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Original Research

Influence of kinesiophobia and pain catastrophism on objective function in women with patellofemoral pain

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ABSTRACT

Objectives: (i) To compare kinesiophobia, pain catastrophism and objective function between women with patellofemoral pain (PFP) and pain-free; (ii) to investigate the association of kinesiophobia and pain catastrophism with objetive function in women with PFP.
Design: Case-control.
Setting: Laboratory-based. *Participants*: Fifty-five women with PFP and forty pain-free women.
Main outcome measures: Kinesiophobia and pain catastrophism were assessed using the Tampa Scale of Kinesiophobia and Pain Catastrophizing Scale, respectively. Forward step-down, single leg hop, and modified star balance tests were used to assess objective function. Independent t-tests were used for between-groups comparisons and Pearson correlation coefficients were used to investigate the association between the outcomes.
Results: Women with PFP had significantly worse kinesiophobia ($p < 0.001$; Effect size (ES) = 1.16), pain catastrophism ($p < 0.001$; ES = 1.57), and poorer objective function (step-down, ($p < 0.001$; ES = 0.99); single-leg hop ($p = 0.002$; ES = 0.74); modified star balance ($p < 0.001$; ES = 0.66) than pain-free controls. Kinesiophobia and pain catastrophism were not correlated with objective function.
Conclusion: Greater kinesiophobia, pain catastrophism and poorer objective function is evident in women with PFP, compared to pain-free controls. Kinesiophobia and pain catastrophism were not associated with objective function in women with PFP. Future research is necessary to understand how other physical and psychological factors might affect objective function.

1. Introduction

Patellofemoral pain (PFP) is one of the most common diagnosis in orthopedic outpatients clinics (Smith, Selfe, & Rathleff, 2018). PFP accounts for 25–40% of all knee problems in adults (Smith, Selfe, et al., 2018). Notably, women are more than two times likely to experience PFP than men (Boling et al., 2010). Prognosis for people with PFP is often poor, with 57% of people reporting unfavorable recovery 5–8 years after rehabilitation (Lankhorst et al., 2016).

People with PFP frequently report pain during activities that load the patellofemoral joint (PFJ) during weight bearing on a flexed knee (e.g. stair negotiation, squatting, running, etc.) (Crossley et al., 2016). Objective functional tests that simulate daily activities, are often explored to assess functional limitations in people with PFP (Aminaka & Gribble, 2008; dos Reis et al., 2015; Loudon, Wiesner, Goist-foley, Asjes, & Loudon, 2002). People with PFP were found to present functional limitations on objective functional tests such as forward step down test, single leg hop test, star excursion balance test (Aminaka & Gribble, 2008; dos Reis et al., 2015; Loudon et al., 2002). However, the underlying mechanisms why it occurs require further investigation (Dye, 2005; Powers, Witvrouw, Davis, & Crossley, 2017). For instance, is impaired objective function strictly due to altered mechanics or psychological factors may play a role?

Psychological impairments such as kinesiophobia (i.e., fear of re-

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injury due to movement) and pain catastrophism (i.e. exaggerated and ruminating negative cognitions and emotions during actual or perceived pain) were reported in people with PFP (Maclachlan, Collins, Matthews, Hodges, & Vicenzino, 2017; Smith, Moffatt, et al., 2018). Studies have also reported that greater kinesiophobia is associated with severe self-reported disability in people with PFP (Maclachlan, Matthews, Hodges, Collins, & Vicenzino, 2018). However, the influence of kinesiophobia and pain catastrophism on objective function have not yet been evaluated in people with PFP, and may provide a treatment target for improvement.

The aims of this study are twofold: (i) to compare kinesiophobia, pain catastrophism, and objective function between women with PFP and pain-free controls; and (ii) to investigate the relationship of kinesiophobia and pain catastrophism with objective function in women with PFP. We hypothesized that women with PFP would have greater kinesiophobia and pain catastrophism, and poorer objective function compared to pain-free controls. We also hypothesized that kinesiophobia and pain catastrophism would have strong associations with objective function of women with PFP.

2. Methods

2.1. Study design and participants

Fifty-five women with PFP and forty pain-free (controls) women aged 18–35 years old were recruited for this case-control laboratory-based study via advertisements at universities, gyms, public places for physical activity (e.g. parks, clubs) and posts on social media. The study was approved by the University Ethics Committee. Each participant provided written informed consent prior to data collection.

The PFP eligibility criteria were based on previous studies (Crossley et al., 2016) and the diagnoses of PFP were made by a physiotherapist with more than five years of clinical experience. The inclusion criteria for PFP participants were as follows: (1) women were eligible to participate; (2) anterior knee pain when performing at least two of the following activities: sitting for prolonged time, squatting, kneeling, running, climbing and descending stairs, jumping and landing; (3) insidious onset symptoms lasting at least 4 months; and (4) the worst pain level in the previous month corresponding to at least 30 mm in the visual analogue pain scale (VAS) (Crossley, Bennell, Cowan, & Green, 2004). Women were included in the pain-free group if they had no signs or symptoms of PFP or other neurological or musculoskeletal conditions. Exclusion criteria, assessed by a physiotherapist, for both PFP and pain-free groups were as follows: (1) sign or symptoms of any other current or past knee dysfunction; (2) history of surgery in any lower limb joint; (3) history of patellar subluxation or clinical evidence of meniscal injury or ligament instability; (4) symptomatic osteoarthritis in any lower limb joint; (5) patellar tendon pathology; (6) referred pain coming from the lumbar spine, hips, ankles, or feet; (7) presence of medical conditions; and (8) had physiotherapy treatment for PFP up to six months prior to the clinical assessment.

2.2. Procedures

Demographic data were collected prior to testing, including age, body mass, height and test leg length, and body mass index was calculated. All participants were asked to report the duration of their knee-related symptoms (months).

2.3. Psychological factors

PFP participants and pain-free controls completed the Tampa Scale of Kinesiophobia (Tampa Scale) and the Pain Catastrophizing Scale (PCS). The Tampa Scale is 17-item questionnaire to quantify fear of movement and re-injury due to movement and physical activity on a scale of 0–68, where 68 indicates greater fear of re-injury due to movement (French, France, Vigneau, French, & Evans, 2007; Kori, Miller, & Todd, 1990). The PCS is a 13-item questionnaire that describes thoughts and feelings that individuals experience when they have pain. Participants were instructed to reflect on the experiences provided by pain in the past and indicate one of the 13 thoughts or feelings perceived at the time of pain. The scale ranges from 0 to 52, where 52 represents greater catastrophic pain (Sullivan, Bishop, & Pivik, 1995).

2.4. Objective function

The following three functional tasks were used to assess objective function in women with PFP and pain-free controls: (i) forward step-down test (FSDT), (ii) single leg hop test (SLHT), and (iii) modified star excursion balance test (SEBT) (Fig. 1).

The FSDT is a functional test that simulates, in the clinical environment, the activity of going down stairs (Loudon et al., 2002), increasing the load on the knee at different flexion angles, as well as dynamic muscle control (Park, Cynn, & Choung, 2013). Participants stood on a 20 cm high platform in a bipodal stance and were asked to keep their trunk straight, hands on their waist, and to bend the knee on the tested side until the heel of the non-tested limb touched the floor. Participants were asked not to apply any weight on the heel of the non-tested limb once it reached the floor and to immediately re-extend the knee of the tested limb to re-turn to the starting position. The number of successful repetitions performed in 30 s was recorded. The trial was discarded and repeated if the participants lost their balance or had to support their body weight

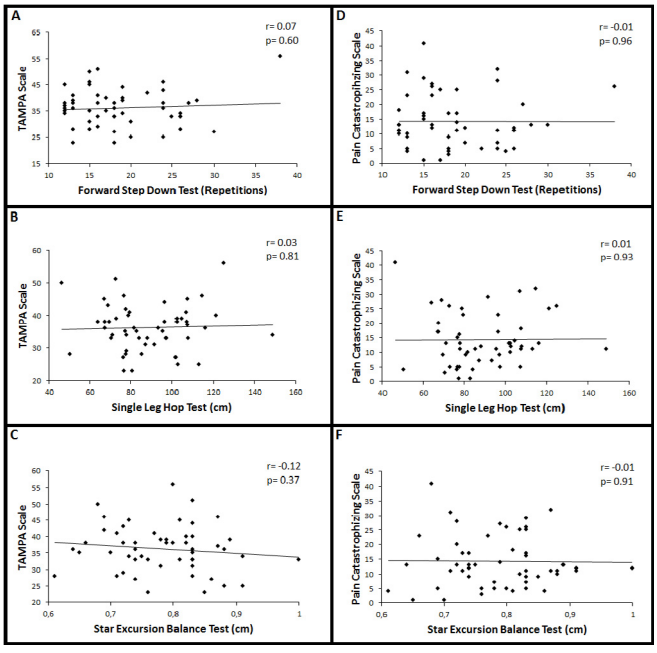


Fig. 1. Relationship between psychological factors and objective function in women with patellofemoral pain. **A -** represents the relationship between TAMPA Scale and Forward Step Down Test, **B -** represents the relationship between TAMPA Scale and Single Leg Hop Test, **C -** represents the relationship between TAMPA Scale and Star Excursion Balance Test. **D -** represents the relationship between Pain Catastrophizing Scale and Forward Step Down Test, **E -** represents the relationship between Pain Catastrophizing Scale and Single Leg Hop Test and **F -** represents the relationship between Pain Catastrophizing Scale and Modified Star Excursion Balance Test.

on the non-tested leg (Loudon et al., 2002; Park et al., 2013).

The SLHT is an established functional test routinely used to assess lower limb function in people with PFP (Augustsson et al., 2006; Kalytczak et al., 2016). Initially, the participants were positioned with the heel in a marking on the floor and were instructed to stand in unipodal support. Then, the participants hopped forward with their test leg as far as possible landing on the same foot. During this movement, the arms were allowed to swing. The distance of the jump was measured in centimeters at the heel position from which the participant landed. In addition, the hop was validated only if the participant was able to maintain their balance upon landing, keeping their landing foot on the ground, without performing extra leaps, until the examiner marked where the participant landed. The test was performed three times and we considered the average of these 3 times. If a hop trial was not validated, the participants were asked to repeat the trial.

The SEBT evaluates the dynamic postural control (P. A. Gribble, Hertel, & Plisky, 2012; Kinzey & Armstrong, 1998; Ness, Taylor, Haberl, Reuteman, & Borgert, 2015) of the lower limbs (Chevidikunnan, Al Saif, Gaowgzeh, & Mamdouh, 2016), through a series of single-leg squats. In the current study, we used a modified SEBT considering only anterior, posterolateral and posteromedial directions for analyses (P. a Gribble & Hertel, 2004). Participants stood on one leg in the center of a grid formed by 8 lines extending out at 45° from each other (P. A. Gribble et al., 2012). While maintining balance, participants were asked to reach with the non-test leg as far as possible along the line in the anterior, posterolateral and posteromedial directions. Participants were instructed to keep their hands on their waist and to keep the heel of the stance leg on the ground during the whole test. We recorded the reaching distance as the distance from the center of the grid to the point of maximum excursion of the reaching leg. The trial was discarded if the participants lost their balance, moved the foot from the center of the grid, or did not keep the hands on the waist during the test performance. For the statistical analysis, the mean of the three reach directions were used (Gribble et al., 2012; Hertel, Braham, Hale, & Olmsted-Kramer, 2006). The data were normalized by the leg length (SEBT direction score = distance reached [cm]/leg length [cm]), then multiplied by 100 to obtain the reach distance as a percentage of leg length. Greater values indicate better functional performance.

The order of tasks was randomized, via concealed allocation. Participants drew the order of tests from an envelope. The self-reported most symptomatic limb was evaluated in PFP participants and dominant limb in pain-free controls. A single investigator who remained blinded to the groups provided standardized instructions and feedback to the participants, and the testing conditions were also kept standardized among participants (i.e., lighting, temperature and measuring instruments). All participants performed functional tests barefoot. Participants performed three familiarization trials in order to minimize the effects of learning influencing outcomes. Both the order of familiarization and the trials were randomized to avoid possible effects of neuromuscular fatigue or knee joint overload in a specific functional test.

2.5. Statistical analysis

Sample size calculations were performed to ensure statistical power to detect between-group differences. In order to compare objective function between women with PFP and pain-free controls, we used the results available in the literature with the highest standard deviation and the smallest difference to be detected (Portney & Watkins, 2009). The sample size was calculated based on a previous study using the FSDT (Loudon et al., 2002), standard deviation = 5 smallest difference to detect = 4 steps. For a test with a power of 80% (1-$\beta = 0.80$) and $\alpha = 0.05$, two-tailed, the sample size calculated was 34 participants per group.

Prior to statistical analysis, all variables were assessed for normality and found to be normally distributed based on obtainment of $p > 0.05$ in the Kolmogorov-Smirnov test. Independent t-tests were performed to compare demographic data, kinesiophobia, pain catastrophism and objective functional tests between women with PFP and pain-free controls (Table 1). Pearson correlation coefficients were calculated to quantify the relationship between kinesiophobia and pain catastrophism and objective function in women with PFP. Effect sizes (ES: Hedges'g) were calculated for each comparison using the Review Manager software (Version 5.3, Copenhagen, Denmark). The interpretation of the effect sizes values were as follows (Sullivan & Feinn, 2012): Hedges'g > 0.2 represents a 'small effect', >0.5 represents a "medium effect', >0.8 a 'large effect', and >1.3 a 'very large effect'. Statistical analysis was performed using SPSS (IBM version 23, SPSS inc., Chicago, Il) and the significance level was set at 0.05 for all statistical analyses.

3. Results

Ninety-five participants were included in this study (55 PFP; 40 pain-free controls). There were no significant differences in age ($p = 0.771$), height ($p = 0.481$), body mass ($p = 0.088$) and BMI ($p = 0.179$) between pain-free controls and women with PFP (Table 1).

3.1. Psychological factors

Relative to pain-free controls, women with PFP had higher kinesiophobia (ES = 1.16, large effect) and pain catastrophism (ES = 1.57, very large effect) (Table 1).

3.2. Objective function

There were statistically significant differences in objective function between the two groups (Table 1). Relative to pain-free controls, women with PFP had poorer objective function on FSDT (ES = 0.99, large effect), SLHT (ES = 0.74, medium effect) and modified SEBT (ES = 0.66, medium effect).

3.3. Association between psychological factors and objective function in women with PFP

There were no statistically significant associations between kinesiophobia and pain catastrophism and FSDT, SLH, and SEBT performance in women with PFP (Fig. 1).

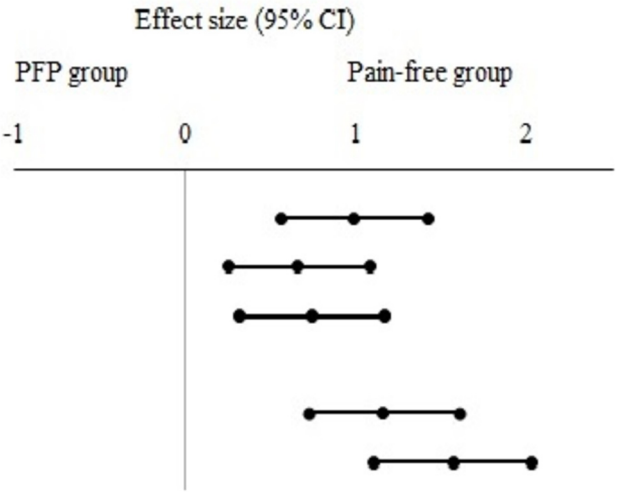
4. Discussion

Women with PFP have greater kinesiophobia and pain catastrophism and poorer objective function when compared with pain-free controls. There were no significant associations observed between kinesiophobia and pain catastrophism with objective function in women with PFP.

Our finding that women with PFP have poorer objective functional performance is consistent with previous research, including the FSDT (De Oliveira Silva, Barton, et al., 2018; Loudon et al., 2002) and SEBT (Aminaka & Gribble, 2008). Our study also indicates reduced SLHT performance, which is accordance with a recent study (Nunes et al., 2019), but, contrary to the findings from dos Reis et al. (2015), who reported no statistically significant differences in the first jump of single leg triple hop test between women with PFP and pain-free controls. However, this may have been due

Table 1
Participant characteristics, objective function and psychological factors for pain-free controls and women with PFP.

Variable	Pain-free (n = 40)	PFP (n = 55)	Mean Difference [95% CI]	P-value (<0.05)
Demographics				
Age (years)	22.05 (3.11)	21.86 (2.76)	0.19 [-1.09 to 1.46]	0.771
Body mass (kg)	57.20 (8.17)	60.03 (6.70)	−2.83 [-6.07 to 0.40]	0.088
Height (m)	1.61 (0.62)	1.61 (0.59)	−0.09 [-3.58 to 1.72]	0.481
Body mass index (kg/m^2)	22.09 (3.00)	22.94 (2.79)	−0.85 [-2.11 to 0.39]	0.179
Worst VAS pain last month (mm)	N.A	50.15 (17.18)	N.A.	
Symptoms duration (months)	N.A	58.51 (22.64)	N.A.	
Objective function				
FSDT (n)	23 (5)	18 (5)	5 [3 to 7]	<0.001*
SLHT (cm)	95.81 (18.14)	84.40 (16.18)	11.41 [4.16 to 18.66]	0.002*
SEBT† (%)	84 (8)	78 (8)	6 [2 to 9]	<0.001*
Self-reported psychological measures				
Tampa Scale	27.30 (3.93)	36.53 (6.91)	- 9.23 [-11.51 to -6.94]	<0.001*
PCS	0.83 (2.09)	14.23 (9.01)	-13.40 [-15.98 to -10.81]	<0.001*



Data are presented as mean (standard deviation), unless otherwise stated. Abbreviations: PFP = Patellofemoral pain; CI = confidence interval; FSDT = Forward step down test; SLHT = Single leg hop test; Modified SEBT = Star excursion balance test is presented as % of leg length; Tampa = Tampa Scale of Kinesiophobia; PCS = Pain Catastrophizing Scale. N.A. = Comparison not applied. †SEBT data were normalized to leg length. * indicates statistical significance.

to Reis et al. study being underpowered to detect between-group differences in the single leg triple hop test, as their sample size calculation was based on kinematics (dos Reis et al., 2015).

We observed greater kinesiophobia and pain catastrophism in women with PFP. Higher kinesiophobia is consistent with recent findings reported by Machlachlan et al., but the same study reported no differences in pain catastrophism between people with PFP and pain-free controls (Maclachlan et al., 2018). Inconsistent pain catastrophism results may be the result of different pain-free control groups. Specifically, pain catastrophism was much lower in our pain-free group (PCS = 0.83) compared to the Maclachlan et al. study (PCS = 6.5), with inclusion and exclusion criteria the likely reason for differences. In our study, pain-free participants did not have any signs or symptoms of any current or past knee dysfunction, or history of surgery in any lower limb joint. Whereas, participants in Maclachlan et al.'s study were included if they were pain-free for 3 months at the time of recruitment, and no information about previous injuries was provided. Our pain catatrophism findings are supported by recent qualitative research (Smith, Moffatt, et al., 2018) indicating that people with PFP have pain-related fear and an inability to make sense of their pain, factors which may lead to greater pain catastrophism (Van Wilgen, Van Ittersum, Kaptein, & Van Wijhe, 2008). Previous research has reported that improvements in kinesiophobia and pain catastrophism are related to improvements in pain and disability of people with PFP (Doménech, Sanchis-Alfonso, & Espejo, 2014). Thus, further research is required to better understand these psychological factors in this patient-population.

Contrary to our hypothesis, we found no significant association between kinesiophobia or pain catastrophism with objective function. We have also recently reported an absence of association between kinesiophobia and knee extensor strength in a different cohort of people with PFP (De Oliveira Silva et al., 2019). This finding may help explain why kinesiophobia was not associated with objective function in the current cohort. However, kinesiophobia has been reported to be associated with self-reported function in people with PFP (Maclachlan et al., 2018), highlighting the need for further research to improve our understanding of the relationship between psychological impairments and objective function in people with PFP. It is important to highlight that although kinesiophobia and pain catastrophism were not related to objective function assessed in our study, these three tasks do not represent all aspects of daily function. Therefore, investigating the relationship between kinesiophobia and pain catastrophism with other functional tasks is warranted. In addition, research is also necessary to understand the relationship between psychological impairments and other factors such as movement patterns (De Oliveira Silva et al., 2019), sensitized profile (De Oliveira Silva, Rathleff, Petersen, Azevedo, & Barton, 2018; Pedler, Kamper, & Sterling, 2016) and prognosis of PFP.

4.1. Limitations and future directions

There are a number of limitations of this study that should be acknowledged. The design of our study limits us to draw any prospective conclusion as the lack of relationships in cross-sectional data does not necessarily mean that improvements in kinesiophobia and catastrophism over time will not be related to changes in objective functional tests measured in our study. Another limitation of our study was that some participants with PFP presented the symptomatic limb different from the dominant limb of pain-free participants. Future research should consider evaluating the influence of limb dominance on balance tests. Only women were included in our study due to the high prevalence of PFP in this population (Boling et al., 2010), meaning further studies including men, adolescents and older populations with PFP are required

before findings can be applied to these populations.

4.2. Clinical implications

Despite demonstrating the presence of kinesiophobia, pain catastrophism and poorer objective function in tasks such as hopping, stepping down and squatting, the lack of association between these features suggest they both may need to be assessed and targeted in people with PFP. Currently, there is no randomized controlled trial which has targeted psychological factors as a primary outcome for people with PFP (Briani et al., 2018; Collins et al., 2018) and only few studies have assessed psychological factors of people with PFP (De Oliveira Silva, Barton, et al., 2018; Maclachlan et al., 2018, 2017; Smith, Moffatt, et al., 2018).

5. Conclusion

Women with PFP have greater kinesiophobia and pain catastrophism and poorer objective function compared to pain-free controls. However, no associations were observed between kinesiophobia and pain catastrophism with objective functional performance in hopping, stepping down and squatting. Further research is necessary to understand how other physical and psychological factors might affect objective function of women with PFP.

Declarations of interest

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Ethical approval

The study was approved by the São Paulo State University Ethics Committee (number: 1.484.129).

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