-severe group also had significantly higher levels of kinesiophobia, leaving anxiety as the only construct that was not different between any of the groups. A relationship between psychological impairment and higher levels of disability has previously been found in people with other knee conditions such as ACL injuries [29–31] and knee osteoarthritis [32–36]. It is also evident in other musculoskeletal conditions such as low back pain [37–41]. Thus, our findings should change how severe PFP is

Table 3: Demographic, psychological, pain and physical function outcomes for pain-free and clustered PFP groups (mean (SD) unless otherwise indicated), with between-group comparisons (mean difference (95% CI; *p*-value).

	Pain-free (*n* = 50)	PFP: less severe (*n* = 57)	PFP: more severe (*n* = 43)	ANOVA *p*-value	Between-group comparisons: MD (95% CI; *p*-value)		
					Pain-free–less severe	Pain-free–more severe	Less severe–more severe
Demographics							
Age[a]	25.5 (30)	26 (7)	26 (7)	0.8			
Number of females (%)	36 (72)	43 (75.4)	29 (67.4)	0.7			
BMI[a]	22.8 (20.7)	23.3 (5)	25.8 (21.6)	0.006	1.1 (−0.4 to 2.5; 0.1)	2.9 (1.1 to 4.6; <0.001)	1.8 (−0.8 to 3.7; 0.6)
IPAQ weekly activity level[a]	2,606 (1708.5)	2,358 (2,790)	2,533 (3,192)	0.8			
Psychological measures							
TSK		37.5 (5.6)	41.8 (5.5)	<0.001			4.3 (2.1 to 6.5; <0.001)
HADS-A[a]	6 (4)	6 (5)	7 (5)	0.4			
HADS-D[a]	2 (3)	2 (2)	4 (3)	0.001	−0.2 (−1.1 to 0.7; 0.6)	1.5 (0.4 to 2.6; 0.01)	1.8 (0.8 to 2.8; <0.001)
PCS[a]	6.5 (14)	6 (11)	13 (9)	0.004	−0.8 (−4.1 to 2.5; 0.6)	4.9 (1 to 8.8; 0.01)	5.7 (2.4 to 9; <0.001)
Pain and physical function							
NRS		5.5 (1.9)	6.9 (1.8)	<0.001			1.4 (0.6 to 2.1; <0.001)
Kujala Patellofemoral Score		76.1 (7)	64.5 (8.4)	<0.001			−11.6 (−14.7 to −8.6; <0.001)
KOOS – symptoms		81.9 (8.9)	69.9 (11.4)	<0.001			−12 (−16 to −7.9; <0.001)
KOOS – pain		78.1 (10.3)	61.5 (7.8)	<0.001			−16.6 (−20.3 to −12.8; <0.001)
KOOS – ADL[a]		91.2 (10.3)	72.1 (19.1)	<0.001			−18.4 (−21.9 to −14.9; <0.001)
KOOS – sport/rec		66.5 (15.4)	32.7 (16.9)	<0.001			−33.8 (−40.2 to −27.4; <0.001)
KOOS – QoL		56.3 (12.3)	36.2 (14.6)	<0.001			−20.1 (−25.4 to −14.7; <0.001)
KOOS – PF		67.2 (9.5)	41.8 (9.8)	<0.001			−25.4 (−29.3 to −21.6; <0.001)

[a] = Median (interquartile range); IPAQ = International Physical activity Scale; TSK = Tampa Scale for Kinesiophobia; HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; PCS = Pain Catastrophizing Scale; NRS = Numerical Rating Scale (worst pain over past week); KOOS = Knee injury and Osteoarthritis Outcome Score; ALD = activities of daily living; sport/rec = sport and recreational function; QoL = quality of life; PF = patellofemoral; MD = mean difference.

Table 4: Correlations between psychological factors and measures of physical function and pain.

	Anxiety (HADS-A)	Depression (HADS-D)	Kinesiophobia (TSK)	Catastrophizing
Anxiety (HADS-A)	1			
Depression (HADS-D)	0.52[a]	1		
Kinesiophobia (TSK)	0.29[a]	0.40[a]	1	
Catastrophizing (PCS)	0.47[a]	0.37[a]	0.45[a]	1

All values are Pearson correlation coefficients (r); HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; TSK = Tampa Scale for Kinesiophobia; PCS = Pain Catastrophizing Scale; [a]$p \leq 0.05$.

Table 5: Multivariate backward stepwise linear regression demonstrating psychological factor contribution to PFP as defined by all subscales of the KOOS.

	PFP as defined by all KOOS subscales			
	R^2	R^2 corrected	β (95% CI)	p-Value
Psychological variables	0.17	0.15		<0.001
Kinesiophobia (TSK)			−0.27 (−0.04 to −0.01)	0.008
Depression (HADS-D)			−0.22 (−0.08 to −0.04)	0.03
Anxiety (HADS-A)				0.1 (Excluded from model)
Catastrophizing (PCS)				0.1 (Excluded from model)

TSK = Tampa Scale of Kinesiophobia; HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; PCS = Pain Catastrophizing Scale.

conceptualised and sit within a broader body of evidence; one that draws attention to an important link between physical and non-physical features of musculoskeletal health and well-being.

Previous PFP studies can be used to highlight the relationship between psychological well-being and condition severity. Two studies, employing the same battery of psychological measures, reported levels of psychological impairment that were worse than those recorded in our more-severe group [42, 43]. The PFP groups in the earlier studies had average pain scores that were similar or higher than the worst pain experienced by our more-severe subgroup. The groups also demonstrated Lysholm Knee Scores that placed them in the lowest and, therefore, worst category of Lysholm score-related disability [44]. Recruitment for the aforementioned studies was conducted through a clinic that specialises in orthopaedic surgery which, the authors highlight, likely led to the samples comprising the worst of PFP cases. Although recruitment methods may limit generalizability, the findings support the hypothesis that those with higher levels of PFP-related disability are more likely to have worse psychological profiles.

Although pain and disability in severe PFP might share a relationship with psychological well-being, other features of PFP may not. A recent cross-sectional study that subgrouped persons with PFP measured several psychological factors across their PFP groups [45]. These included depression (Hopkins Symptom Checklist) and cognitive processes (subscales of the World Health Organisation Disability Assessment Schedule), but the study reported no significant differences between groups. In that study, the results of six physical tests (passive knee flexion, calf flexibility, hip abductor strength, quadriceps strength, total patellar mobility, and foot pronation) were used to create their three subgroups (1 – strong; 2 – weak and tighter; 3 – weak and pronated foot). The differing methodological approaches between that and the present study provide results that can be used in a complementary manner. A greater understanding of physical impairments may help target physical interventions, but these physical features do not appear to relate to psychological profiles. Conversely, our assessment of disability, while lacking physical impairment-specific information, appears to provide evidence of psychological impairment in more severely disabling PFP.

There was a strong association of depression and kinesiophobia with KOOS (representing pain and disability of PFP), but contrary to our hypothesis we found low levels of association of catastrophizing scores with KOOS. These findings raise questions about the application of theoretical psychological frameworks to PFP populations. The FAM has been popularly applied to musculoskeletal pain conditions for over 20 years. But inherent to the FAM is a circular assumption that, following an experience of

pain, catastrophic cognitions precede and lead to pain-related fear and avoidance behaviours [46]. Thus, according to the FAM, high levels of kinesiophobia abide with high levels of catastrophizing. Our findings demonstrate that movement (or pain) related fear can stand independently from catastrophizing. They also suggest that reconceptualised versions of the FAM, that recognise psychological factor independence and cumulative interactions [47] or other fear related frameworks such as the social pathway model [48] may be more helpful in understanding PFP populations similar to ours.

4.1 Clinical implications

Subgrouping our PFP cohort according to severity of symptoms on the KOOS scale, identified significant differences in psychological factors. Those with more-severe PFP had higher levels of kinesiophobia, depression and catastrophizing. Thus, clinicians need to be aware of the possibility of this relationship between high levels of disability and psychological impairment. Psychological factors have been associated with higher pain severity 4 weeks after lower limb trauma [49], and with a lack of improvement and worsening disability following physiotherapy intervention [50]. If identified, psychological impairments could be targeted with specific treatments that reduce the negative influence these factors are likely to have on the outcomes of active management strategies [51].

4.2 Strengths and limitations

The strengths of this study include that we: (a) recruited a consecutively sampled PFP cohort from the general public; (b) employed a control group of comparable age, sex and activity levels; and (c) used accessible and easy to administer psychological measures, which have been used extensively in clinical practice and musculoskeletal pain research. While the creation of subgroups is also a strength of this study, the method by which we clustered stands as one of many. We used all subscales of the KOOS as this allowed us incorporate a multitude of factors (pain, symptoms, physical function and quality of life) when defining our clusters. Had the clusters been derived from other condition-related or demographic measures or physical features, results may have differed.

Limitations of this study relate to the nature of the recruited PFP group, the use of recommended measure cut-offs, and the size of the sample. For this study, we focussed on psychological factors in a cohort of PFP who presented without co-existing comorbidities and pain in other body regions. Inclusion of those with PFP plus additional co-morbidities may capture a different demographic in terms of self-perceived disability and psychological factors. As cut-off points of the psychological measures have not been established in PFP groups, we used values from other musculoskeletal cohorts. Whether these cut-offs are appropriate for PFP remains to be determined. Where we dichotomised our PFP cohort on the basis of these cut-offs, our data needs to be interpreted with a degree of caution. Finally, any null effects that we report might also be a function of sample.

4.3 Future research

There are several potential avenues for further research into the psychological features of PFP. One research direction involves the study of social factors pertaining to education, employment and relationship status alongside psychological factors. Social factors have been found to influence the experience of musculoskeletal pain [52, 53] and will add further depth to our understanding of PFP subgroups. A second research approach should investigate the causal aspects of psychosocial factors in PFP. This would require prospective cohort studies that are more likely to validate temporal relationships. If high levels of severity of symptoms and disability are a precursor to psychological problems, then early intervention aimed at reducing the severity of PFP may prevent the development of psychological problems and their impact on overall well-being. Previous PFP research has shown that high levels of patient-reported disability can be prognostic of poor long-term outcome [54]. Thus, a third research direction could explore the prognostic capabilities of psychological features in PFP and how attending to these might impact on treatment outcomes.

5 Conclusion

This study has shown that at a group level, individuals with localised PFP and a comparable pain-free group have similar psychological profiles. It has also shown that condition severity, defined by the KOOS, is related to psychological features. Those who have higher levels of PFP-related symptoms and disability are more likely to have psychological impairment in the form of higher levels of kinesiophobia, depression and catastrophizing. Persons with severe PFP and psychological impairment may benefit from management strategies comprising specific

interventions that target both physical and non-physical aspects of the condition.

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