9-14-2023

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The Effect of a Psychologically Informed Video Series to Treat Adolescents' Patellofemoral Pain: A Randomized Controlled Trial

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This study was approved by Nationwide Children's Hospital Institutional Review Board: IRB number: IRB18-00724

Public Trials Registry Clinicaltrials.gov NCT04752501

Funding: American Academy of Sports Physical Therapy Legacy Fund

Conflict of interest: The authors have no conflicts of interest to report.

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Word Count: 2,585

AUTHOR CONTRIBUTIONS: Mitchell Selhorst contributed to the design, conduct, data collection, analysis, interpretation, and writing and editing of this work. Jessica Hoehn, Laura Schmitt and
Alicia Fernandez-Fernandez designed contributed to the design, interpretation, writing, and editing of this study. Jason Benedict contributed to the design, data analysis and interpretation, writing, and editing of this study.

Patient Involvement: Patients were involved in the creation of the psychologically informed videos prior to implementation in the randomized controlled trial. Patients provided feedback on unclear information, and what they may like more information on. The videos were modified/edited multiple times based upon the patient feedback until no further edits were requested.

Data Sharing Statement: We will make the data and associated documentation available to users only under a data-sharing agreement that provides for: (1) a commitment to using the data only for research purposes and not to identify any individual participant; (2) a commitment to securing the data using appropriate computer technology; and (3) a commitment to destroying or returning the data after analyses are completed. Email requests for data-sharing agreements to Mitchell.Selhorst@Nationwidechildrens.org

Funding: American Academy of Sports Physical Therapy Legacy Fund

Statement of Financial Disclosure and Conflict of Interest: The authors have no conflicts of interest to report. The authors affirm that they have no financial affiliation (including research funding) or involvement with any commercial organization that has a direct financial interest in any matter included in this manuscript, except as disclosed and cited in the manuscript. Any other conflict of interest (i.e., personal associations or involvement as a director, officer, or expert witness) is also disclosed and cited in the manuscript

ABSTRACT

Objective: To test whether a series of brief, psychologically informed educational videos added to physical therapy improved function among adolescents with patellofemoral pain (PFP). The secondary aims were to assess pain and psychological beliefs.

Design: A double-blinded randomized controlled trial.

Methods: Sixty-eight adolescents with PFP were randomly assigned to view brief, psychologically-informed videos (n=34) or control videos (n=34) in addition to usual care physical therapy. The psychologically-informed videos targeted fear-avoidance beliefs, kinesiophobia, and pain catastrophizing. The control videos conveyed basic anatomy, biomedical factors, and lower extremity mechanics. Outcomes were assessed at baseline, three weeks, six weeks (primary endpoint), and three months. The primary outcome was change in the Anterior Knee Pain Scale (AKPS). Secondary outcomes were changes in Numeric Pain Rating Scale (NPRS) and psychological beliefs (Modified Fear-Avoidance Beliefs Questionnaire-Physical Activity, Tampa Kinesiophobia Scale-11, and Pain Catastrophizing Scale-Child).

Results: Adolescents in the psychologically-informed group experienced significantly greater improvements in function (AKPS mean difference = 8 points, 95% CI: 2.2, 13.2; p-value = 0.01) and pain (NPRS mean difference 1.2 points, 95% CI: 0.1, 2.4; p-value = 0.04) at six weeks compared to the control group. The psychologically-informed group had significantly greater reductions in psychological beliefs over time than the control group (*p*-value= <0.001, partial $\eta^2 = 0.32$).

Conclusion: Incorporating psychologically-informed education into physical therapy care improved function, pain, and psychological beliefs to a greater extent than the control group.

Trial registration: ClinicalTrials.gov: NCT04752501)

Keywords: Adolescent; Anterior knee pain; Education; Kinesiophobia; Fear Avoidance

INTRODUCTION

Patellofemoral Pain (PFP) is one of the most common knee complaints in adolescents.[9, 10] Nearly one-in-three adolescents experience PFP,[42, 54, 56] and it is often erroneously considered a benign and self-limiting condition.[33, 45] However, PFP can profoundly affect an adolescent's function, quality of life, and physical activity.[42, 56] Therapeutic exercise is beneficial for treating PFP and is the mainstay treatment, but even after intervention, most adolescents (51%-91%) report continued PFP.[21, 42, 56] Seven in 10 adolescents reduce or stop sport participation.[42] The unresolved pain and reduced physical activity levels underscore why adolescents with PFP need better care.[42]

PFP is frequently framed as resulting from abnormal biomechanics leading to increased patellofemoral joint loading.[37] However, individuals with PFP may have elevated anxiety, depression, fear-avoidance beliefs, kinesiophobia, and pain catastrophizing, which correlate with greater pain and reduced functional ability.[12, 13, 17, 32, 35, 38] A recent International Consensus stated researchers should prioritize studying psychological factors in PFP, including fear-avoidance beliefs, kinesiophobia, and pain catastrophizing.[59] Fear-avoidance, kinesiophobia, and pain catastrophizing are adversely

associated with function and pain in adolescents with PFP.[34, 47, 48] Adolescents with PFP may perceive pain as a sign of damage,[60] fear moving, and avoid painful activities, resulting in reduced activity levels and prolonged pain.[16] Additionally, these maladaptive beliefs significantly predicted disability even after accounting for common factors associated with PFP, including sex, pain, strength, and flexibility.[47]

Psychologically-informed interventions aim to reshape maladaptive beliefs, including fear avoidance, kinesiophobia, and pain catastrophizing in individuals with chronic pain. The downside of psychologically-informed interventions is that they are time intensive and require specialized training.[3, 4, 14, 18, 31, 55, 67] Many physical therapists are not trained to provide in-depth psychologically-informed interventions.[64] A brief, one-time psychologically-informed educational video can reduce fear avoidance beliefs, kinesiophobia, and pain catastrophizing among adolescents with PFP.[48, 51] However, the one-time intervention only had short-term benefits. We wondered whether a one-time intervention was an insufficient dose for longer-lasting effects.

The primary aim of this study was to test whether a series of brief, psychologically informed educational videos added to physical therapy improved function among adolescents with PFP. The secondary aims were to assess pain and psychological beliefs. We hypothesized that adolescents who viewed a series of brief, psychologically-informed educational videos throughout their care would have greater improvements in function and reduced maladaptive psychological beliefs and pain, compared to those who viewed control videos.

METHODS

Design

This study was a double-blinded, parallel-group (1:1 ratio) randomized controlled study performed in the outpatient physical therapy (PT) clinics of a pediatric hospital in the United States. Adolescents who reported pain in the front of their knee from March 2021 through April 2022 were eligible to participate. The institutional review board approved this study before recruitment and data collection began. All patients and guardians provided written informed consent before participation. This study was prospectively registered at ClinicalTrials.gov (Identifier number ClinicalTrials.gov Identifier: NCT04752501)

Participants

Inclusion criteria: Participants were adolescents (12-17 years) who reported pain around or behind the patella, aggravated by at least one activity that loads the patellofemoral joint during weight-bearing on a flexed knee (e.g., squatting, stairs, running, jumping). The lead author diagnosed PFP according to established recommended criteria.[7]

Exclusion criteria: Participants were excluded if they had 1) a prior patellar dislocation, 2) suspicion of another knee diagnosis, 3) other concomitant injury of the lower quarter, 4) previous surgery in the lower quarter, or 5) a neurologic or developmental disorder which altered leg function.

Intervention

Participants were randomly assigned to either the psychologically-informed education group or the control group (biomedical education). Participants viewed a three-

part education video series on an iPad immediately (video 1), one-week (video 2), and two-weeks (video 3) after baseline assessment. All participants attended exercise-based PT twice a week (1-hour sessions).

Psychologically-Informed Education Group: The experimental group watched three short videos.[50] Video 1 (8 minutes and 30 seconds) targeted beliefs about fear avoidance, kinesiophobia, and pain catastrophizing. Video 2 (five minutes) discussed ways to deal with pain and a graded return to activity. Video 3 (five minutes and 30 seconds) discussed simple cognitive restructuring methods. Recommended adult psychological and pain neuroscience education was modified and tailored to adolescents with PFP.[29] To ensure that the information provided was understandable for all adolescent participants, the narrator's script was written at a 6th-grade reading level.

Control Group (Biomedical Education): Participants watched a video series equal in length to the psychologically-informed educational videos. The control video series discussed basic leg anatomy and function (video 1), leg biomechanics (video 2), and basic leg exercises (video 3). The videos provided no psychosocial education or positive reinforcement about the participant's condition.

Exercise-Based Physical Therapy

Participants completed tailored exercise-based PT focused on exercises to improve lower quarter flexibility, strength, and neuromuscular control. Each treating therapist completed a 1-hour training session where they were instructed on the type of exercises to prescribe. Exercise prescription was based on evidence-based exercise therapy and movement

retraining recommendations.[26] No psychologically informed education or treatment was provided during physical therapy care.

Outcomes

All self-reported measures of function, pain, and psychological beliefs were completed using REDCap electronic data capture tools.[19, 20] Participants completed the self-report measures at baseline (pre-intervention), one week, three weeks, six weeks (primary endpoint), and at three-months.

Participant Demographics: Demographic data were collected from each participant, including age, sex, and body mass index.[25] Participants responded to questions about the duration of symptoms and the knee injured (unilateral, bilateral). Activity participation information was collected, including participation in organized sports and the National Institutes of Health Patient Reported Outcome Measurement Information System (**PROMIS**) Pediatric Physical Activity Scale to standardize the method of grading the participant's activity level.[58]

Anterior Knee Pain Scale (AKPS): a 13-item self-report questionnaire, which assessed knee function and symptoms. The AKPS is scored 0-100, with 100 representing no disability. The AKPS has excellent validity and reliability and is recommended for use among individuals 12-50 years with PFP.[6, 63, 64] The minimal clinically important difference of the AKPS is 8 points. [6]

Numeric Pain Rating Scale (NPRS): an 11-point pain-rating scale ranging from 0 (no pain) to 10 (worst imaginable pain), which assessed the patient's highest pain in the previous

24 hours.[23] The NPRS has been validated for assessing PFP,[36] and has a minimal clinically important difference of 1.2 points.[36]

Psychological Variables*:* The psychological variables of interest included fear-avoidance beliefs, kinesiophobia, and pain catastrophizing, assessed using the Modified Fear-Avoidance Beliefs Questionnaire-Physical Activity (FABQ-PA) subscale[35, 61] the Tampa Scale for Kinesiophobia-11 (TSK-11),[66] and the Pain Catastrophizing Scale-Child (PCS-C) respectively.[5] To determine change in the TSK-11, scores were first subtracted by 11 before assessing percent reduction as the scale begins at 11 instead of zero. The FABQ-PA, TSK-11, and PCS-C have good validity in adolescents with pain,[5, 46, 65, 68] and are associated with pain and function among adolescents with PFP.[47]

Randomization and Blinding

Participants watched educational videos but were unaware whether the videos were intended for the control or experimental group. The study staff and treating physical therapists were blinded to group allocation until after completing all measurements. Participants were instructed not to discuss the educational videos with the investigators or physical therapists to maintain blinding. An individual outside the study created a computer-generated list using the website www.randomizer.org to randomize participants. The computer-generated list was uploaded to the REDcap system, which allowed participants to watch the allocated videos while keeping the study staff blinded.

Sample Size

Sample size estimates based on previous literature were generated using anticipated differences necessary to detect clinically-important change at the six-week time-point using the primary outcome of interest: Anterior Knee Pain Scale. Statistical

significance using repeated-measures ANOVA was set at an alpha level of 0.05, a minimal clinically-important difference of 8, and a within-group standard deviation (SD) of 11.1.[6, 53] Assuming a dropout rate of 10%, a sample size of 34 participants in each group (n=68) was calculated to provide sufficient statistical power (80%) to detect a meaningful between-group difference.

Data Analysis

Summary statistics using either means (SDs) or medians (IQR) for continuous variables and n (%) for categorical variables were calculated to assess between-group balance after randomization at baseline. Two-way repeated-measures analysis of variance (ANOVA) tested the study's hypotheses. Post-hoc testing assessed between-group differences (t-tests) at six weeks (primary endpoint), and three months. A chi-square analysis was used to compare the number of participants who had exceed the MCID on the AKPS at six weeks. To be included in the analysis, patients had to have provided data at baseline and at a minimum of one additional time point. As only one participant was not included due to dropping out and there were no other missing data, multiple imputation was not applied, and all analyses were performed on complete case data. Alpha <0.05 was considered statistically significant. Effect sizes were assessed using partial η^2 for the repeated measure ANOVAs (small partial $\eta^2 = 0.01$, medium partial $\eta^2 = 0.06$, and large partial $\eta^2 = 0.14$), and Cohen d for the t-tests (small d = 0.2, medium d = 0.5, and large d = 0.8).[27] Analyses were performed using R version 4.1.

RESULTS

Over 18 months, 68 adolescents with PFP were enrolled in the trial (**FIGURE 1**). Participants were randomized into either the psychologically-informed group (n = 34) or the control group (n = 34). Dropout was minimal in both groups (psychologically-informed n=0, 0%; control group n = 1, 1.5%), with the one participant stopping prior to completing the assigned educational intervention and follow-up assessments. Baseline characteristics were available for all participants (**TABLE 1**). Both groups completed a similar number of PT visits over the trial (psychologically-informed group = 7.9 ± 3.5 visits, control group = 8.6 ± 3.5 visits, *p*-value = 0.50).

Primary Outcome - Function

The psychologically-informed group had significantly greater improvements in function compared to the control group (*p*-value = 0.03, partial η^2 = 0.06) (**FIGURE 2)**. Significant between group differences with a moderate treatment effect were observed in function at six weeks (p-value = 0.01; Cohen *d* = 0.64) and three months (*p-value* = 0.01; Cohen *d* =0.56) (TABLE 2). Additionally, at six weeks, significantly more participants in the psychologically informed group demonstrated clinically significant improvement on the AKPS (76%, n=26) compared to the control group (52%, n=17) (p-value = 0.03).

Pain

The psychologically-informed group had significantly greater improvements in pain over time than the control group (*p*-value = 0.04, partial η^2 = 0.06) (**FIGURE 3**). Significant between group differences with a moderate treatment effect were observed in pain at six

weeks (p-value = 0.01; Cohen *d* = 0.55) and three months (*p-value* = 0.02; Cohen *d* =0.53) **(TABLE 2)**.

Psychological Beliefs

The psychologically-informed group had significantly greater reductions in maladaptive psychological beliefs over time than the control group (*p*-value= <0.001, partial η^2 = 0.32) (**TABLE 3**). Significant between group differences with a large treatment effect were observed for all three questionnaires at six weeks: FABQ-PA (p-value < 0.001, Cohen *d* = 0.83), TSK-11 (p-value < 0.001, Cohen *d* = 0.90), and PCS-C (p-value < 0.001, Cohen *d* = 0.79). This difference was maintained for all questionnaires at three months: FABQ-PA (p-value < 0.001, Cohen *d* = 0.83), TSK-11 (p-value < 0.001, Cohen *d* = 0.90), and PCS-c (p-value < 0.001, Cohen *d* = 0.79).

DISCUSSION

Adolescents with PFP had improved function and pain after receiving treatment, and those who viewed the psychologically-informed videos had significantly greater improvements. Adolescents in the psychologically-informed group were more likely to experience clinically-meaningful improvements in function after six weeks. The psychologically-informed video series reduced fear-avoidance beliefs, kinesiophobia, and pain catastrophizing, with a large treatment effect.

Our results suggest that psychologically-informed education is a beneficial adjunct when treating PFP, which is consistent with previous research. [8, 48, 51, 52] Participants who viewed our three-part video series had similar improvements in function compared to studies using a one-part psychologically-informed education video.[48] However, those

who viewed the three-part series had a greater reduction in pain and maladaptive psychological beliefs.[48] We previously combined elements of cognitive behavioral care and exercise to treat adolescents with PFP, finding similar improvements in pain and function at six weeks.[52] Our video series required less time to implement and train the physical therapists. In fact, the barriers to implementing the combined cognitive behavioral care and exercise were the impetus to create the current psychologically-informed education videos. Psychologically-informed interventions are beneficial for adults with PFP.[1, 8, 24] De Oliveira Silva et al.[8] demonstrated potential benefits from an online multi-media resource, which included understanding your pain and fear of movement education. Bagheri et al.[1] demonstrated that mindfulness practice might be an effective adjunct to exercise in females with PFP.

The biopsychosocial model of pain suggests an inherent link between pain and the mind, with emotions, thoughts, and beliefs influencing the pain experience.[15] Patients with PFP have altered pain processing and central sensitization.[2] Patients with PFP had altered functional connectivity between numerous cortical and subcortical brain regions relative to healthy controls.[11] These connectivity alterations in the brain were related to perceived disability, dysfunction, and kinesiophobia.[11] Even after PFP symptoms resolved, adolescents continued to experience altered pain modulation and sensitivity.[22] We did not assess changes in pain processing or sensitivity. Still, the link between PFP and the central nervous system suggests a mechanism by which psychologically-informed education may improve function and pain in this population.

Psychologically-informed education for youth has been provided in different ways, including traditional one-on-one format,[52] videos,[49] lectures,[30] apps,[57] and even a comic

book.[43] Our psychologically-informed education was delivered via video to standardize the information and ease implementation. The medium by which psychologically-informed education is taught is likely less important than the information provided and its accessibility.[39] The information provided should follow psychologically-informed recommendations and must be covered at an age-appropriate level.[28, 44, 62]

Our results support the benefits of traditional physical therapy interventions while highlighting how, in isolation, they are insufficient to resolve PFP for many adolescents. Almost half of the adolescents in the control group (48%) did not achieve clinically-meaningful improvement after physical therapy exercise and biomedical education. Studies assessing exercise, activity modification, and taping[40, 41] also found that many adolescents with PFP have continued pain and dysfunction at three months. A meta-analysis of 1,281 adolescents with atraumatic knee pain, a majority with PFP, found that >50% had continued pain at three months.[21] Adolescents who are female, have symptoms longer, or have bilateral knee pain have a worse prognosis.[21] Clinicians should consider additional interventions, including psychologically-informed education, when working with adolescents who have PFP.

Limitations

Because our study was a blinded trial, the treating physical therapist could not discuss or incorporate principles of psychologically-informed practice into care, potentially limiting the intervention's effectiveness. In clinical practice, the physical therapist would know about the patient's psychologically-informed education. They could discuss the educational content, answer questions, provide personalized examples, and reinforce the principles throughout the episode of care.

While a risk of contamination exists with the participants' therapist providing unintentional psychologically-informed content, this concern is lessened due to the significant difference in the change of psychological beliefs between groups. The exercise-based physical therapy sessions were tailored to the participant using evidence-based recommendations rather than a standardized protocol. Differences in exercise selection and progression may have affected outcomes.

The control group had fewer athletes and, in some participants, a much longer duration of symptoms, which may have influenced outcomes. Finally, we only included adolescents, and our results may not generalize to adults with PFP.

CONCLUSION

Incorporating psychologically-informed education into physical therapy care improved function, pain, and psychological beliefs to a greater extent than the control group for adolescents with patellofemoral pain.

KEY FINDINGS

Findings:

- Adding brief, psychologically informed education to an exercise-based physical therapy program improved function and reduced pain among adolescents with patellofemoral pain (PFP).
- Psychological beliefs are important and may influence response to exercise interventions in adolescents with PFP.

Implications:

- Clinicians should consider incorporating brief, psychologically informed education into rehabilitation programs designed with adolescents who have PFP.

Caution

- We assessed the effects of a psychologically informed intervention on adolescents with PFP, and the results should not be generalized to adults.

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TABLE 1. Baseline Characteristics

	All Patients (n=68)	Psychologically-informed group (n=34)	Control group (n=33)
Age (years)	14.8 ± 1.6	14.7 ± 1.6	14.9 ± 1.6
Sex (% female)	46 (68%)	24 (71%)	22 (65%)
Body mass index (kg/m^2)	22.3 ± 5.3	22.2 ± 5.8	22.4 ± 4.7
Duration of symptoms (weeks)*	12 (6, 52)	12 (6, 39)	12 (6, 66)
Bilateral knee pain (% yes)	24 (35%)	11 (32%)	13 (38%)
Participates in organized sport (% yes)	58 (85%)	32 (94%)	26 (77%)
PROMIS Pediatric Physical Activity Scale	23.5 ± 8.6	24.3 ± 8.1	22.3 ± 9.0
Numeric Pain Rating Scale	4.7 ± 2.1	4.8 ± 2.2	4.6 ± 2.1
Anterior Knee Pain Scale	72.8 ± 12.2	72.9 ± 12.7	72.7 ± 11.8
Fear Avoidance Beliefs Questionnaire-Physical Activity Subscale	13.9 ± 5.0	14.2 ± 4.4	13.6 ± 5.5
Tampa Kinesiophobia Scale-11	23.5 ± 4.9	23.5 ± 4.6	23.5 ± 5.1
Pain Catastrophizing Scale-Child	19.8 ± 10.3	19.0 ± 9.5	20.6 ± 11.3

Abbreviation: **PROMIS**, Patient Reported Outcome Measurement Information System
Values are mean ± SD unless otherwise indicated
***median (interquartile range)

TABLE 2. Change in Clinical Outcomes Over Time

	Treatment Group	Baseline	3-week	6-week*	3-month
AKPS	Psychologically-informed (n=34)	72.9 ± 12.7	81.7 ± 13.7	90.5 ± 10.1	92.7 ± 8.9
	Control (n=33)	72.7 ± 11.8	78.4 ± 14.6	82.5 ± 14.2	86.5 ± 12.7
	Group Difference (95% CI)	0.1 (-6.0, 5.9)	3.3 (-3.6, 10.2)	8.0 (1.9, 13.9)	6.2 (0.8, 11.5)
NPRS	Psychologically-informed (n=34)	4.8 ± 2.2	2.8 ± 2.2	1.3 ± 1.9	1.2 ± 1.8
	Control (n=33)	4.6 ± 2.1	3.6 ± 2.3	2.5 ± 2.3	2.4 ± 2.5
	Group Difference (95% CI)	-0.2 (-1.3, 0.8)	0.8 (-0.3, 1.9)	1.2 (0.1, 2.2)	1.1 (0.1, 2.2)

Abbreviation: **AKPS**, Anterior Knee Pain Scale; **NPRS**, Numeric Pain Rating Scale.
Values are mean ± SD
*Primary endpoint

TABLE 3. Change in Psychological Beliefs Over Time

	Treatment Group	Baseline	3-week	6-week*	3-month
FABQ-PA	Psychologically-informed (n=34)	14.3 ± 5.1	6.6 ± 5.5	5.0 ± 5.9	7.1 ± 6.9
	Control (n=33)	14.0 ± 4.0	12.1 ± 6.6	10.0 ± 6.0	11.3 ± 8.0
	Group Difference (95% CI)	-0.6 (-3.0, 1.8)	5.5 (2.6, 8.5)	5.0 (2.1, 8.0)	4.2 (0.6, 7.9)
TSK-11	Psychologically-informed (n=34)	23.5 ± 4.6	16.8 ± 5.2	15.4 ± 4.5	15.9 ± 5.2
	Control (n=33)	23.5 ± 5.1	22.4 ± 7.1	20.4 ± 6.5	20.1 ± 7.9
	Group Difference (95% CI)	0.0 (-2.6, 2.5)	5.8 (2.8, 8.9)	5.0 (2.3, 7.8)	4.1 (0.8, 7.4)
PCS-C	Psychologically-informed (n=34)	19.0 ± 9.5	10.5 ± 9.6	7.9 ± 8.4	7.2 ± 8.3
	Control (n=33)	20.6 ± 11.3	17.8 ± 12.7	16.4 ± 13.2	13.6 ± 12.5
	Group Difference (95% CI)	1.6 (-3.4, 6.5)	7.5 (2.0, 12.9)	8.7 (3.3, 14.1)	6.3 (1.1, 11.5)

Abbreviation: **FABQ-PA**, Fear Avoidance Beliefs Questionnaire-Physical Activity; **TSK-11**, Tampa Scale for Kinesiophobia-11; **PCS-C**, Pain Catastrophizing Scale-Child.
Values are mean ± SD
*Primary endpoint

FIGURES

FIGURE 1. Participant flow diagram

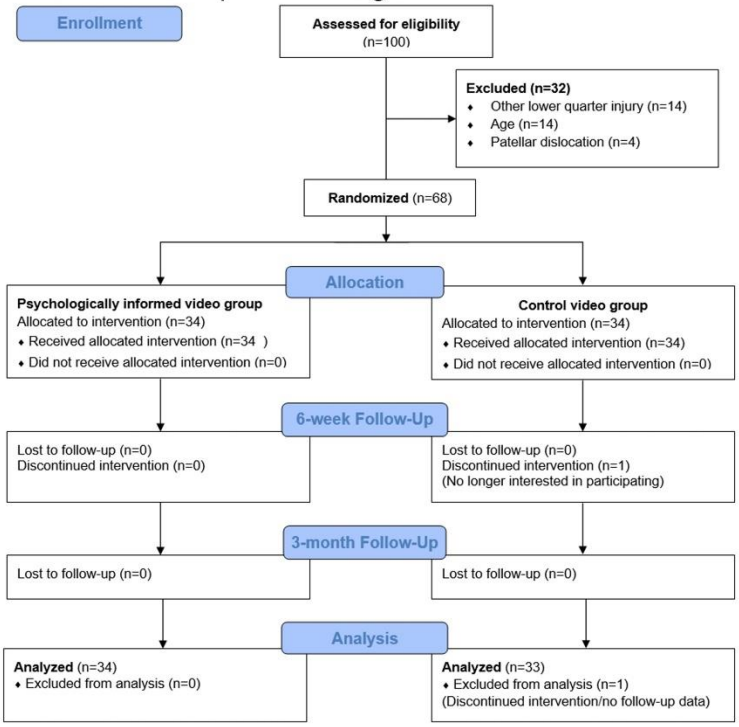

Figure 2. Change in Function Over Time

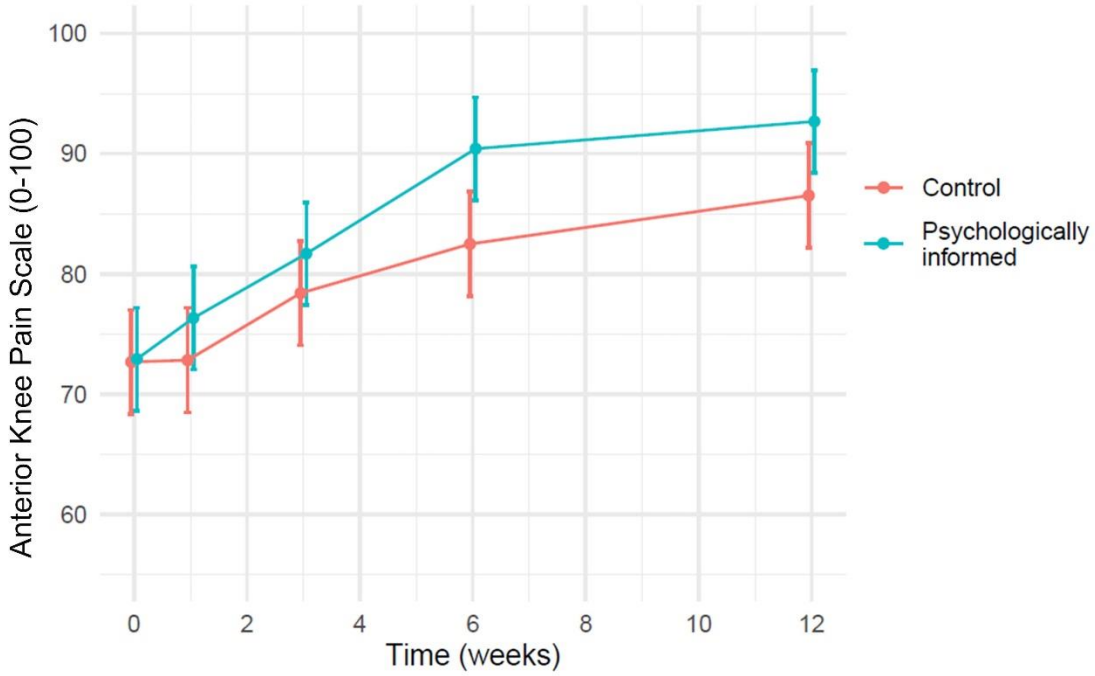

Figure 3. Change in Pain Over Time

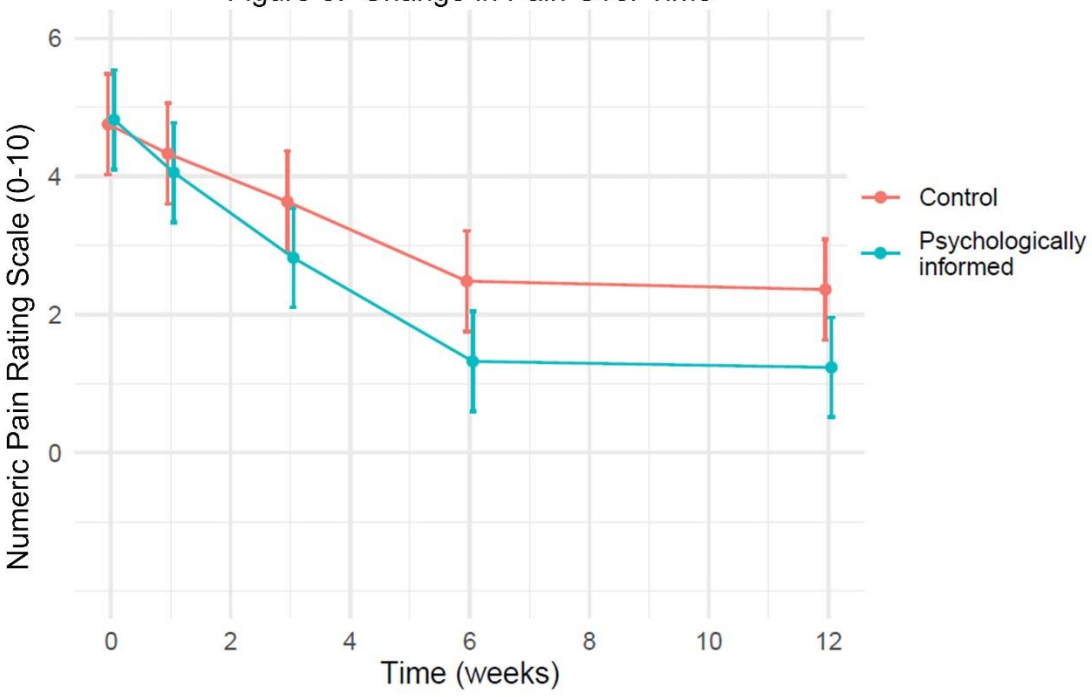

Figure 4. Change in Psychological Beliefs Over Time