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Quality of life in adolescents with longstanding non-traumatic knee pain: An analysis of 316 adolescents with Patellofemoral Pain and Osgood-Schlatter Disease

Chris Djurtoft [a, b, *, 1], Tomer Yona [c, 1], Ewa Maria Roos [d], Kristian Thorborg [e, f], Per Hölmich [e, g, h], Sten Rasmussen [i, j], Jens Lykkegaard Olesen [a, i], Michael Skovdal Rathleff [a, b, k]

[a] Center for General Practice at Aalborg University, Aalborg, Denmark
[b] Department of Health Science and Technology, Aalborg University, Denmark
[c] Department of Biomedical Engineering, Technion, Israel Institute of Technology, Haifa, Israel
[d] Research Unit for Musculoskeletal Function and Physiotherapy, Center for Muscle and Joint Health, Institute of Sport Science and Clinical Biomechanics, University of Southern Denmark, Odense, Denmark
[e] Sports Orthopedic Research Center – Copenhagen (SORC-C), Hvidovre, Denmark
[f] Physical Medicine and Rehabilitation Research-Copenhagen (PMR-C), Hvidovre, Denmark
[g] Department of Orthopedic Surgery, Copenhagen University Hospital, Hvidovre, Denmark
[h] Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark
[i] Department of Clinical Medicine, Aalborg University, Aalborg, Denmark
[j] Department of Orthopedic Surgery, Aalborg University Hospital, Denmark
[k] Department of Physiotherapy and Occupational Therapy, Aalborg University Hospital, Aalborg, Denmark

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ABSTRACT

Objectives: To describe the Quality of Life (QoL) among adolescents with Patellofemoral Pain (PFP) and Osgood-Schlatter Disease (OSD) and investigate characteristics associated with QoL.
Study design: Cross-sectional.
Participants: 316 adolescents with PFP or OSD.
Main outcome measures: QoL subscale of The Knee injury and Osteoarthritis Outcome Score (KOOS) and the EuroQol 5-dimensions (EQ-5D).
Results: The KOOS-QoL was 51 ± 18, and the total index score for the EQ5D was 0.67 ± 0.21. KOOS-QoL subscale showed that 60% reported being aware of their knee problems daily or constantly, 38% reported severe to extreme lack of confidence in their knees, 28% reported severe to extreme difficulty with their knees, and 20% reported severely or totally modifying their lifestyle to avoid potentially damaging activities to their knee. EQ-5D showed that 79% experienced problems with everyday activities, 48% reported mobility problems, 17% felt worried, sad, or unhappy, and 7% reported problems looking after themselves.
Conclusions: Many adolescents with longstanding non-traumatic knee pain experience low QoL. More than half were aware of their knee problems at least daily, one in three reported a severe lack of confidence in their knee, and one in six felt worried, sad, or unhappy.

1. Introduction

Chronic musculoskeletal pain (CMP) affects up to one-third of adolescents (10–19 years old) (Eccleston et al., 2020; Fuglkjær, Dissing, & Hestbæk, 2017; Rathleff, Roos, Olesen, & Rasmussen, 2013). During this critical period in life, pain may have a detrimental impact on a child's physical, emotional, and social

* Corresponding author. Center for General Practice at Aalborg University, Fyrkildevej 7, 9220, Aalborg, Denmark.
E-mail address: cdjurt@dcm.aau.dk (C. Djurtoft).
[1] Shared first authorship.

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functioning (Eccleston et al., 2020; Fegran et al., 2021; Khanom, McDonagh, Briggs, Bakir, & McBeth, 2020). Non-traumatic knee pain is the most common pain origin among adolescents, with Patellofemoral Pain (PFP) and Osgood-Schlatter Disease (OSD) having the highest prevalence (Rathleff et al., 2013). PFP and OSD show similar pain patterns, including pain in the anterior part of the knee, and are commonly observed among highly active adolescents (Rathleff et al., 2020a; Rathleff, Graven-Nielsen et al., 2019). PFP and OSD are often seen as self-limiting, but recent evidence shows that approximately half of the adolescents having knee pain will continue to experience pain after 12 months, and nearly 75% of adolescents will reduce sports participation due to their knee pain (Holden et al., 2021; Rathleff, Rathleff, Olesen, Rasmussen, & Roos, 2016; Rathleff, Holden, et al., 2019). The impact of experiencing non-traumatic knee pain has significant consequences, as issues extend to basic functional tasks (running and stair-walking), shorter sleeping time, worse sleep quality, and worse quality of life (QoL) than their peers without pain (Holden et al., 2021; Mikkelsen et al., 2021; Palermo, Law, Churchill, & Walker, 2012; Rathleff et al., 2016; Rathleff, Holden, et al., 2019).

A recent individual participants meta-analysis investigating prognostic factors for long-term outcomes demonstrated that 51% of adolescents with non-traumatic knee pain still report knee pain after 12 months (Holden et al., 2021). Notably, low Health-Related Quality of Life (HRQoL) was one of the strongest prognostic factors for poor outcomes and the only identified construct that seems modifiable (Holden et al., 2021). Importantly, modifiable risk factors have high clinical value, as they might help clinicians tailor patient-centered management strategies to enhance rehabilitation success (Murillo et al., 2022). However, it is challenging to identify characteristics of predictive value, and previous evidence regarding prognostic factors in adolescents CMP is sparse and inconsistent (Holden et al., 2021; Huguet et al., 2016; Pate et al., 2020).

Despite the fact that HRQoL has been suggested as an important modifiable prognostic factor in this population, it has remained unclear which characteristics are associated with this phenomenon (Holden et al., 2021; Huguet et al., 2016). However, QoL is a multidimensional construct that is highly subjective and associated with many aspects in adolescents experiencing CMP, such as stress, loneliness, lower self-efficacy, and lower self-esteem (Karimi & Brazier, 2016; Losada-Puente, Araújo, & Muñoz-Cantero, 2020; Mikkelsen et al., 2021). Additionally, identifying ways to manage and improve QoL is ranked as a high research priority among children with CMP, which emphasizes the need for an increased understanding of what influences QoL in adolescents diagnosed with PFP or OSD (Birnie et al., 2019). This will strengthen our knowledge of this phenomenon and plausibly provide important modifiable targets for current management strategies (Pate et al., 2020).

Existing data from three published original trials on adolescents with PFP and OSD foster the opportunity to explore QoL and influencing characteristics in this population (Rathleff et al., 2020b; Rathleff, Graven-Nielsen et al., 2019). Combining data from these three trials increases the sample size, thus strengthens statistical power. Therefore, we aimed to 1) describe QoL among adolescents with PFP or OSD according to the EuroQol 5-dimensions (EQ-5D) and The Knee injury and Osteoarthritis Outcome Score (KOOS) QoL and 2) investigate measures of QoL and its association with characteristics in terms of sports participation, sports activities per week, pain duration, pain intensity, bilateral knee pain, body mass index (BMI), sex, age, and use of pain medication.

2. Materials and methods

2.1. Study design

Our study is reported in accordance with the Strengthening the reporting of observational studies in epidemiology (STROBE) statement (Elm et al., 2007). This cross-sectional explorative study was designed as an individual participant analysis of three previous clinical trials on adolescents (defined by the World Health Organization (WHO) as the second decade of life, 10–19 years old (Singh, Siddiqi, Parameshwar, & Chandra-Mouli, 2019)) suffering from longstanding non-traumatic knee pain. Trials are registered on clinicaltrials.gov (NCT02799394, NCT02402673, NCT01438762). Signed informed consent was obtained from all participants, and all data were stored on a secure fileshare. This study was initiated by the original author group of the original publications (Rathleff, Roos, Olesen, & Rasmussen, 2015, 2020b; Rathleff, Graven-Nielsen et al., 2019).

2.2. Description of included studies

The three studies recruited adolescents diagnosed with PFP or OSD (Rathleff et al., 2015, 2020b; Rathleff, Graven-Nielsen et al., 2019). Study one (n = 121 adolescents from 15 to 19 years of age) and study three (n = 144 adolescents from 10 to 14 years of age) included adolescents with PFP (Rathleff et al., 2015; Rathleff, Graven-Nielsen et al., 2019). Study two (n = 51 adolescents from 10 to 14 years of age) included adolescents with OSD (Rathleff et al., 2020b).

2.3. Patient demographics and exposures

All studies collected information on sports participation, sports activities per week, pain duration, bilateral knee pain, BMI, sex, age, use of pain medication, and knee pain intensity (worst pain last week) using a visual analog scale or numeric pain rating scales (measured on a 0–100 scale with 0 being “no pain” and 100 being “the worst pain imaginable”).

Knee-related QoL was collected by the KOOS questionnaire, which contains five subscales (pain, symptoms, activity in daily living, function in sport and recreation, and knee-related QoL) scored from 0 to 100 (worst to best) (Collins, Misra, Felson, Crossley, & Roos, 2011; Roos, Roos, Lohmander, Ekdahl, & Beynnon, 1998). As this analysis's primary interest was to describe QoL, we collected data from the KOOS-QoL subscale and individual items representing the knee-related QoL. Health-related QoL was measured by the adult version of EQ-5D in study one (Rathleff et al., 2015) and the EQ-5D youth version in study two and three (Rathleff et al., 2020b; Rathleff, Graven-Nielsen et al., 2019). The two versions contain the same items but slightly different wordings to ensure adolescents below the age of 15 also comprehend the language used. The Danish weights were used to calculate the EQ-5D index score (a higher index score equals better QoL) (*EuroQol Research Foundation. EQ-5D-Y User Guide, 2020*, n.d.).

2.4. Data harmonization and checking

After acquiring the data, we relabeled individual data sets and recoded them to ensure consistency and construct a single, merged dataset. MSR and TY merged the dataset and compared it with the individual dataset and previous publications. The individual patient

data validity was checked by undertaking completeness and consistency checks on individual participant data to identify missing or invalid (e.g., out of range) items. Missing information or inconsistencies were checked and rectified as necessary. The original three studies were powered to explore the clinical benefits of a specific management strategy. The sample size was thus fixed by the original studies.

2.5. Data analysis

Normally distributed continuous variables are described as mean ± standard deviation. Non-normally distributed data is presented as median, interquartile range, and [range]. Categorical variables are expressed as frequencies and percentages.

For Knee-related QoL, we calculated the subscale mean score measured by the KOOS-QoL as recommended, where points are summed, converted to percentages of a maximum score, and reversed to a 0–100, worst to best scale (Collins et al., 2011; Roos et al., 1998). In addition, the individual items were divided into scores from Likert scales (Collins et al., 2011; Roos et al., 1998). All items were answered on a 5-point Likert scale (never/not at all, monthly/mildly, weekly/moderately, daily/severely, constantly/totally/extreme), yielding 0–4 points, with 0 points representing no difficulty (Collins et al., 2011; Roos et al., 1998). For the QoL measured by the EQ-5D, we present the index score as a general proxy for QoL, the "health profiles", and the individual five items divided into "no problems" or "any problems", as suggested in the EQ-5D User Guide (*EuroQol Research Foundation. EQ-5D-Y User Guide, 2020*, n.d.).

Characteristics associated with the KOOS-QoL and EQ-5D are presented using box plots, displaying the range, median, and interquartile range of scores. The horizontal line represents the median score, and each box represents the interquartile range. The "whiskers" signify the lowest and highest score for each group. The circles outside the whiskers represent scores above the 10th and 90th percentiles, respectively; these scores fall outside the regular range of values in a distribution and are regarded as outliers. For pragmatic reasons, we divided BMI into five groups (1: <18.5, 2: 18.5 to 24.9, 3: 25 to 29.9, 4: 30 to 39.9, and 5: ≥40) according to the description provided by the WHO (de Onis et al., 2007). No participants had a BMI >40; therefore, this category is not represented. We divided knee pain duration into three categories (1: 0–6 months, 2: 6–12 months, and 3: ≥12 months), as recommended (Barton et al., 2021), and lastly, knee pain-intensity was divided into quartiles (Q1: 0-0.25, Q2: 0.25–0.5, Q3: 0.5–0.75, and Q4: 0,75–1). All analyses were carried out using Statistical Package for the Social Sciences (SPSS), version 25 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp). Based on visual interpretation (median and interquartile range), we examined the association between measures of QoL and included variables (Portney, 2020). As this was an explorative study, we avoided specific hypothesis testing. We interpreted the estimates and figures and looked for differences between subgroups that would be clinically meaningful (Portney, 2020).

3. Results

3.1. Characteristics of participants

A total of 316 participants were included in the dataset; 237 (75%) were girls, 241 (76%) reported bilateral knee pain, and the median age was 14, ranging from 10 to 19 years of age (Table 1). Of all participants, 243 (77%) engaged in sports activities at least twice a week, and 66 (21%) used pain medication due to knee pain.

3.2. KOOS-QoL subscale scores

The mean (±SD) KOOS-QoL subscale score for the 316 participants was 51 ± 18. The most prominent item of KOOS-QoL was awareness of the knee problem, with 191 (60%) reporting daily or constant awareness (Table 2). Secondly, 119 (38%) adolescents reported a severe to extreme lack of confidence in their knee, and 87 (28%) reported severe to extreme difficulty with their knees. Lastly, 64 (20%) reported severely or totally modifying their lifestyle to avoid potentially damaging activities.

3.3. EQ-5D scores

The mean (±SD) total index score of the EQ5D was 0.67 ± 0.21. Pain or discomfort was the most affected item on EQ-5D (Table 3), with 297 (94%) reporting problems. A total of 250 (79%) participants reported problems with usual activities, and 153 (48%) reported problems with mobility. Feeling worried, sad, or unhappy was noted in 55 (17%) participants, and 23 (7%) reported having problems looking after themselves.

3.4. Characteristics associated with QoL

Visual inspection showed no strong linear association between weekly sports participation and KOOS-QoL or EQ-5D scores (Fig. 1A). Adolescents who participated in little or no sport and those who participated six times weekly or more reported the lowest QoL. For pain duration, no association was observed at any time-points (Fig. 1B). Visual inspection revealed no association between knee pain intensity and KOOS-QoL or EQ-5D scores (Fig. 1C). Adolescents reporting use of pain medication did not score lower QoL compared to adolescents who reported no use of pain medication (Fig. 1D). Lastly, adolescents who participated in sports activities reported similar QoL to those adolescents who weren't engaged in sports activities (Fig. 1E).

Sex and age were not associated with lower QoL (Fig. 2A and B). For BMI, we observed no association in measures of QoL and any of the predefined groups (Fig. 2C). Lastly, adolescents with bilateral knee pain reported similar levels of QoL as those with unilateral knee pain (Fig. 2D).

4. Discussion

We found that a large proportion of adolescents reported a lack of confidence in their knees, often feeling sad or worried, and modified their usual activities due to knee pain. Our findings contribute to the growing evidence that PFP and OSD are associated with negative psychological impact (Holden et al., 2021; Johansen et al., 2022; Rathleff et al., 2020a). These findings extend our current knowledge and highlight the negative impact longstanding non-traumatic knee pain can have on adolescents, which emphasizes the complex experience of CMP (Khanom et al., 2020; Sørensen & Christiansen, 2017). This may prompt clinicians with new targets during rehabilitation, beyond the functional deficits these young individuals diagnosed with PFP or OSD may experience.

4.1. Explanation of findings

Of the 316 adolescents, 74% changed their usual activities to avoid what they perceived as damaging to their knees, and 38% reported a severe to extreme lack of confidence in their knees. Our findings are consistent with a previous study among adolescents diagnosed with either PFP or OSD, which showed that more than 50% reported their reduced sports participation due to *"pain"*, and "*I*

Table 1
Characteristics of included participants and studies.

	Study 1 Patellofemoral pain (n = 121)	Study 2 Osgood-Schlatter Disease (n = 51)	Study 3 Patellofemoral Pain (n = 144)	All participants (n = 316)
Age (years), median [range]	17 [15–19]	13 [10–15]	13 [10–14]	14 [10–19]
Female sex,n (%)	97 (80.2)	25 (49)	115 (79.9)	237 (75)
Body mass index, (kg/m2) median [range]	21.6 [17.1–32.8]	20.3 [14.7–27.6]	19 [14–28]	19.8 [14–32.8]
Pain duration (months) median [range]	39 [2–192]	18 [2–60]	18 [2–78]	24 [2–192]
Worst pain last week, (VAS/NRS: 0–100), median [range]	48 [3–97]	70 [0–100]	60 [0–100]	55 [0–100]
Bilateral knee pain,n (%)	95 (78.5)	35 (68.6)	111 (77.1)	241 (76.3)
Use of pain medication,n (%)	24 (19.8)	6 (11.8)	36 (25)	66 (20.9)
Sport activities (yes),n (%)	81 (66.9)	38 (74.5)	124 (86.1)	243 (76.9)
Sport activities per week, median [range]	2 [0–7]	2 [0–6]	2 [0–7]	2 [0–7]

Continuous variables are presented as median [range]. Nominal variables are presented as number (percentages). Abbreviations; NRS, numeric rating scale; VAS, visual analogue scale; (0–100) 0 being "no pain" and 100 being "the worst pain imaginable".

Table 2
Participants Knee injury and Osteoarthritis Outcome Score (KOOS) QoL subscale.

	Study 1 Patellofemoral pain (n = 121)	Study 2 Osgood-Schlatter Disease (n = 51)	Study 3 Patellofemoral Pain (n = 144)	All participants (n = 316)
Q1. How often are you aware of your knee problem? [n (%)]				
Never	2 (1.7)	1 (2)	0	3 (0.9)
Monthly	7 (5.8)	1 (2)	3 (2)	11 (3.5)
Weekly	62 (51.2)	9 (17.6)	40 (27.8)	111 (35.1)
Daily	47 (38.8)	32 (62.7)	87 (60.4)	166 (52.5)
Constantly	3 (2.5)	8 (15.7)	14 (9.7)	25 (7.9)
Missing	0	0	7	7
Q2. Have you modified your lifestyle to avoid potentially damaging activities to your knee? [n (%)]				
Not at all	40 (33.1)	7 (13.7)	36 (25)	83 (26.3)
Mildly	53 (43.8)	15 (29.4)	54 (37.5)	122 (38.6)
Moderately	9 (7.4)	14 (27.5)	24 (16.7)	47 (14.9)
Severely	15 (12.4)	10 (19.6)	25 (17.4)	50 (15.8)
Totally	4 (3.3)	5 (9.8)	5 (3.5)	14 (4.4)
Missing	0	0	7	7
Q3. How much are you troubled with lack of confidence in your knee? [n (%)]				
Not at all	7 (5.8)	4 (7.8)	27 (18.8)	38 (12)
Mildly	33 (27.3)	12 (23.5)	28 (19.4)	73 (23.1)
Moderately	35 (28.9)	12 (23.5)	39 (27.1)	86 (27.2)
Severely	43 (35.3)	21 (41.2)	41 (28.5)	105 (33.2)
Extremely	3 (2.5)	2 (3.9)	9 (6.3)	14 (4.4)
Missing	0	0	7	7
Q4. In general, how much difficulty do you have with your knee? [n (%)]				
None	4 (3.3)	4 (7.8)	10 (6.9)	18 (5.7)
Mild	36 (29.8)	5 (9.8)	21 (14.6)	62 (19.6)
Moderate	62 (51.2)	17 (33.3)	70 (48.6)	149 (47.2)
Severe	18 (14.9)	24 (47.1)	39 (27.1)	81 (25.6)
Extreme	1 (0.8)	1 (2)	4 (2.8)	6 (1.9)
Missing	0	0	7	7
KOOS QoL subscale Mean Score [Mean ±SD]	55 ± 16	43 ± 16	51 ± 19	51 ± 18

Descriptive data are [n (%)] unless otherwise stated. Values in the bottom row (KOOS QoL subscale) are mean ± SD. KOOS QoL subscale scored from 0 to 100 (worst to best). Abbreviations; KOOS, Knee injury and Osteoarthritis Outcome Score; SD, Standard deviation; QoL, Quality of life.

am afraid to damage my knee" (Rathleff et al., 2020a). Adolescents understanding of their pain condition may directly impact how they interpret and manage their pain (Fegran et al., 2021; Khanom et al., 2020; Sørensen & Christiansen, 2017). Some adolescents with a lived experience of CMP ascribe positive changes in their understanding of pain (i.e., pain as non-threatening) as important contributors towards their recovery (Fegran et al., 2021; Joslin, Donovan-Hall, & Roberts, 2021; Khanom et al., 2020). Johansen et al. recently showed that the individual perceptions of 'why do I have pain' (i.e., functional theories) strongly drive behavior in young adults with non-traumatic knee pain, underlining the importance of knowledge about their condition (Johansen et al., 2022). Adolescents with more knowledge about the causes of their pain also showed an increased ability to accept, cope and control their knee pain (Johansen et al., 2022). These psychological processes of change may explain why QoL is associated with prognosis (Holden et al., 2021; Johansen et al., 2022; Khanom et al., 2020). Combined with our findings, it might suggest that psychological processes, such as negative beliefs about pain, play an important role in rehabilitation for adolescents with longstanding non-traumatic knee pain.

Our findings raise important questions about current rehabilitation for adolescents experiencing longstanding non-traumatic knee pain. Traditionally, PFP and OSD management has focused on physical interventions, such as exercise, resistance training, taping, and stretching (Ciatawi & Dusak, 2022; Smith et al., 2017; Willy et al., 2019; Winters et al., 2020). However, it is unclear if these interventions target the QoL dimensions we have identified (Eccleston et al., 2020; Neal, Bartholomew, Barton, Morrissey, & Lack, 2022; Winters et al., 2020). Previous research on

Table 3
EQ-5D data, showing frequencies and proportions by dimension and severity level.

	Study 1 Patellofemoral pain (n = 121)	Study 2 Osgood-Schlatter Disease (n = 51)	Study 3 Patellofemoral Pain (n = 144)	All participants (n = 316)
Mobility [n (%)]				
No problems	70 (57.9)	25 (49)	68 (47.2)	163 (51.6)
Some problems	51 (42.1)	26 (51)	68 (47.2)	145 (45.9)
A lot of problems	0	0	8 (5.6)	8 (2.5)
Missing	0	0	7	7
Looking After Myself [n (%)]				
No problems	118 (97.5)	45 (88.2)	130 (90.3)	293 (92.7)
Some problems	3 (2.5)	6 (11.8)	14 (9.7)	23 (7.3)
A lot of problems	0	0	0	0
Missing	0	0	7	7
Doing Usual Activities [n (%)]				
No problems	28 (23.1)	7 (13.7)	31 (21.5)	66 (20.9)
Some problems	90 (74.4)	36 (70.6)	91 (63.2)	217 (68.7)
A lot of problems	3 (2.5)	8 (15.7)	22 (15.3)	33 (10.4)
Missing	0	0	7	7
Having Pain or Discomfort [n (%)]				
No problems	9 (7.4)	1 (2)	9 (6.3)	19 (6)
Some problems	107 (88.4)	38 (74.5)	98 (68.1)	243 (76.9)
A lot of problems	5 (4.1)	12 (23.5)	37 (25.7)	54 (17.1)
Missing	0	0	7	7
Feeling Worried, Sad or Unhappy [n (%)]				
No problems	106 (87.6)	40 (78.4)	115 (79.9)	261 (82.6)
Some problems	14 (11.6)	9 (17.6)	26 (18.1)	49 (15.5)
A lot of problems	1 (0.8)	2 (3.9)	3 (2.1)	6 (1.9)
Missing	0	0	7	7
EQ5D Index-score [Mean ±SD]	0.74 ± 0.12	0.63 ± 0.23	0.62 ± 0.25	0.67 ± 0.21

Descriptive data are [n (%)] unless otherwise stated. Values in the bottom row (EQ5D Index-score) are mean ± SD. EQ-5D index score (0–100) where a higher index score equals better QoL. Abbreviations; EQ5D, EuroQol 5-dimensions; SD, Standard deviation.

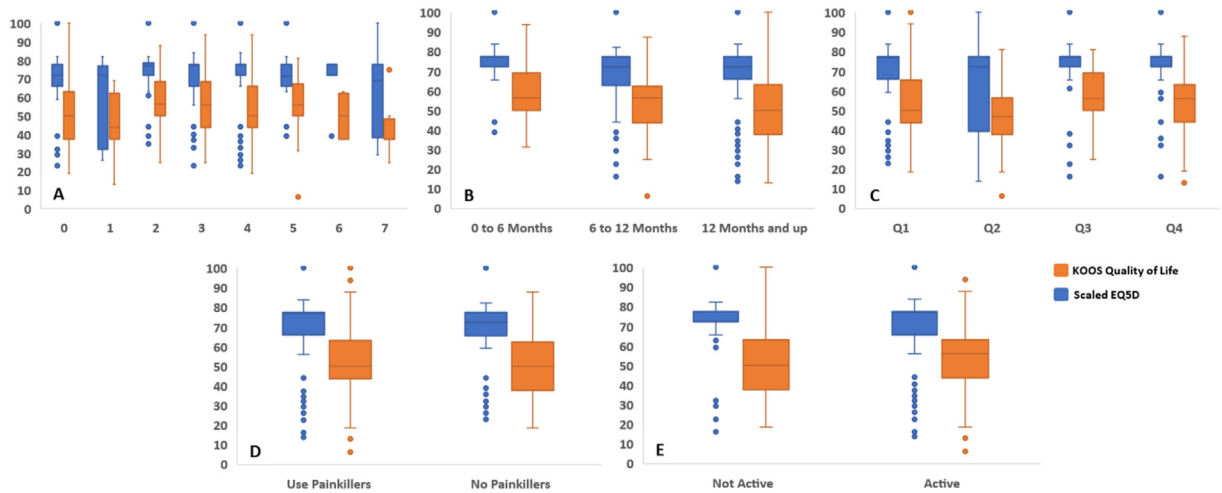

Fig. 1. Association between measures of QoL (EQ-5D index score and KOOS QoL scores) and characteristics. (A) Sports activities per week; (B) Knee pain duration; (C) Knee pain intensity; (D) Pain medication; (E) Sports participation. The horizontal line represents the median score, and each box represents the interquartile range. The "whiskers" signify the lowest and highest score for each group. The circles outside the whiskers represent scores above the 10th and 90th percentiles. The error bars represent the. Abbreviations; EQ5D, EuroQol 5-dimensions; KOOS, Knee injury and Osteoarthritis Outcome Score; Q, Quartiles; QoL, Quality of life.

adolescents with non-traumatic knee pain show that over the course of treatment, QoL does not improve to the same extent as pain and function (Rathleff et al., 2015, 2018; Rathleff, Graven-Nielsen et al., 2019). This raises the question of whether we need to reconsider content and focus during rehabilitating adolescents with PFP or OSD (Birnie, Ouellette, Amaral, & Stinson, 2020; Eccleston et al., 2020). Our findings suggest that evidence-based management for adolescents with PFP and OSD may benefit from a broader range of modifiable targets, such as understanding of pain, low confidence, negative emotions, and fear of damaging the knees to improve QoL and potentially their prognosis. Nonetheless, we cannot exclude any possibilities that other relevant contributing dimensions may play a significant role during rehabilitation since these were not measured. The cross-sectional design of this study prevents us from both causal conclusions and a longitudinal understanding; we urge future studies to examine this further.

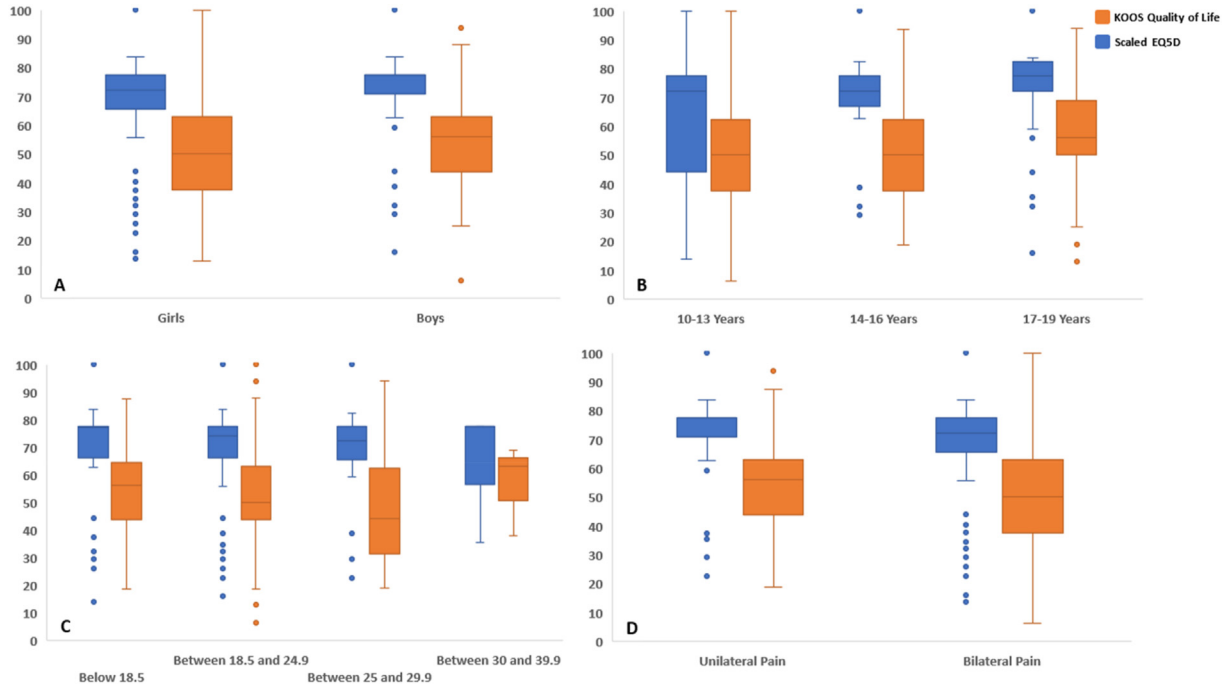

Fig. 2. Association between measures of QoL (EQ-5D index score and KOOS QoL scores). (A) Sex; (B) Age; (C) Body mass index (BMI); (D) Bilateral knee pain. The horizontal line represents the median score, and each box represents the interquartile range. The "whiskers" signify the lowest and highest score for each group. The circles outside the whiskers represent scores above the 10th and 90th percentiles. Abbreviations; EQ5D, EuroQol 5-dimensions; KOOS, Knee injury and Osteoarthritis Outcome Score; QoL, Quality of life.

In the current study, we observed that over half (60%) of adolescents with PFP or OSD reported daily or constant awareness of their knee pain, and almost one-fifth felt worried, sad, or unhappy. However, these negative beliefs and important dimensions of QoL were not associated with the duration of knee pain, although this is a well-known determinant for prognosis (Holden et al., 2021). Measures of QoL have been suggested as a proxy for the current state of life in relation to self-evaluated health and, therefore, are prone to a significant change in meaning over time (Schwartz & Rapkin, 2004; Vanier et al., 2021). Adolescents' preferences and goals change over the course of time and are highly dependent of the perceived stage of rehabilitation (Johansen et al., 2022; Joslin et al., 2021; Weiss et al., 2013). Sprangers and Schwartz describe this phenomenon as *response shift*, a result of changing personal norms, values, or conceptualizing on QoL throughout the course of a condition (Sprangers & Schwartz, 1999; Vanier et al., 2021). The response shift illustrates individual capacity to adapt to their context (i.e., acceptance of pain), shifting focus away from what one cannot (for now) to what one can do to exert control of pain (Sprangers & Schwartz, 1999; Vanier et al., 2021). This aligns with qualitative evidence that suggests some adolescents with CMP ascribe enhanced knowledge of pain as a legitimization of helpful self-management behaviors (e.g., accepting limitations, justifying actions to peers, and prioritizing new life goals) (Fegran et al., 2021; Johansen et al., 2022; Joslin et al., 2021). These processes of change may expedite satisfactory levels of perceived QoL (Johansen et al., 2022; Joslin et al., 2021; Ruskin et al., 2017). The temporal and adaptive nature of perceived QoL may explain why this phenomenon differs from other outcomes in the long-term (Vanier et al., 2021).

In our study, we did not find any strong association between measures of QoL and characteristics. However, a common theme across our results were the large data variability, which emphasizes the heterogeneity of self-reported QoL in this population. This is consistent with previous research on traumatic knee injuries in young individuals (Truong et al., 2020). They showed that QoL was very variable and that several individual psychological, social, and contextual dimensions related to QoL influenced and changed differently across all stages during rehabilitation (Truong et al., 2020). These issues reflect the diverse impact and needs during rehabilitation these young individuals may experience. Adolescents' diverse clinical presentation may provide a plausible explanation for current insufficient evidence of recommending specific treatments in the context of non-traumatic knee pain (Neal et al., 2022; Winters et al., 2020). It has been suggested that current management for adolescents' CMP may benefit from a higher degree of personalization that fit into each individual context (Eccleston et al., 2020; McCracken, Yu, & Vowles, 2022). The current study adds new and important insights of psychological processes of change (e.g., understanding of pain, lack of confidence in the knee) into the field of adolescents suffering from PFP or OSD. Our results may help tackle some of the challenges clinicians face when tailoring rehabilitation to fit an individual adolescent.

4.2. Clinical implications

Our findings may help increase clinicians' awareness of psychological processes in adolescents diagnosed with PFP or OSD. It is our clear recommendation that clinicians keep our results in mind when providing personalized evidence-based pain assessment and subsequent management for adolescents with PFP or OSD. There may be unique management options to consider in clinical settings. Future management of care might benefit from clinicians addressing the whole biopsychosocial perspective, tailored to the individual's context. Our results highlighted the presence of unique processes of change, such as understanding of pain, which clinicians may consider addressing in the care they provide (Eccleston et al., 2020; Neal et al., 2022; Winters et al., 2020). Lancet Child & Adolescent Health Commission emphasized the importance of intervening earlier to ensure young people get the proper management at the

right time (Eccleston et al., 2020). Early identification of these modifiable targets (e.g., processes of change) may help clinicians tailor personalized rehabilitation to optimize relevant outcomes, such as adolescents' perceived QoL (Eccleston et al., 2020).

4.3. Strength and limitations

Strengths of our study include the large sample, the broad age range of participants, and the use of two complementary measures of QoL, one knee-specific and one generic measure, which yielded similar results (Haraldstad et al., 2019). We highlight the fact that psychological processes are highly prevalent in these young individuals and deeply rooted in measures of perceived QoL. Our results may downplay the divisions of therapies (e.g., education vs. exercises) and instead encourage researchers and clinicians to embrace processes of change that are known to drive important outcomes, such as QoL (Holden et al., 2021). The following limitations should also be considered in interpreting the findings of our study. First, our results rely on a cross-sectional explorative study design. Therefore, our results should be seen as hypotheses generating rather than proving any causal or temporal relationships between measures of QoL and characteristics. Second, recent studies emphasize that current measures of QoL are prone to conceptual and methodological challenges and may lack the validity of the target construct (Hansen et al., 2022; Haraldstad et al., 2019; Le et al., 2021). Therefore, our data must be interpreted cautiously as we may have missed important dimensions of QoL (Haraldstad et al., 2019; Krogsgaard & Hansen, 2022; Le et al., 2021; Vanier et al., 2021). Third, we used visual interpretation to analyze the data exclusively. In most situations, a combination of visual and statistical analyses may provide the clearest interpretation (Portney, 2020).

5. Future research

Using qualitative methods, future studies should explore the questions of QoL to capture the entire experience of longstanding non-traumatic knee pain and understand how and why changes in perception occur over time. We encourage future studies to use a longitudinal design to understand how QoL can be modified and explore co-occurring dimensions associated with QoL as well as changes in QoL. This will provide essential knowledge to further understand the complexity of living well with (or despite) knee pain and potentially develop new management strategies for these individuals.

6. Conclusion

A high proportion of adolescents with longstanding non-traumatic knee pain experience low QoL. More than half were aware of their knee problems at least daily, one in three reported a severe lack of confidence in their knee, and one in six felt worried, sad, or unhappy. Our results may encourage clinicians to extend the scope and address psychological processes of change in rehabilitation for adolescents with longstanding non-traumatic knee pain.

Name of the public trials registry and the registration number

ClinicalTrials.gov Identifier: NCT02799394, NCT02402673, NCT01438762.

Data availability

Data are available upon request to corresponding author.

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Authors' contributions statement

Chris Djurtoft: Conceptualization, Methodology, Software, Formal analysis, Data Curation, Investigation, Writing - Original Draft, Writing - Review & Editing, Visualization. Project administration. **Tomer Yona:** Conceptualization, Methodology, Software, Formal analysis, Data Curation, Investigation, Writing - Original Draft, Writing - Review & Editing, Visualization. Project administration. **Ewa Maria Roos:** Conceptualization, Resources, Methodology, Validation. Visualization, Writing - Review & Editing. **Kristian Thorborg:** Conceptualization, Resources, Methodology, Validation. Visualization, Writing - Review & Editing. **Per Hölmich:** Validation. Visualization, Writing - Review & Editing. **Sten Rasmussen:** Validation. Visualization, Writing - Review & Editing. **Jens Lykkegaard Olesen:** Validation. Visualization, Writing - Review & Editing. **Michael Skovdal Rathleff:** Supervision, Resources, Methodology, Writing- Reviewing and Editing, Project administration, Funding acquisition.

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Ethical approval and institutional review board

Ethics Committee of North Denmark Region. This study was exempt from a full ethical approval by The North Denmark Region Committee on Health Research Ethics.

Declaration of competing interest

None declared.

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References

Barton, C. J., de Oliveira Silva, D., Morton, S., Collins, N. J., Rathleff, M. S., Vicenzino, B., et al. (2021). REPORT-PFP: A consensus from the international patellofemoral research network to improve REPORTing of quantitative PatelloFemoral pain studies. *British Journal of Sports Medicine, 55*(20), 1135. https://doi.org/10.1136/bjsports-2020-103700

Birnie, K. A., Dib, K., Ouellette, C., Dib, M. A., Nelson, K., Pahtayken, D., et al. (2019). Partnering for pain: A priority setting partnership to identify patient-oriented research priorities for pediatric chronic pain in Canada. *CMAJ Open, 7*(4), E654. https://doi.org/10.9778/cmajo.20190060

Birnie, K. A., Ouellette, C., Amaral, T. do, & Stinson, J. N. (2020). Mapping the evidence and gaps of interventions for pediatric chronic pain to inform policy, research, and practice: A systematic review and quality assessment of systematic reviews. *Canadian Journal of Pain = Revue Canadienne de La Douleur, 4*, 129–148. https://doi.org/10.1080/24740527.2020.1757384

Ciatawi, K., & Dusak, I. W. S. (2022). Osgood-schlatter disease: A review of current diagnosis and management. *Current Orthopaedic Practice, 33*(3). https://doi.org/10.1097/BCO.0000000000001110

Collins, N. J., Misra, D., Felson, D. T., Crossley, K. M., & Roos, E. M. (2011). Measures of knee function: International knee documentation committee (IKDC) subjective knee evaluation form, knee injury and osteoarthritis outcome score (KOOS), knee injury and osteoarthritis outcome score physical function short form (KOOS-PS), knee outcome survey activities of daily living scale (KOS-ADL), lysholm knee scoring scale, oxford knee score (OKS), western ontario and McMaster universities osteoarthritis index (WOMAC), activity rating scale (ARS), and tegner activity score (TAS). *Arthritis Care & Research, 63*(S11), S208–S228. https://doi.org/10.1002/acr.20632

Eccleston, C., Fisher, E., Howard, R. F., Slater, R. C., Forgeron, P., Palermo, T. M., et al. (2020). Delivering transformative action in paediatric pain: A lancet child & adolescent health commission. *The Lancet. Child & Adolescent Health*. https://doi.org/10.1016/S2352-4642(20)30277-7

Elm, E. von, Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., & Vandenbroucke, J. P. (2007). Strengthening the reporting of observational studies in epidemiology (STROBE) statement: Guidelines for reporting observational studies. *BMJ, 335*(7624), 806. https://doi.org/10.1136/bmj.39335.541782.AD

EuroQol Research Foundation. EQ-5D-Y User Guide. (2020) (n.d.). Retrieved August 15, 2022, from https://euroqol.org/publications/user-guides.

Fegran, L., Johannessen, B., Ludvigsen, M. S., Westergren, T., Høie, M., Slettebø, Å., et al. (2021). Experiences of a non-clinical set of adolescents and young adults living with persistent pain: A qualitative metasynthesis. *BMJ Open, 11*(4), Article e043776. https://doi.org/10.1136/bmjopen-2020-043776

Fuglkjær, S., Dissing, K. B., & Hestbæk, L. (2017). Prevalence and incidence of musculoskeletal extremity complaints in children and adolescents. A systematic review. *BMC Musculoskeletal Disorders, 18*(1), 418. https://doi.org/10.1186/s12891-017-1771-2

Hansen, C. F., Jensen, J., Odgaard, A., Siersma, V., Comins, J. D., Brodersen, J., et al. (2022). Four of five frequently used orthopedic PROMs possess inadequate content validity: A COSMIN evaluation of the mHHS, HAGOS, IKDC-SKF, KOOS and KNEES-ACL. *Knee Surgery, Sports Traumatology, Arthroscopy, 30*(11), 3602–3615. https://doi.org/10.1007/s00167-021-06761-y

Haraldstad, K., Wahl, A., Andenæs, R., Andersen, J. R., Andersen, M. H., Beisland, E., et al., network, the L.. (2019). A systematic review of quality of life research in medicine and health sciences. *Quality of Life Research, 28*(10), 2641–2650. https://doi.org/10.1007/s11136-019-02214-9

Holden, S., Kasza, J., Winters, M., van Middelkoop, M., Rathleff, M. S., & Group, A. K. H. (2021). Prognostic factors for adolescent knee pain: An individual participant data meta-analysis of 1281 patients. *Pain, 162*(6). https://doi.org/10.1097/j.pain.0000000000002184

Huguet, A., Tougas, M. E., Hayden, J., McGrath, P. J., Stinson, J. N., & Chambers, C. T. (2016). Systematic review with meta-analysis of childhood and adolescent risk and prognostic factors for musculoskeletal pain. *Pain, 157*(12), 2640–2656. https://doi.org/10.1097/j.pain.0000000000000685

Johansen, S. K., Holden, S., Pourbordbari, N., Jensen, M. B., Thomsen, J. L., & Rathleff, M. S. (2022). PAINSTORIES: Exploring the temporal developments in the challenges, barriers, and self-management needs of adolescents with longstanding knee pain: A qualitative, retrospective interview study with young adults experiencing knee pain since adolescence. *The Journal of Pain, 23*(4), 577–594. https://doi.org/10.1016/j.jpain.2021.10.006

Joslin, R., Donovan-Hall, M., & Roberts, L. (2021). Exploring the outcomes that matter most to young people treated for chronic pain: A qualitative study. *Children, 8*(12). https://doi.org/10.3390/children8121170

Karimi, M., & Brazier, J. (2016). Health, health-related quality of life, and quality of life: What is the difference? *PharmacoEconomics, 34*(7), 645–649. https://doi.org/10.1007/s40273-016-0389-9

Khanom, S., McDonagh, J. E., Briggs, M., Bakir, E., & McBeth, J. (2020). Adolescents' experiences of fluctuating pain in musculoskeletal disorders: A qualitative systematic review and thematic synthesis. *BMC Musculoskeletal Disorders, 21*(1), 645. https://doi.org/10.1186/s12891-020-03627-1

Krogsgaard, M. R., & Hansen, C. F. (2022). Patient-reported outcome measures: It is time for authors, reviewers, journal editors and health care strategists to take sufficient responsibility. *Knee Surgery, Sports Traumatology, Arthroscopy, 30*(11), 3589–3593. https://doi.org/10.1007/s00167-022-07138-5

Le, C. Y., Truong, L. K., Holt, C. J., Filbay, S. R., Dennett, L., Johnson, J. A., et al. (2021). Searching for the holy grail: A systematic review of health-related quality of life measures for active youth. *Journal of Orthopaedic & Sports Physical Therapy, 51*(10), 478–491. https://doi.org/10.2519/jospt.2021.10412

Losada-Puente, L., Araújo, A. M., & Muñoz-Cantero, J. M. (2020). A systematic review of the assessment of quality of life in adolescents. *Social Indicators Research, 147*(3), 1039–1057. https://doi.org/10.1007/s11205-019-02171-3

McCracken, L. M., Yu, L., & Vowles, K. E. (2022). New generation psychological treatments in chronic pain. *BMJ, 376*, Article e057212. https://doi.org/10.1136/bmj-2021-057212

Mikkelsen, H. T., Haraldstad, K., Helseth, S., Skarstein, S., Småstuen, M. C., & Rohde, G. (2021). Pain and health-related quality of life in adolescents and the mediating role of self-esteem and self-efficacy: A cross-sectional study including adolescents and parents. *BMC Psychology, 9*(1), 128. https://doi.org/10.1186/s40359-021-00629-z

Murillo, C., Vo, T.-T., Vansteelandt, S., Harrison, L. E., Cagnie, B., Coppieters, I., et al. (2022). How do psychologically based interventions for chronic musculoskeletal pain work? A systematic review and meta-analysis of specific moderators and mediators of treatment. *Clinical Psychology Review, 94*, Article 102160. https://doi.org/10.1016/j.cpr.2022.102160

Neal, B. S., Bartholomew, C., Barton, C. J., Morrissey, D., & Lack, S. D. (2022). Six treatments have positive effects at 3 Months for people with patellofemoral pain: A systematic review with meta-analysis. *Journal of Orthopaedic & Sports Physical Therapy, 52*(11), 750–768. https://doi.org/10.2519/jospt.2022.11359

de Onis, M., Onyango, A. W., Borghi, E., Siyam, A., Nishida, C., & Siekmann, J. (2007). Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization, 85*(9), 660–667. https://doi.org/10.2471/blt.07.043497

Palermo, T. M., Law, E., Churchill, S. S., & Walker, A. (2012). Longitudinal course and impact of insomnia symptoms in adolescents with and without chronic pain. *The Journal of Pain, 13*(11), 1099–1106. https://doi.org/10.1016/j.jpain.2012.08.003

Pate, J. W., Hancock, M. J., Hush, J. M., Gray, K., Pounder, M., & Pacey, V. (2020). Prognostic factors for pain and functional disability in children and adolescents with persisting pain: A systematic review and meta-analysis. *European Journal of Pain, 24*(4), 722–741. https://doi.org/10.1002/ejp.1539

Portney, L. G. (2020). *Foundations of clinical research : Applications to evidence-based practice* (4th ed.). Davis: F.A.

Rathleff, M. S., Graven-Nielsen, T., Hölmich, P., Winiarski, L., Krommes, K., Holden, S., et al. (2019). Activity modification and load management of adolescents with patellofemoral pain: A prospective intervention study including 151 adolescents. *The American Journal of Sports Medicine, 47*(7), 1629–1637. https://doi.org/10.1177/0363546519843915

Rathleff, M. S., Holden, S., Straszek, C. L., Olesen, J. L., Jensen, M. B., & Roos, E. M. (2019). Five-year prognosis and impact of adolescent knee pain: A prospective population-based cohort study of 504 adolescents in Denmark. *BMJ Open, 9*(5), Article e024113. https://doi.org/10.1136/bmjopen-2018-024113

Rathleff, M. S., Rathleff, C. R., Holden, S., Thorborg, K., & Olesen, J. L. (2018). Exercise therapy, patient education, and patellar taping in the treatment of adolescents with patellofemoral pain: A prospective pilot study with 6 months follow-up. *Pilot and Feasibility Studies, 4*, 73. https://doi.org/10.1186/s40814-017-0227-7

Rathleff, M. S., Rathleff, C. R., Olesen, J. L., Rasmussen, S., & Roos, E. M. (2016). Is knee pain during adolescence a self-limiting condition?: Prognosis of patellofemoral pain and other types of knee pain. *The American Journal of Sports Medicine, 44*(5), 1165–1171. https://doi.org/10.1177/0363546515622456

Rathleff, M. S., Roos, E. M., Olesen, J. L., & Rasmussen, S. (2013). High prevalence of daily and multi-site pain – a cross-sectional population-based study among 3000 Danish adolescents. *BMC Pediatrics, 13*(1), 191. https://doi.org/10.1186/1471-2431-13-191

Rathleff, M. S., Roos, E. M., Olesen, J. L., & Rasmussen, S. (2015). Exercise during school hours when added to patient education improves outcome for 2 years in adolescent patellofemoral pain: A cluster randomised trial. *British Journal of Sports Medicine, 49*(6), 406. https://doi.org/10.1136/bjsports-2014-093929

Rathleff, M. S., Winiarski, L., Krommes, K., Graven-Nielsen, T., Hölmich, P., Olesen, J. L., et al. (2020a). Pain, sports participation, and physical function in adolescents with patellofemoral pain and osgood-schlatter disease: A matched cross-sectional study. *Journal of Orthopaedic & Sports Physical Therapy, 50*(3), 149–157. https://doi.org/10.2519/jospt.2020.8770

Rathleff, M. S., Winiarski, L. M., Krommes, K., Graven-Nielsen, T., Hölmich, P., Olesen, J. L., et al. (2020b). Activity modification and knee strengthening for osgood-schlatter disease: A prospective cohort study. *Orthopaedic Journal of Sports Medicine, 8*. https://doi.org/10.1177/2325967120911106

Roos, E. M., Roos, H. P., Lohmander, L. S., Ekdahl, C., & Beynnon, B. D. (1998). Knee injury and osteoarthritis outcome score (KOOS)—development of a self-administered outcome measure. *Journal of Orthopaedic & Sports Physical Therapy, 28*(2), 88–96. https://doi.org/10.2519/jospt.1998.28.2.88

Ruskin, D., Harris, L., Stinson, J., Kohut, S. A., Walker, K., & McCarthy, E. (2017). I learned to let go of my pain". The effects of mindfulness meditation on adolescents with chronic pain: An analysis of participants' treatment experience. *Children, 4*(12). https://doi.org/10.3390/children4120110

Schwartz, C. E., & Rapkin, B. D. (2004). Reconsidering the psychometrics of quality of life assessment in light of response shift and appraisal. *Health and Quality of Life Outcomes, 2*, 16. https://doi.org/10.1186/1477-7525-2-16

Singh, J. A., Siddiqi, M., Parameshwar, P., & Chandra-Mouli, V. (2019). World health organization guidance on ethical considerations in planning and reviewing research studies on sexual and reproductive health in adolescents. *Journal of Adolescent Health : Official Publication of the Society for Adolescent Medicine, 64*(4), 427–429. https://doi.org/10.1016/j.jadohealth.2019.01.008

Smith, B. E., Hendrick, P., Bateman, M., Moffatt, F., Rathleff, M. S., Selfe, J., et al. (2017). Current management strategies for patellofemoral pain: An online survey of 99 practising UK physiotherapists. *BMC Musculoskeletal Disorders, 18*(1), 181. https://doi.org/10.1186/s12891-017-1539-8

Sørensen, K., & Christiansen, B. (2017). Adolescents' experience of complex persistent pain. *Scandinavian Journal of Pain, 15*, 106–112. https://doi.org/10.1016/j.sjpain.2017.02.002

Sprangers, M. A. G., & Schwartz, C. E. (1999). Integrating response shift into health-related quality of life research: A theoretical model. *Social Science & Medicine, 48*(11), 1507–1515. https://doi.org/10.1016/S0277-9536(99)00045-3

Truong, L. K., Mosewich, A. D., Holt, C. J., Le, C. Y., Miciak, M., & Whittaker, J. L. (2020). Psychological, social and contextual factors across recovery stages following a sport-related knee injury: A scoping review. *British Journal of Sports Medicine, 54*(19), 1149. https://doi.org/10.1136/bjsports-2019-101206

Vanier, A., Oort, F. J., McClimans, L., Ow, N., Gulek, B. G., Böhnke, J. R., et al., Group,

the R. S. S. W.. (2021). Response shift in patient-reported outcomes: Definition, theory, and a revised model. *Quality of Life Research, 30*(12), 3309–3322. https://doi.org/10.1007/s11136-021-02846-w

Weiss, K. E., Hahn, A., Wallace, D. P., Biggs, B., Bruce, B. K., & Harrison, T. E. (2013). Acceptance of pain: Associations with depression, catastrophizing, and functional disability among children and adolescents in an interdisciplinary chronic pain rehabilitation program. *Journal of Pediatric Psychology, 38*(7), 756–765. https://doi.org/10.1093/jpepsy/jst028

Willy, R. W., Hoglund, L. T., Barton, C. J., Bolgla, L. A., Scalzitti, D. A., Logerstedt, D. S., et al. (2019). Patellofemoral pain. *Journal of Orthopaedic & Sports Physical Therapy, 49*(9), CPG1–CPG95. https://doi.org/10.2519/jospt.2019.0302

Winters, M., Holden, S., Lura, C. B., Welton, N. J., Caldwell, D. M., Vicenzino, B. T., et al. (2020). Comparative effectiveness of treatments for patellofemoral pain: A living systematic review with network meta-analysis. *British Journal of Sports Medicine*. https://doi.org/10.1136/bjsports-2020-102819