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Physical activity and education about physical activity for chronic musculoskeletal pain in children and adolescents (Review)

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[Intervention Review]

Physical activity and education about physical activity for chronic musculoskeletal pain in children and adolescents

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ABSTRACT

Background

Chronic pain is a major health and socioeconomic burden, which is prevalent in children and adolescents. Among the most widely used interventions in children and adolescents are physical activity (including exercises) and education about physical activity.

Objectives

To evaluate the effectiveness of physical activity, education about physical activity, or both, compared with usual care (including waiting-list, and minimal interventions, such as advice, relaxation classes, or social group meetings) or active medical care in children and adolescents with chronic musculoskeletal pain.

Search methods

We searched CENTRAL, MEDLINE, Embase, CINAHL, PsycINFO, PEDro, and LILACS from the date of their inception to October 2022. We also searched the reference lists of eligible papers, ClinicalTrials.gov, and the World Health Organization (WHO) International Clinical Trials Registry Platform.

Selection criteria

We included randomised controlled trials (RCTs) that compared physical activity or education about physical activity, or both, with usual care (including waiting-list and minimal interventions) or active medical care, in children and adolescents with chronic musculoskeletal pain.

Data collection and analysis

Two review authors independently determined the eligibility of the included studies. Our primary outcomes were pain intensity, disability, and adverse events. Our secondary outcomes were depression, anxiety, fear avoidance, quality of life, physical activity level, and caregiver distress. We extracted data at postintervention assessment, and long-term follow-up. Two review authors independently assessed risk of

bias for each study, using the RoB 1. We assessed the overall certainty of the evidence using the GRADE approach. We reported continuous outcomes as mean differences, and determined clinically important differences from the literature, or 10% of the scale.

Main results

We included four studies (243 participants with juvenile idiopathic arthritis). We judged all included studies to be at unclear risk of selection bias, performance bias, and detection bias, and at high risk of attrition bias. We downgraded the certainty of the evidence for each outcome to very low due to serious or very serious study limitations, inconsistency, and imprecision.

Physical activity compared with usual care

Physical activity may slightly reduce pain intensity (0 to 100 scale; 0 = no pain) compared with usual care at postintervention (standardised mean difference (SMD) -0.45, 95% confidence interval (CI) -0.82 to -0.08; 2 studies, 118 participants; recalculated as a mean difference (MD) -12.19, 95% CI -21.99 to -2.38; I^2 = 0%; very low-certainty evidence). Physical activity may slightly improve disability (0 to 3 scale; 0 = no disability) compared with usual care at postintervention assessment (MD -0.37, 95% CI -0.56 to -0.19; I^2 = 0%; 3 studies, 170 participants; very low-certainty evidence). We found no clear evidence of a difference in quality of life (QoL; 0 to 100 scale; lower scores = better QoL) between physical activity and usual care at postintervention assessment (SMD -0.46, 95% CI -1.27 to 0.35; 4 studies, 201 participants; very low-certainty evidence; recalculated as MD -6.30, 95% CI -18.23 to 5.64; I^2 = 91%).

None of the included studies measured adverse events, depression, or anxiety for this comparison.

Physical activity compared with active medical care

We found no studies that could be analysed in this comparison.

Education about physical activity compared with usual care or active medical care

We found no studies that could be analysed in this comparison.

Physical activity and education about physical activity compared with usual care or active medical care

We found no studies that could be analysed in this comparison.

Authors' conclusions

We are unable to confidently state whether interventions based on physical activity and education about physical activity are more effective than usual care for children and adolescents with chronic musculoskeletal pain.

We found very low-certainty evidence that physical activity may reduce pain intensity and improve disability postintervention compared with usual care, for children and adolescents with juvenile idiopathic arthritis.

We did not find any studies reporting educational interventions; it remains unknown how these interventions influence the outcomes in children and adolescents with chronic musculoskeletal pain.

Treatment decisions should consider the current best evidence, the professional's experience, and the young person's preferences.

Further randomised controlled trials in other common chronic musculoskeletal pain conditions, with high methodological quality, large sample size, and long-term follow-up are urgently needed.

PLAIN LANGUAGE SUMMARY

How effective are physical activity and education for chronic musculoskeletal pain in children and adolescents?

Key messages

- We are uncertain whether physical activity reduces pain or improves disability compared with usual care. We did not find studies that compared physical activities with medical care intervention (e.g. education).

- We did not find studies that evaluated education about physical activity, with or without physical activity, in children and adolescents.

- Due to the small number of included studies, and the ways in which the studies were conducted, which could introduce errors into their results, we cannot conclude whether physical activity, education about physical activity, or both, are effective compared with active medical care or usual care.

What is chronic musculoskeletal pain in children and adolescents?

Chronic pain is pain that lasts longer than three months. Chronic musculoskeletal pain (e.g. pain in muscles and bones) is common in children and adolescents, and has a negative impact on their lives. The most common chronic musculoskeletal pain in children and adolescents is pain in their back, neck, and arms, and pain resulting from sports injuries.

What is the impact caused by musculoskeletal pain in children and adolescents?

Children and adolescents with chronic pain report disability and a low mood; they socialise less with their friends, and recognise pain as an obstacle to exercising and participating in physical activities. This can result in missed school, and overall poor health in adult life.

How is musculoskeletal pain treated in children and adolescents?

Chronic musculoskeletal pain is usually managed with physical activity, education about physical activity, or both. Most of the time, these approaches are delivered as part of a complex intervention, i.e. interventions with different components (e.g. psychology, medicines, physical activity).

What did we want to find out?

We wanted to find out if physical activity, education about physical activity, or both, was better than usual care or medical care treatment (also known as active medical care) for improving:

- Pain

- Disability

- Quality of life

We also wanted to find out if physical activity, education about physical activity, or both, led to any unwanted side effects.

What did we do?

We searched for studies that compared physical activity, or education about physical activity, or both, with usual care or active medical care, in school-aged children and adolescents (4 years to 18 years) with any chronic musculoskeletal pain.

We compared and summarised the results of the studies, and rated our confidence in the evidence, based on factors, such as study methods and size.

What did we find?

We found four studies with a total of 243 participants. The studies only included children and adolescents with juvenile idiopathic arthritis. The number of young people included in each study ranged from 32 to 93; the average age of the participants was 11 years. The treatments ranged from three to six months in length. Only one study assessed outcomes at long-term follow-up. We only found studies that compared physical activity with usual care.

We are uncertain if physical activity reduces pain or improves disability better than usual care. We are uncertain about the effects of physical activity on quality of life. None of the studies reported whether the participants experienced unwanted side effects.

What are the limitations of the evidence?

The studies only included a small number of children and adolescents, and may have been done in ways that could introduce errors in their results. Both reasons limit our confidence in the evidence.

Possible side effects of the physical activities and usual care were not adequately reported.

Our uncertainty in the results does not allow us to conclude whether physical activity for chronic musculoskeletal pain in children and adolescents improves their pain, disability, or quality of life.

In practice, healthcare providers should consider the availability and quality of research evidence about physical therapies, preferences of the young people in pain, and the professional's experience.

How up to date is this evidence?

The evidence is current to October 2022.

SUMMARY OF FINDINGS

Summary of findings 1. Summary of findings

Physical activity compared with usual care for chronic musculoskeletal pain in children and adolescents

Patient or population: children and adolescents aged 4 years to 18 years, with chronic musculoskeletal pain

Settings: primary care

Intervention: physical activity

Comparison: usual care

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No. of Participants (studies)	Certainty of the evidence (GRADE)	Comments
	Assumed risk with usual care	Corresponding risk with physical activity				
Pain intensity measured on CHQ (0-100; 0 = worse pain), and VAS (0 to 100; 0 = no pain) *Postintervention: first assessment after end of treatment; no later than 3 months*	-	The mean pain in the physical activity group was **0.45 lower (0.82 lower to 0.08 higher)**	-	118 participants (2 studies)	⊕⊝⊝⊝ **very low**[a,b]	SMD -0.45 (95% CI -0.82 to -0.08) *recalculated as MD -12.19 (95% CI -21.99 to -2.38)*
Disability measured on CHAQ (0 to 3; 0 = no disability) *Postintervention: first assessment after end of treatment; no later than 3 months*	The mean disability (postintervention) in the control group was **0.0**	The mean disability in the intervention group was **-0.37 lower** (0.56 lower to 0.19 lower)	-	170 participants (3 studies)	⊕⊝⊝ **very low**[a,b]	*MD -0.37 (95% CI -0.56 to -0.19)*
Adverse events *none of the studies reported on this outcome*	-	-	-	-	-	-
Depression *none of the studies reported on this outcome*	-	-	-	-	-	-
Anxiety *none of the studies reported on this outcome*	-	-	-	-	-	-

Quality of life measured on multiple scales (0 to 100; higher score = better quality of life) *Postintervention: first assessment after end of treatment; no later than 3 months*	-	The mean quality of life at in the intervention group was **0.46 higher** (1.27 higher to 0.35 lower)	-	201 participants (4 studies)	⊕⊖⊖⊖ **very low**[a,b,c]	*SMD -0.46 (95% CI -1.27 to 0.35) recalculated as MD -6.30 (95% CI -18.23 to 5.64)*

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **CHQ**: Child Health Questionnaire; **CHAQ**: Childhood Health Assessment Questionnaire; **MD**: mean difference; **RR:** risk ratio; **SMD**: standardised mean difference; **VAS**: visual analogue scale

GRADE Working Group grades of evidence

High: we are very confident that the true effect lies close to that of the estimate of the effect

Moderate: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different

Low: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect

Very low: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

[a]Downgraded twice due to very serious study limitations (more than 25% of the participants are from studies with a high risk of bias)
[b]Downgraded due to serious imprecision (fewer than 400 participants included in the comparison)
[c]Downgraded due to serious inconsistency (significant heterogeneity was present by visual inspection, or the I^2 value was greater than 50%)

Summary of findings 2. Summary of findings

Education compared with usual care for chronic musculoskeletal pain in children and adolescents

Patient or population: children and adolescents aged 4 years to 18 years, with chronic musculoskeletal pain

Settings: primary care

Intervention: education

Comparison: usual care

Outcomes	Illustrative comparative risks* (95% CI)	Relative effect (95% CI)	No. of Participants (studies)	Certainty of the evidence (GRADE)	Comments

	Assumed risk for usual care	Corresponding risk for physical activity				
Pain intensity *none of the studies reported on this outcome*	-	-	-	-	-	-
Disability *none of the studies reported on this outcome*	-	-	-	-	-	-
Adverse events *none of the studies reported on this outcome*	-	-	-	-	-	-
Depression *none of the studies reported on this outcome*	-	-	-	-	-	-
Anxiety *none of the studies reported on this outcome*	-	-	-	-	-	-
Quality of life *none of the studies reported on this outcome*	-	-	-	-	-	-

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **RR:** risk ratio

GRADE Working Group grades of evidence

High: we are very confident that the true effect lies close to that of the estimate of the effect

Moderate: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different

Low: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect

Very low: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

Summary of findings 3. Summary of findings

Physical activity plus education compared with usual care for chronic musculoskeletal pain in children and adolescents						
Patient or population: children and adolescents aged 4 years to 18 years, with chronic musculoskeletal pain **Settings:** primary care **Intervention:** physical activity plus education **Comparison:** usual care						
Outcomes	**Illustrative comparative risks* (95% CI)**		**Relative effect (95% CI)**	**No. of Participants (studies)**	**Certainty of the evidence (GRADE)**	**Comments**
	Assumed risk for usual care	**Corresponding risk for physical activity**				
Pain intensity *none of the studies reported on this outcome*	-	-	-	-	-	-
Disability *none of the studies reported on this outcome*	-	-	-	-	-	-
Adverse events *none of the studies reported on this outcome*	-	-	-	-	-	-
Depression *none of the studies reported on this outcome*	-	-	-	-	-	-
Anxiety *none of the studies reported on this outcome*	-	-	-	-	-	-
Quality of life *none of the studies reported on this outcome*	-	-	-	-	-	-

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **RR:** risk ratio

GRADE Working Group grades of evidence

High: we are very confident that the true effect lies close to that of the estimate of the effect

Moderate: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different

Low: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect

Very low: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

BACKGROUND

Description of the condition

Chronic pain (i.e. pain lasting longer than three months) is responsible for a major socioeconomic burden, and affects about one-third of the population worldwide (Elzahaf 2012; Harstall 2003). Chronic pain is prevalent in children and adolescents, as well as adults (Rathleff 2017). The worldwide prevalence of chronic pain in children and adolescents is 10% to 20%; musculoskeletal conditions represent a large proportion (Henschke 2014; King 2011). There is evidence that musculoskeletal conditions are also a major contributor to disability in this population, with rates of disability increasing with age (Global 2016; Murray 2013). Chronic pain is also associated with an economic burden to society, although the availability of these data are limited; for example the national cost of paediatric chronic pain in the USA has been estimated as USD 19.5 billion annually (Groenewald 2014).

Among the different conditions that can lead to disabling musculoskeletal pain, the most common in children and adolescents are back pain, neck pain, upper limb pain, and sports injuries. Low back pain is among the most prevalent in children and adolescents (Akdag 2011), with a monthly prevalence of 37% reported in a large study of 404,206 children from 28 countries (Swain 2014). The prevalence of neck pain has been reported to be 28%, lower limb pain 15%, and upper limb pain 8% (Jeffries 2007; Picavet 2016). However, the region of the body seems to have little influence on the impact of pain on children's lives (Dunn 2011). Children and adolescents with chronic pain report disability, worse mood, and less socialisation than their friends (Hainsworth 2012; Huguet 2008; Roth-Isigkeit 2005). There is evidence that children and adolescents recognise pain as an obstacle to doing exercise and participating in physical activities, which can result in school absenteeism and overall poor health in adult life (Roth-Isigkeit 2005; Wilson 2010).

The experience of persistent pain in childhood may have important consequences in adult life. Children with chronic pain have an increased likelihood of developing other painful conditions in adulthood, such as back pain, headaches, and abdominal pain (Dunn 2011; Harreby 1995). For example, children who experience low back pain in adolescence are 3.5 times more likely to experience the condition in adult life (Hestbaek 2006). Other adverse consequences in adulthood for children who suffer from musculoskeletal pain include higher risk of obesity (Paulis 2014), smoking (Shiri 2010), mental health disorders (Hainsworth 2012; Noel 2016), and increased risk of suicide (van Tilburg 2011).

Description of the intervention

Chronic musculoskeletal pain in children is most commonly managed with conservative treatments (Kamper 2016a). Among the most commonly used interventions are physical activity (including exercise) and education about physical activity. In people with chronic pain, physical activity and education can be delivered independently or in combination, to address the complexity of symptoms in people with chronic pain (Friedrichsdorf 2016).

Physical activity

Physical activity is defined as any bodily movement produced by skeletal muscles that results in energy expenditure. It can be categorised into occupational, sports, conditioning, household, or other activities. It includes all forms of activity, such as daily walking or cycling, active play, active recreation (e.g. working out in a gym, kayaking), dancing, gardening, or playing active games, exercise, and organised and competitive sports (WHO 2019). Exercise is considered a subset of physical activity that is planned, structured, and repetitive, and has a final or an intermediate objective of improvement or maintenance of physical fitness (i.e. attributes that are either health- or skill-related), which can be performed with or without supervision (Caspersen 1985; Stay Active Report 2011).

Education about physical activity

Education is a mainstay of medical care. Education related to physical activity can be defined as the process of providing information with the aim to increase knowledge and understanding about physical activity, sedentary behaviour, or lifestyle, in order to build a person's internal resources to maintain participation in their valued activities and avoid inactivity. This can be delivered by healthcare professionals, parents, and caregivers (after previous training), or via printed materials (e.g. booklet, folder) or telecommunication networks (e.g. website, app (Dobbins 2013)).

How the intervention might work

Physical activity

While mechanisms of effect in musculoskeletal pain are not well understood for physical activity interventions, several theoretical models have been proposed including cognitive, behavioural, and biomechanical models. There is evidence that exercise and physical activity act on physical and psychological mechanisms to reduce pain and disability (e.g. fear-avoidance belief model). These may have an influence on the cognitive level by reducing fear and anxiety related to pain and movement, and build physical strength and endurance (Smith 2018). Supervised exercise has been reported to be an effective intervention to reduce pain compared with no treatment (Kamper 2016b; Michaleff 2014); however, the certainty of evidence related to physical activity interventions is low (Kamper 2016b).

Education about physical activity

Educational interventions are often based on theoretical models that promote changes in behaviour to obtain the benefits of physical activity (Dobbins 2013). The social cognitive theory is one of the most used models in educational interventions (Dobbins 2013). It purports that motivations and actions are controlled by thought, and behaviour change occurs when an individual anticipates an outcome (Bandura 1982; Dobbins 2013). The health-belief model is also used to develop educational interventions; it considers that changes in behaviour are affected by the perceived susceptibility of developing health problems and the belief that behaviour change will be beneficial in avoiding the health problem (Dobbins 2013; Hochbaum 1958; Rosenstock 1966). Recent studies show that educational interventions may be effective in improving knowledge about pain, but by themselves, have limited or no effect on reducing pain intensity (Lynch-Jordan 2014). Educational interventions aimed at increasing knowledge and understanding of physical activity have the potential to benefit children and adolescents with chronic musculoskeletal pain due to their lower level of physical activity (Friedrichsdorf 2016; Kamper 2016b; Wilson 2012). Physical activity combined with education about

physical activity are more likely to be effective in reducing pain when compared with home exercise, advice, or no treatment (Kamper 2016b).

Why it is important to do this review

Chronic musculoskeletal pain is a prevalent condition during childhood, and has a negative impact on the lives of children and adolescents. Chronic musculoskeletal pain is usually managed with physical activity or education about physical activity, or both, and most commonly, these approaches are delivered as part of a complex intervention (i.e. multicomponent interventions). To date, one high-quality systematic review has analysed physical activity versus control, but there is no high-quality synthesis of evidence on education about physical activity (Fisher 2021). Thus, a Cochrane Review is needed to inform clinicians, children and adolescents with chronic pain, their parents and caregivers, and policy makers on the effects of physical activity versus control, and education about physical activity versus control.

OBJECTIVES

To evaluate the effectiveness of physical activity, education about physical activity, or both, compared with usual care (including waiting-list, and minimal interventions, such as advice, relaxation classes, or social group meetings) or active medical care in children and adolescents with chronic musculoskeletal pain.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) or cross-over controlled trials that delivered physical activity or education about physical activity, or both, to children and adolescents with chronic musculoskeletal pain. RCTs are the best design to minimise bias when evaluating the effectiveness of an intervention. Cross-over trials are adequate to evaluate interventions with a temporary effect in the treatment of chronic conditions. We excluded studies that were not randomised, including quasi-randomised trials, controlled trials, case series, abstracts, and letters, unless they provided additional information from published RCTs and cross-over controlled trials.

Types of participants

We considered studies that included children and adolescents of school age (4 years to 18 years) with any chronic musculoskeletal pain (e.g. neck or back pain, shoulder pain, knee pain, widespread pain/fibromyalgia, neuropathic pain, complex regional pain syndrome, and juvenile idiopathic arthritis). Chronic pain was defined as any pain that lasted more than three months. We included studies on children and adolescents with musculoskeletal pain and other pain complaints (e.g. back pain and headache). We included studies of children and adolescents with mixed pain conditions (e.g. headache and abdominal pain) if data for chronic musculoskeletal pain were available separately, or if they corresponded to at least 75% of the sample. We included studies of mixed populations of children and adults if the study presented data for children or adolescents separately. We excluded studies that included participants with cancer-related pain, or isolated headaches, migraine, or visceral (e.g. abdominal) pain. We excluded studies that included participants receiving palliative care.

Types of interventions

We included studies of interventions involving physical activity or education about physical activity, or both, as a key component. We considered educational interventions related to physical activity, sedentary behaviour, and lifestyle. The educational intervention was delivered as a standalone intervention and not as part of another intervention. For example, we did not include education that formed part of a broader psychological intervention (e.g. cognitive behavioural therapy, acceptance, or commitment therapy), or was part of a neuroscience pain education intervention. Information was delivered by healthcare professionals, parents or caregivers (after previous training), or via printed materials (e.g. booklet, folder) or media (e.g. website). We excluded multicomponent interventions in which physical activity was combined with another intervention, and the effect of physical activity could not be isolated from the other intervention (e.g. physical activity and diet compared with usual care).

Comparators

We included studies in which the comparison group was provided with usual care (including waiting-list and minimal interventions, such as advice, relaxation classes, or social group meetings), or active medical care. We also included studies in which multiple participant groups received the same non-exercise treatment, for example, physical activity plus usual care compared with usual care alone. In our review, we considered usual care as the main comparison group, because there is no accepted standardised treatment in this field that could be used as a control comparator. Any interventions tested in this review lie outside current usual care practices. As an under-treated population, it was likely that usual care included minimal intervention. We also believed that usual care would be the comparison group most used in studies, providing larger homogeneity for our primary comparison. It was also most similar to practice, therefore, providing the most useful clinical comparison.

Types of outcome measures

We extracted outcomes at the postintervention assessment (i.e. the first assessment point after end of treatment, no later than three months), and long-term follow-up (closest to 12 months after the intervention).

All outcomes were to be measured using an instrument with acceptable validity tested in a population of children and adolescents.

Primary outcomes

- Pain intensity, measured using a visual analogue scale (VAS), numerical rating scale (NRS), verbal rating scale, questionnaire, or Likert scale. We also considered other pain assessments that were commonly used for young age groups, such as facial or verbal expression, movements, posture, and interaction with the environment.
- Disability, measured using a self-reported outcome measure, including generic and condition-specific measurement tools (e.g. Functional Disability Inventory, PedsQL)
- Adverse events (incidence and nature)

Secondary outcomes

- Depression (e.g. Children's Depression Inventory)
- Anxiety (e.g. Revised Child Anxiety and Depression Scale)
- Fear avoidance (e.g. Fear of Pain Questionnaire Child)
- Quality of life (e.g. Pediatric Quality of Life Inventory)
- Physical activity level (measured objectively, i.e. accelerometers or pedometers, or self-reported with validated questionnaires)
- Caregiver distress (e.g. Caregiver Well-Being Scale)

Search methods for identification of studies

Electronic searches

With assistance from the Cochrane Pain, Palliative and Supportive Care (PaPaS) Review Group, we searched the following databases, with no restrictions placed on language or year of publication.

- The Cochrane Central Register of Controlled Trials (CENTRAL; 2022, Issue 10) in the Cochrane Library (searched 13 October 2022; Appendix 1);
- MEDLINE OvidSP (1946 to 13 October 2022; Appendix 2);
- Embase OvidSP (1980 to 2022 week 41; Appendix 3);
- CINAHL EBSCO (Cumulative Index to Nursing and Allied Health Literature; 1981 to 13 October 2022; Appendix 4);
- PsycINFO Proquest (1806 to 13 October 2022; Appendix 5);
- PEDro (Physiotherapy Evidence Database; www.pedro.org.au; 1929 to 19 October 2022; Appendix 6);
- LILACS Birme (Latin American and Caribbean Health Sciences Literature; lilacs.bvsalud.org/en/; 1986 to 19 October 2022; Appendix 7).

We used a combination of MeSH terms or equivalent and text word terms related to the health conditions (e.g. musculoskeletal pain, chronic pain, fibromyalgia, etc), the participants (e.g. adolescent, child, teenage, etc), and intervention type (e.g. exercise, health education, physical education, etc). We tailored searches to individual databases.

Searching other resources

We searched ClinicalTrials.gov and the World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP: apps.who.int/trialsearch) for ongoing studies. We checked reference lists of reviews identified in the searches and retrieved articles for additional studies. We also contacted study authors for additional information, when necessary.

Data collection and analysis

Selection of studies

Two review authors (MNL and PVS) independently determined eligibility by reading the title and abstract of each report identified by the search. They eliminated reports that clearly did not meet the inclusion criteria, and obtained full copies of the remaining reports. Any disagreements that could not be resolved by discussion between the two review authors doing the initial screening were arbitrated by a third review author (TY). Two review authors (MNL and PVS) independently read the full-text reports that were selected, to identify eligible studies. They resolved any conflicts by discussion; in the event of disagreement, a third author adjudicated. We included a PRISMA flow chart, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2022; Moher 2009).

Data extraction and management

Two review authors independently extracted data using a standardised piloted form, and checked for agreement before entry into Review Manager 5 (RevMan 5 (Review Manager 2020)). In the event of disagreement, a third author adjudicated (TY). We extracted the following information.

- Bibliometric data (authors, year of publication, language)
- Study characteristics (study design, sample size, description of the sample, country, recruitment year(s) and procedure, conflict of interest, funding source)
- Characteristics of the participants (gender, age, condition, duration of pain)
- Description of the interventions (experimental and control), according to the TIDieR checklist (Hoffmann 2014; Yamato 2018; Appendix 8)
- Duration of follow-up
- Outcome measures of interest
- Time periods of outcome assessment

We collated multiple reports of the same study, so that each study rather than each report was the unit of interest in the review. We collected characteristics of the included studies in sufficient detail to populate a Characteristics of included studies table.

Assessment of risk of bias in included studies

Two review authors (MNL and PVS) independently assessed risk of bias for each study, using the criteria outlined in the *Cochrane Handbook* (Higgins 2017). Disagreements were resolved by discussion or a third review author. We completed the risk of bias table for each included study, using RoB 1.

For each study, we assessed the following:

- Selection bias
  - Random sequence generation: we assessed the method used to generate the allocation sequence as: low risk of bias (any truly random process, e.g. random number table; computer random number generator); unclear risk of bias (method used to generate sequence not clearly stated). We excluded studies using a non-random process (e.g. alternation, odd or even date of birth; hospital or clinic record number).
  - Allocation concealment: the method used to conceal allocation to interventions prior to assignment determines whether intervention allocation could have been foreseen in advance of or during recruitment, or changed after assignment. We assessed the methods as: low risk of bias (e.g. telephone or central randomisation; consecutively numbered, sealed, opaque envelopes); unclear risk of bias (method not clearly stated). We excluded studies that did not conceal allocation (e.g. open list).
- Performance bias
  - Treatment expectations: it is often not possible to blind study participants and personnel in pragmatic studies that evaluate physical activity interventions. Therefore, following PaPaS Review Group guidance, we assessed treatment expectations between groups at baseline. We considered

studies to have low risk of bias if they reported expectations or treatment credibility between groups as equal. We considered studies to have high risk of bias when differences were reported in studies between groups; and rated studies as unclear risk of bias when studies did not describe baseline expectations between treatment and control group.

- Detection bias
  - Blinding of outcome assessment: we assessed the methods used to blind outcome assessors from knowledge of which intervention a participant received. We assessed the methods as: low risk of bias (study had a clear statement that outcome assessors were unaware of treatment allocation, and ideally described how this was achieved); unclear risk of bias (study stated that outcome assessors were blind to treatment allocation but lacked a clear statement on how it was achieved); high risk of bias (outcome assessors were not blinded to group allocation or study did not provide information on blinding of outcome assessors). We considered studies to have unclear risk of bias for self-reported outcomes, since participants could not be blinded.
- Attrition bias
  - Incomplete outcome data: we assessed attrition bias by considering whether participant dropout rate was appropriately described and acceptable: low risk of bias (less than 10% dropout and appeared to be missing at random; numbers given per group and reasons for dropout described); unclear risk of bias (less than 20%, but reasons not described and numbers per group not given; unclear that data were missing at random); high risk of bias (over 20%, even if imputed appropriately).
  - Intention-to-treat analysis: we assessed whether participants were analysed in the group to which they were allocated as: low risk of bias (if analysed data in group to which originally assigned with appropriately imputed data, or as an available-case analysis); unclear risk of bias (insufficient information provided to determine if analysis was per protocol or intention-to-treat); high risk of bias (if per-protocol analysis used; when available data were not analysed, or participant data were not included in group to which they were originally assigned).
- Reporting bias
  - Selective reporting: we assessed whether primary and secondary outcome measures were prespecified (e.g. study protocol, study registry), and whether they were consistent with those reported: low risk of bias (study protocol available and all prespecified outcomes of interest adequately reported; study protocol not available, but all expected outcomes of interest adequately reported; all primary outcomes numerically reported, with point estimates and measures of variance for all time points); high risk of bias (no protocol publicly available); unclear risk of bias (no mention of protocol, and published report did not include enough information to make a judgement).
- Other sources of bias
  - Groups' similarity at baseline (potential bias arising by chance with random allocation): low risk of bias (groups were similar at baseline for demographic factors, duration and severity of complaints, and value of main outcome measures); unclear risk of bias (not enough information about baseline factors); high risk of bias (groups were clearly different at baseline for the most important prognostic factors).

Measures of treatment effect

We analysed pain intensity, presented on a continuous scale from 0 to 100, as a mean difference (MD) with 95% confidence interval (CI). For the other continuous outcomes (e.g. disability, quality of life), we quantified the treatment effects with a standardised mean difference (SMD) and 95% CI, as studies often used different measurement scales to assess these outcomes. We considered between-group differences of at least 10% of the scale as clinically important (Busse 2015; Saragiotto 2016). To facilitate interpretation, we also translated the pooled SMD values to the equivalent in commonly used scales, using the standard deviation reported in the included studies.

For dichotomised data (responder analyses), we considered the analyses based on a 30% or greater reduction in pain intensity to represent a moderately important benefit, and a 50% or greater reduction in pain intensity to represent a substantially important benefit, as suggested by the PEDIMMPACT guidelines (McGrath 2008). In such cases, we calculated the risk ratios (RR), and number needed to treat for an additional beneficial outcome (NNTB) for positive outcomes. We calculated dichotomous outcomes (e.g. adverse events) using RR and 95% CI.

Unit of analysis issues

We considered randomisation at the individual level. To deal with repeated observations on participants, we followed the strategy of defining the outcomes (stated previously) and the time points a priori (Higgins 2022). We planned to include studies that included multiple treatment arms; if there was a shared group, we planned to split this to include two or more (reasonably independent) comparisons, as indicated.

We did not identify any cross-over or cluster-RCTs in this review. We planned to analyse their data according to recommendations in the *Cochrane Handbook* (Higgins 2022a).

Dealing with missing data

We contacted authors to request necessary data that were not reported, or were unclear in the manuscript. If data were reported as a median and interquartile range (IQR), we assumed that the median was equivalent to the mean, and the width of the IQR was equivalent to 1.35 times the standard deviation (Higgins 2022). We also estimated data from graphs, if they were not presented in tables or text. If any information regarding standard deviations was missing, we calculated them from confidence intervals or standard errors (if available) from the same study. If no measure of variability was presented anywhere in the text, we estimated the standard deviation from the most similar study in the review, taking into consideration the study population, size, and the risk of bias.

Assessment of heterogeneity

We assessed heterogeneity by visually inspecting the forest plots (e.g. overlapping confidence intervals), and more formally with the Chi^2 test and the I^2 statistic, as recommended in the *Cochrane Handbook* (Higgins 2022). We interpreted heterogeneity as:

- 0% to 40%; might not be important;
- 30% to 60%; may represent moderate heterogeneity;

- 50% to 90%; may represent substantial heterogeneity;
- 75% to 100%; considerable heterogeneity.

Assessment of reporting biases

We performed comprehensive searches to reduce the possibility of reporting biases. We planned to use funnel plots to visually explore the likelihood of reporting biases if we included at least 10 studies in the meta-analysis, and included studies differed in size; and we would have used Egger's test to detect possible small-study bias. We did not add any language restriction to our search strategy to avoid potential language bias.

Data synthesis

We planned to conduct the following comparisons at postintervention (i.e. the first assessment point after the end of treatment, and no later than three months) and at follow-up (closest to 12 months after the intervention).

- Physical activity compared with usual care or active medical care
- Education compared with usual care or active medical care
- Physical activity and education compared with usual care or active medical care

However, due to the limited number of included studies, it was not possible in this review; we will perform this in future updates if more data become available.

We combined the results from individual studies through meta-analysis, using random-effects models. We preferred intention-to-treat analysis over per-protocol or as-treated analysis. Because the type of control is important when determining the estimate of effect, we analysed physical activity, education about physical activity, or physical activity and education using the comparator used in the study.

Subgroup analysis and investigation of heterogeneity

We intended to conduct separate subgroup analyses for the type of intervention and conditions, using the following subgroup definitions.

- Exercise programme (aerobic, strengthening, stretching, coordination, mixed) compared with usual care; active medical care; and waiting-list control, for both postintervention and long-term follow-up
- Region of pain (e.g. spinal, limb, multi-site, widespread/fibromyalgia)
- Specific diagnoses (e.g. juvenile idiopathic arthritis)

We only considered subgroup analyses on primary outcomes, and if sufficient data were available. Due to a limited number of included studies, this was not possible, but we plan to perform these in future updates, if sufficient data are available.

Sensitivity analysis

We planned to perform sensitivity analyses to assess the influence of risk of bias on the overall estimates of treatment effects, by including only studies with overall low or unclear risk of bias for the primary outcomes (i.e. low, or unclear risk of bias for all key domains).

We intended to performed sensitivity analysis by sample size, including studies with at least 50 participants per arm, or 100 in total (Geneen 2017). This was not possible due to a limited number of included studies, but we plan to perform these in future updates, if sufficient data are available.

Summary of findings and assessment of the certainty of the evidence

We included summary of findings tables, as recommended in Section 14.1.1 of the *Cochrane Handbook* (Higgins 2022). We planned to summarise the results in six tables reflecting the six main comparisons in this review:

- physical activity compared with usual care;
- education compared with usual care;
- physical activity plus education compared with usual care;
- physical activity compared with active medical care;
- education compared with active medical care; and
- physical activity plus education compared with active medical care.

However, due to a limited number of included studies, we only included three summary of findings tables for physical activity, education, and physical activity plus education compared with usual care. We plan to include summary of findings for the other comparisons in future updates, if data are available.

We included the following post-treatment outcomes: pain intensity; disability; adverse events; depression; anxiety; and quality of life. We included key information on the certainty of evidence, the magnitude of effect, and the sum of available data on the outcomes.

Two review authors (MNL and PVS) independently rated the certainty of the evidence for each outcome using the GRADE approach, as recommended in the *Cochrane Handbook* (Higgins 2022).

The GRADE approach uses five domains (risk of bias, inconsistency, indirectness, imprecision, and publication bias) to assess the certainty of the body of evidence. We used these guidelines to guide our assessment.

- Study design and risk of bias (downgraded if more than 25% of the participants were from studies with a high risk of bias (one or more bias domains judged as high risk of bias, except performance bias))
- Inconsistency of results (downgraded if significant heterogeneity was present by visual inspection, or if the I^2 value was greater than 50%)
- Indirectness (generalisability of the findings; downgraded if more than 50% of the participants were outside the target group)
- Imprecision (downgraded if fewer than 400 participants were included in the comparison for continuous data, or there were fewer than 300 events for dichotomous data (Mueller 2007)
- Publication bias (downgraded if we identified studies not published due the results or outcomes; downgraded if selective reporting was observed through visual inspection by funnel plots)

We downgraded the evidence by one (−1) or two (−2) if we identified:

- serious (−1) or very serious (−2) limitations to study quality (risk of bias);
- serious (-1) or very serious (-2) inconsistency across studies;
- some (−1) or major (−2) uncertainty about indirectness of evidence;
- serious (-1) or very serious (-2) imprecise data;
- high probability of the presence of publication bias (−1).

We considered evidence based on single studies with fewer than 400 participants, for either continuous or dichotomous outcomes to be inconsistent and imprecise. Therefore, they provided low-certainty evidence, which was downgraded to very low-certainty evidence if there were further limitations (Montori 2005; Saragiotto 2016).

We used these statements to describe the level of certainty in the results for each outcome.

- High: we are very confident that the true effect lies close to that of the estimate of the effect
- Moderate: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different
- Low: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect
- Very low: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

Results of the search

We retrieved a total of 1107 records through database searching. After we removed duplicates, we screened a total of 1084 titles and abstracts, and selected 59 for full-text assessment. We included four studies (five publications, N = 243 participants (Sandstedt 2013; Sieczkowska 2022; Takken 2003; Tarakci 2012)), three ongoing studies (ACTRN12616000665437; NCT05114343; NCT05220384), and one study is awaiting classification (Stavrakidou 2018); we excluded 50 records (Figure 1).

Figure 1.

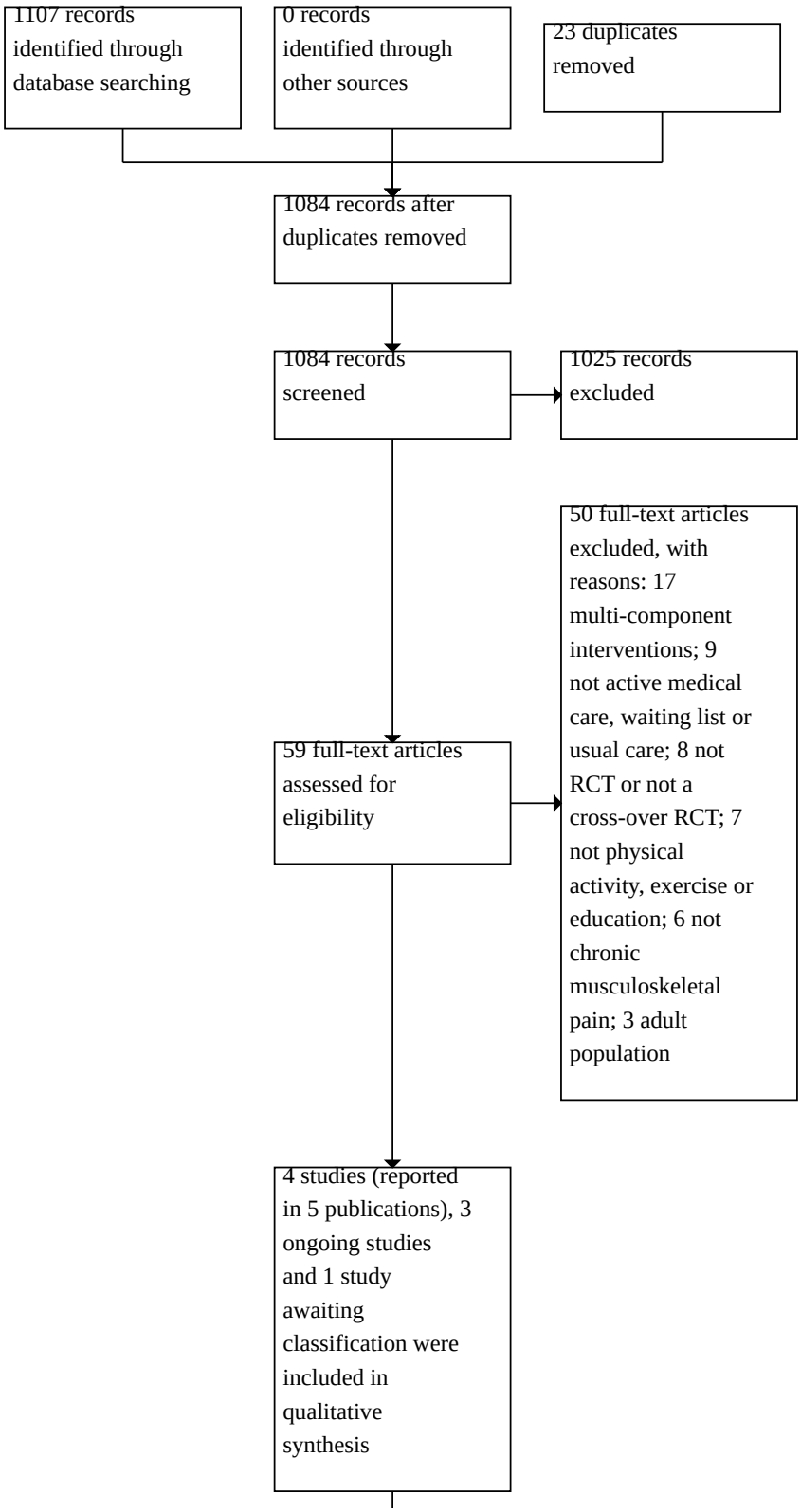
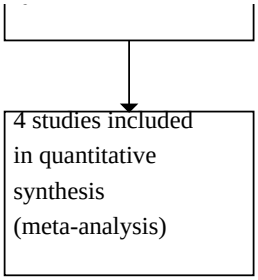


Figure 1. (Continued)



Included studies

See Characteristics of included studies.

We included a total of 243 participants enroled in four studies in this review (Sandstedt 2013; Sieczkowska 2022; Takken 2003; Tarakci 2012). One study reported data in two publications from a single randomised controlled trial (Sandstedt 2013). All four included studies were randomised controlled trials (RCT). We did not find any cross-over controlled trials. Individual study sample sizes ranged from 54 to 93 participants (mean = 60.8, SD = 25.3).

Settings

One study was conducted in Sweden, one in Brazil, one in the Netherlands, and one in Turkey. Three studies were conducted in outpatient clinics; one study did not report information about care settings.

Population

All studies included children and adolescents of both sexes (female = 148; male = 71). One study reported different information in the text and the tables regarding the number of female and male participants (Sandstedt 2013). We contacted the authors twice with no success, therefore, we used the data presented in the study tables.

The participants ranged between 5 years and 21 years (mean = 11.6 years, standard deviation (SD) = 2.6 years).

All studies included children and adolescents with juvenile idiopathic arthritis. None of the studies reported the duration of pain (in months) for the chronic musculoskeletal pain condition. Two studies specified the use of medication to manage the juvenile idiopathic arthritis in the inclusion criteria.

The included studies had specific exclusion criteria. These criteria involved conditions such as cardiovascular involvement, chronic diseases, and lack of exercise prior to and during the study. Some studies also excluded individuals with specific medical conditions, inability to cooperate, or those engaging in certain activities during the study period.

The proportion of dropouts varied from 2% to 25% of participants (mean = 11.5%; SD = 10.16%). The main reasons for dropouts were personal reasons, stopped the training programme, not attending the assessment, and dislike of the treatment.

Recruitment

The recruitment period of the included studies ranged from 2004 to 2020. One study did not report any data regarding the recruitment period. Three studies recruited participants from outpatient clinics of the universities and hospitals, and one study sent letters to children with juvenile idiopathic arthritis.

Interventions and comparators

See Table 1 for a summary of the description of interventions and control groups.

We used the TIDieR checklist to assess the report of the interventions. In general, all the included studies reported a brief name and provided a rationale of the intervention. Only one study reported evaluating adherence or fidelity, however, it did not present data for these outcomes (Appendix 8). Some TIDieR items were not applicable for studies whose control groups were assessment only or waiting list.

The studies included several types of physical activities, including physical exercise with visual instructions; supervised exercises with online contents, such as videos and GIFs; aquatic exercises; and home-based exercises involving range of motion, strengthening, and stretching. The duration of the treatments ranged from three to six months, and none of the studies mentioned the use of a specific theory in designing the interventions. Physical therapists delivered most of the interventions in both the intervention and control groups in outpatient clinics.

Physical activity

Included studies provided data for one comparison, which is physical activity compared with usual care (including waiting list and minimal interventions (Sandstedt 2013; Sieczkowska 2022; Takken 2003; Tarakci 2012)). Sandstedt 2013 conducted a 12-week exercise programme using pictures, instructions, and an exercise diary. It included jumps, muscle strength, core exercises, and was performed in 20 minutes, three times a week. Sieczkowska 2022 conducted a 12-week home-based exercise programme, combining aerobic and bodyweight exercises. Online supervision was provided for one weekly session, while the other two weekly sessions were unsupervised. The exercises were modified every four weeks, and participants received instructional videos, photos, and GIFs. Takken 2003 conducted a 6-month exercise programme with small groups in heated pools, focusing on 60-minute aerobic sessions once a week. Physical therapists delivered the programme face-to-face in an outpatient clinic. Tarakci 2012

evaluated a 12-week individual exercise programme involving range of motion, strengthening, stretching, posture exercises, and functional activities. Physical therapists delivered supervised and unsupervised sessions lasting 45 minutes, three times a week in an outpatient clinic.

Education about physical activity

We did not find any studies that evaluated the effectiveness of education about physical activity in children and adolescents with chronic musculoskeletal pain.

Physical activity and education about physical activity

We did not find any studies that evaluated the effectiveness of physical activity and education about physical activity in children and adolescents with chronic musculoskeletal pain.

Duration of treatments

The duration of the treatments ranged from three to six months (mean = 4.5 months, SD = 1.7) and the mean duration of the treatment sessions was 42 minutes (SD = 20.2). Two studies had a duration of treatment of six months, and two studies had a duration of treatment of three months. Only one study conducted a follow-up assessment, six months after the end of the treatment. All studies provided treatment between once and four times a week. One study conducted a remote intervention, one study conducted a face-to-face intervention, and one study conducted a mixed intervention involving face-to-face sessions and unsupervised sessions at home. One study did not provide any information regarding the method to conduct the intervention.

Adherence

We assessed adherence according to items 11 and 12 of the TIDieR checklist. Only one of the included studies reported a definition or specific mention for adherence in their methods or results. Adherence to the intervention was assessed using diaries. Supervised sessions were evaluated immediately by the trainer, and unsupervised sessions were evaluated through feedback immediately after the completion of the training session.

Pain intensity

Two studies measured pain intensity. One study used a 10 centimetres visual analogue scale (VAS), and the other study reported using a domain of the Child Health Assessment Questionnaire to measure pain using a 100 centimetres VAS. We assumed that this was likely a reporting error and they actually used a 100 mm scale. We converted all measures to a 100-point scale.

Disability

All the included studies measured disability using the Child Health Assessment Questionnaire. One study also used the Juvenile Arthritis Functional Assessment Scale, which provided a performance time for each task for further measurement of disability that was not included in the meta-analyses.

Adverse events

None of the included studies measured the occurrence or nature of adverse events.

Studies that reported quality of life and physical activity are described below. We did not identify any studies evaluating depression, anxiety, fear avoidance, and caregiver distress.

Quality of life

All studies measured quality of life. Two studies used the Pediatric Quality of Life Inventory; one study used the Child Health Questionnaire; and one study used the Juvenile Arthritis Quality of Life Questionnaire.

Physical activity level

None of the studies measured physical activity levels. However, three studies measured activity levels using the 6-minute walking test, and the Step Test. Due to the differences among the instruments, we did not perform a meta-analysis for this outcome.

Follow-up

All the included studies provided data at post-intervention. One included study in the meta-analyses assessed outcomes (disability and quality of life) at long term follow-up, six months after the end of the treatment (Sandstedt 2013).

Funding sources

Among the four included studies, one study reported funding sources by research foundations), and one study reported receiving no financial support for the research. The other two studies did not provide information regarding funding sources.

Conflict of interest

The authors of the four included studies reported having no conflicts of interest while conducting the studies.

Excluded studies

See Characteristics of excluded studies.

We excluded 50 studies during full text screening, with the following reasons: 17 studies delivered multicomponent interventions (Andias 2018; Andias 2022; Armbrust 2015; Armbrust 2016; Dekker 2016; Dissing 2016; Eid 2016; Elnaggar 2016; Epps 2005; Ibrahim 2020; Kashikar-Zuck 2018; Lelieveld 2010; O'Higgins 2019; Schulz 2014; Shear 2022; Stinson 2010; Sunthornsup 2021); nine studies did not fulfil the inclusion criterion for the comparator group (Arman 2019; Azab 2022; Aziz 2017; Baydogan 2015; Elnaggar 2021; Mendonça 2013; Singh-Grewal 2007; Stephens 2008; Zapata 2015); eight studies were not randomised controlled trials or cross-over controlled trials (Bayraktar 2019; Blitz 2017; Catania 2017; Hornsby 2019; Leininger 2017; Singh-Grewal 2006; Takken 2008; Østlie 2011); seven studies did not have physical activity or education about physical activity as an intervention group (Connelly 2019; El Miedany 2019; Hechler 2014; Kashikar-Zuck 2013; Kisling 2021; Shaygan 2021; Tarakci 2020); six studies did not fulfil the inclusion criteria for children and adolescents with chronic musculoskeletal pain (Baadjou 2014; Batistão 2019; Budde 2018; Hicks 2006; Horsak 2019; Lalloo 2022); and three studies involved only adults (Ammerlaan 2017; Moretti 2016; Prado 2021).

Studies awaiting classification

One study protocol did not provide sufficient information to assess its eligibility; therefore, we classified it as awaiting classification (Stavrakidou 2018).

Ongoing studies

See Characteristics of ongoing studies.

We identified three studies through the Trials Registry searches (ACTRN12616000665437; NCT05114343; NCT05220384). After contacting the authors to request data from one study that appeared to be finished, they confirmed that the study was still ongoing, due to a delay in recruitment caused by the COVID-19 pandemic. The other two protocols had start dates in 2021 and 2022. The studies are being conducted in Australia, Brazil, and Hungary, and are considering including children and adolescents with juvenile idiopathic arthritis and other chronic pain conditions.

Risk of bias in included studies

The risk of bias assessments for the individual studies are summarised in Figure 2 and Figure 3.

Figure 2. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies

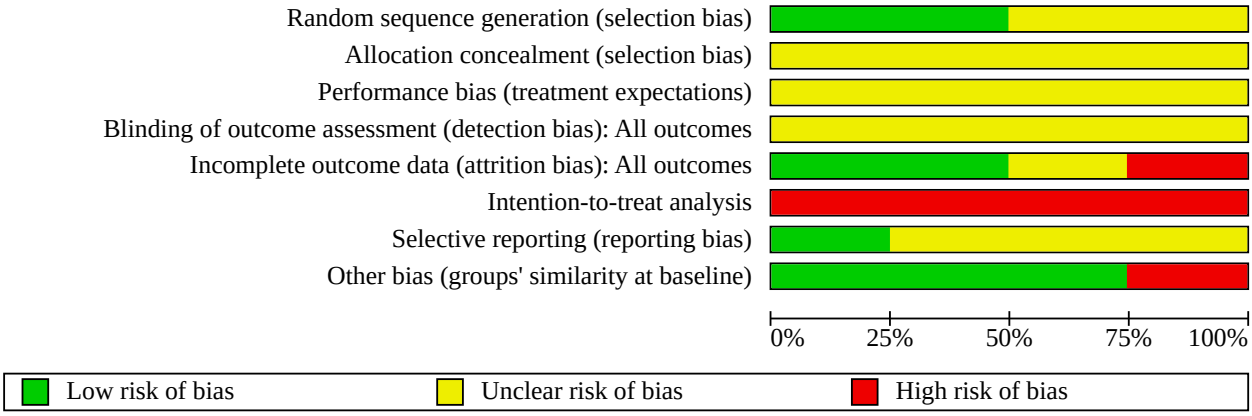
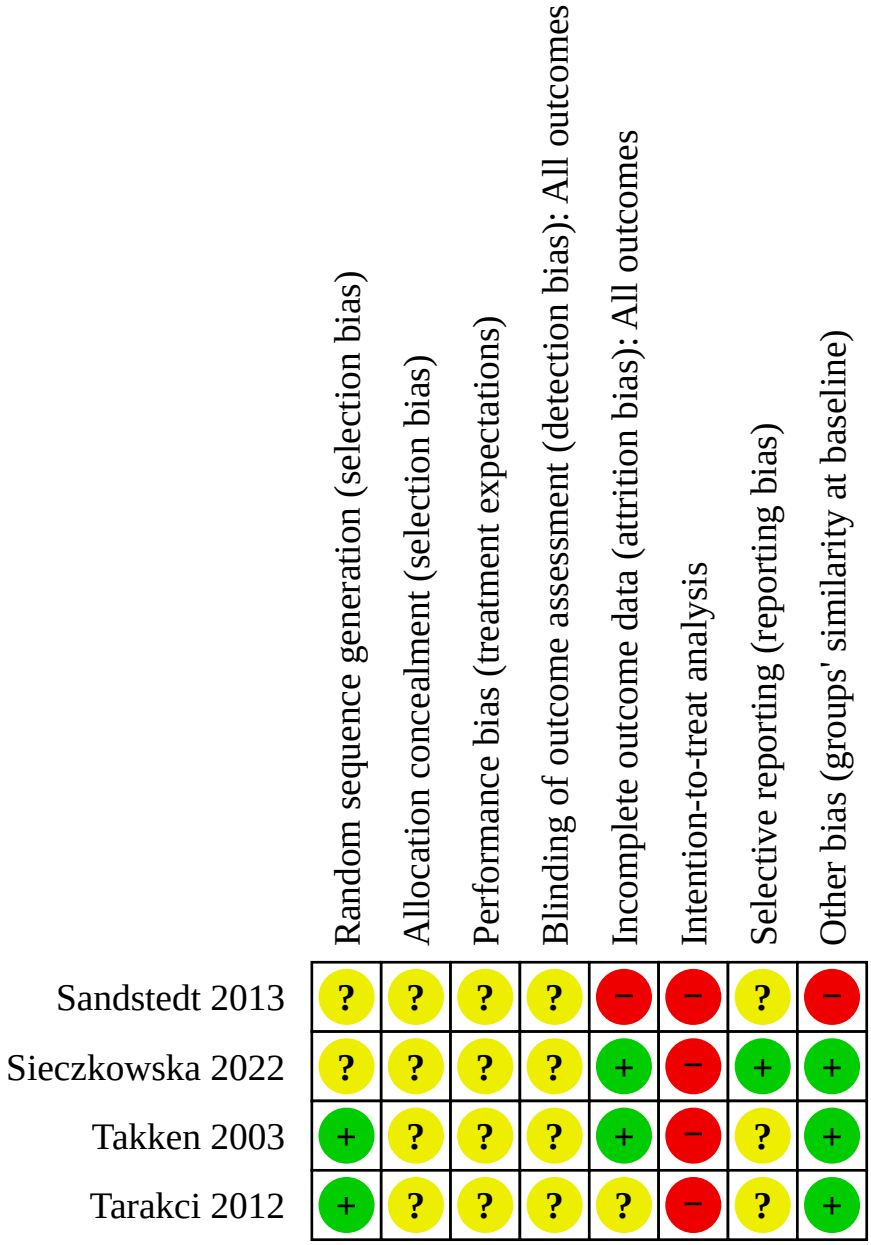


Figure 3. Risk of bias summary: review authors' judgements about each risk of bias item for each included study



Allocation

Random sequence generation

We rated two studies at low risk of bias for this domain (Takken 2003; Tarakci 2012). The remaining two studies did not provide enough information about the method used for the random sequence, and we rated them as unclear risk of bias.

Allocation concealment

We rated all four studies as unclear risk of bias, because they did not provide enough information to rate the method used for allocation.

Blinding

Treatment expectations (performance bias)

None of the included studies formally assessed treatment expectations between groups at baseline, and therefore, we rated all studies as unclear risk of bias.

Blinding of outcome assessment (detection bias)

Three studies provided information about blinding assessors and blinding the researchers responsible for administering assessments (Sandstedt 2013; Takken 2003; Tarakci 2012). One study did not provide enough information on this criterion (Sieczkowska 2022). However, most of the outcomes assessed were patient-reported, thus the participants were the assessors. Since it was not possible to blind the participants, we rated all four studies as 'unclear risk of bias'.

Incomplete outcome data

Incomplete outcome data

All the included studies provided information about incomplete outcome data. Two studies had less than 10% missing data, and we rated them as low risk of bias (Sieczkowska 2022; Takken 2003); one study had less than 20% missing data, but we rated it as unclear risk of bias, since the reasons for missing data were not presented (Tarakci 2012); and one study exceeded the maximum rate of 20% missing data, so we rated it at high risk of bias (Sandstedt 2013).

Intention-to-treat analysis

We judged all studies as 'high risk of bias' because all of them used a per-protocol analysis as the method for analysing the data (Sandstedt 2013; Sieczkowska 2022; Takken 2003; Tarakci 2012).

Selective reporting

Only one study registered in a clinical trial registry; we judged it at low risk of bias (Sieczkowska 2022). We judged the remaining three studies at unclear risk of bias, since none of them published a study protocol or registered the RCT on a publicly available registry, and there was not enough information to make a decision whether the studies included all expected outcomes.

Other potential sources of bias

Groups' similarity at baseline

One study showed differences between the groups at baseline for the disease onset of juvenile idiopathic arthritis, juvenile idiopathic arthritis subtype, and medication intake, so we rated it at high risk of bias since these variables could influence treatment effects (Sandstedt 2013). The other three studies did not show any differences between the groups at baseline, so we rated them at low risk of bias.

Effects of interventions

See: **Summary of findings 1** Summary of findings; **Summary of findings 2** Summary of findings; **Summary of findings 3** Summary of findings

Physical activity compared with usual care

See Summary of findings 1 for the effect of physical activity compared with usual care. All four studies were included in the meta-analyses. One of the included studies in the meta-analyses for this comparison did not provide SDs for the outcomes measured and did not provide comparative data that allowed the calculations of the SD (Sandstedt 2013). As recommended in Section 6.5.2.7 of the *Cochrane Handbook* (Higgins 2022), we imputed the missing SDs from the control group of the study with the lowest risk of bias in the same meta-analysis. Therefore, for pain intensity, we imputed SDs from Tarakci 2012; for disability, we imputed SDs from Takken 2003; and for quality of life, we imputed SDs from Sieczkowska 2022. As described in the methods section, a between-group difference of at least 10% of the scale was considered clinically important for continuous outcomes. We recalculated the results expressed as a standardised mean difference (SMD) to a mean difference (MD) by multiplying the SMD with the posttreatment SD of the control group from the study with the lowest risk of bias included in the same analysis. Therefore, for pain intensity, we used the SD from Tarakci 2012; and for quality of life, we used the SD from Sieczkowska 2022.

Primary outcomes

Pain intensity

There is very low-certainty evidence (downgraded twice due to very serious study limitations and once due to serious imprecision) that physical activity may reduce pain intensity compared with usual care at postintervention assessment (SMD -0.45, 95% confidence interval (CI) -0.82 to -0.08; P = 0.02, I^2 = 0%; 2 studies, 118 participants). This effect can be recalculated to an MD of -12.19 (95% CI -21.99 to -2.38; Analysis 1.1). Neither of the included studies reported pain intensity at long-term follow-up.

Disability

There is very low-certainty evidence (downgraded twice due to very serious study limitations and once due to serious imprecision) that physical activity may improve disability compared with usual care at postintervention assessment (MD -0.37, 95% CI -0.56 to -0.19; P = 0.00; I^2 = 0%; 3 studies, 170 participants; Analysis 1.2). There is very low-certainty evidence (downgraded twice due to very serious study limitations, once due to serious inconsistency, and once due to serious imprecision) that there is no clear difference of effect between physical activity and usual care at long-term follow-up (MD 0.13, 95% CI -0.4 to 0.66 P = 0.63; 1 study, 35 participants).

Adverse events

None of the included studies in this comparison reported adverse events.

Secondary outcomes

Depression

None of the included studies in this comparison reported depression.

Anxiety

None of the included studies in this comparison reported anxiety.

Fear avoidance

None of the included studies in this comparison reported fear avoidance.

Quality of life

We found very low-certainty evidence (downgraded twice due to very serious study limitations, once due to serious imprecision, and once due to serious inconsistency) that there is no clear difference between physical activity and usual care at postintervention assessment for quality of life, on a 0 to 100 scale (SMD -0.46, 95% CI -1.27 to 0.35; P = 0.27; I^2 = 86%; recalculated as MD -6.30, 95% CI -18.23 to 5.64; 4 studies, 201 participants; Analysis 1.3). At long-term follow-up, there is very low-certainty evidence (downgraded twice due to very serious study limitations, once due to serious inconsistency, and once due to serious imprecision) that there is no clear difference of effect between physical activity compared with usual care on quality of life (SMD 0.06, 95% CI -0.61 to 0.73; MD 0.90, 95% CI -8.59 to 10.39; P = 0.85; 1 study, 36 participants).

Physical activity level

We did not combine data for activity levels, but reported the results descriptively, due to the differences between the measurements instruments. Two studies measured activity levels using the 6-minute walking test (Takken 2003; Tarakci 2012). One of them reported an improvement for the physical activity group compared with usual care at post-intervention assessment (P = 0.6); however, when we calculated the effect size with a mean and standard deviation, we found inconclusive results between the groups (MD -14.8, CI -63.1 to 33.5; 1 study, 54 participants). The other study reported an improvement for the usual care group compared with the physical activity group at postintervention assessment (P < 0.001); however, we found inconclusive results between groups when we calculated the effect size with a mean and standard deviation (MD 5.7, CI -36.3 to 47.8; 1 study, 93 participants).

One study measured activity level with the step-test to assess heart rate, and the Borg scale (Sandstedt 2013). When we calculated the effect size with a mean value and standard deviation, we found inconclusive results between the two groups for heart rate (MD 4.5, CI -7.6 to 16.6; 1 study, 64 participants), and the perception of the Borg scale.

Caregiver distress

None of the included studies in this comparison reported caregiver distress.

Physical activity compared with active medical care

There was no evidence for the effectiveness of physical activity compared with active medical care.

Education about physical activity compared with usual care or active medical care

There was no evidence for the effectiveness of education about physical activity compared with usual care or active medical care.

Physical activity and education about physical activity compared with usual care or active medical care

There was no evidence for the effectiveness of physical activity and education about physical activity compared with usual care or active medical care.

DISCUSSION

Summary of main results

We are uncertain if physical activity reduces pain intensity (2 studies, 118 participants; very low-certainty evidence) or improves disability (3 studies, 170 participants; very low-certainty evidence) compared with usual care at postintervention assessment. We are uncertain if physical activity improves quality of life at postintervention assessment (4 studies, 201 participants; very low-certainty evidence). Due to the lack of follow-up data, we were unable to determine whether these effects were maintained. Adverse events, depression, anxiety, fear avoidance and caregiver distress were not assessed for physical activity compared with usual care.

We did not conduct comparisons for physical activity compared with active medical care, education about physical activity, or physical activity plus education compared with any control, since no studies were found evaluating these interventions.

Overall completeness and applicability of evidence

The included studies were conducted in the Netherlands, Turkey, and Sweden. It remains uncertain whether the results of this review could be extrapolated to low- and middle-income countries. The studies included children and adolescents older than five years, and all the studies included children and adolescents with juvenile idiopathic arthritis. Our results are exclusively for children and adolescents with juvenile idiopathic arthritis, potentially limiting the generalisability of our results to wider populations. The included studies had a greater number of female participants (n = 148), and although the reason for this sex predominance is still unknown, juvenile idiopathic arthritis is more prevalent in girls than boys, with a ratio of 6:1 (Cattalini 2019).

We used the TIDieR checklist to report the description of the interventions included in this review. In general, the quality of the description was poor. Most studies did not specify who delivered the interventions (or did not report whether the therapist received previous training); what materials were used to deliver the interventions; and how adherence and fidelity were measured, if at all. This would prevent interventions from being replicated by other studies, and presents potential barriers to their implementation in clinical practice.

There were few studies assessing chronic musculoskeletal pain in children and adolescents that fulfilled our inclusion criteria. Most of the excluded studies examined multicomponent interventions; interventions in which physical activity, or education about physical activity was not the key component, or was combined with psychological, or pain neuroscience education interventions. Therefore, it was not possible to assess the isolated effect of the interventions of interest in this review. Evaluating the effectiveness of multicomponent interventions would be a valuable contribution to the literature, as long as these complex interventions could be adequately characterised and described (e.g. PROFANE taxonomy). Some of the excluded studies were also lacking a comparator that met our inclusion criteria (i.e. the study design was equivalence, comparing two physical therapy treatments). We judged all the included studies as unclear or at high risk of bias (i.e. due to selection bias, treatment expectations, detection bias, intention-to-treat analysis, and reporting bias), and the content of the

interventions included a variety of approaches, such as pictures, hydrotherapy, and home exercises, and the comparators groups were considered as usual care.

There is limited evidence for the effectiveness of physical activity interventions in children and adolescents with chronic musculoskeletal pain for most outcomes at post-treatment assessment and follow-up. We did not find studies delivering education about physical activity or the combination of education plus physical activity interventions. The very low-certainty evidence of our findings means we have little confidence in the estimates of effects and further studies are likely to change effect estimates.

Quality of the evidence

Using the GRADE approach, we downgraded all outcomes to very low-certainty evidence. Most of the outcomes had very serious study limitations, serious inconsistency, and serious imprecision. The sample sizes of the included studies were small, with fewer than 100 participants per study. These studies often present limitations, such as inadequate statistical power or imprecision, which can compromise the reliability and generalisability of their findings. Small studies also tend to show larger treatment effects, potentially introducing bias into the overall effect estimates (Dechartres 2013; Nüesch 2010). When judging the risk of bias of the included studies, we rated most studies at low risk of bias for random sequence generation, and other bias (i.e. groups' similarity at baseline). We rated most studies as unclear risk of bias for allocation concealment, performance bias, blinding of outcome assessors, and incomplete outcome data (one high, one unclear, one low). However, due to the nature of the intervention, it was not possible to blind participants, and since most of the outcomes were self-reported, it was not possible to blind the assessor either. Finally, we rated most of the studies at high risk of bias for intention-to-treat analysis and selective reporting.

Potential biases in the review process

Publication bias could not be assessed using funnel plots because of the small number of included studies per comparison. Even so, we did not find any unpublished studies after inspecting clinical studies registries. Our threshold to establish clinically meaningful effects was somewhat arbitrary, since there is no current consensus. Clinicians, children and adolescents with chronic musculoskeletal pain, policy makers, and regulators also have different views on what constitutes clinically meaningful effects. In this review, we prespecified a 10% between-group difference as clinically important; however, even when the differences were potentially clinically important, our 95% confidence intervals showed a large range, which included values that may be not considered clinically important. There is no definition in the literature on what should be considered active medical care, and in this review, we considered treatments that differed from physical activity or exercises. This may have limited our inclusion for the comparison of active medical care.

Agreements and disagreements with other studies or reviews

The effects of physical activity interventions on chronic pain conditions, including osteoarthritis, fibromyalgia, low back pain, mechanical neck disorder, and patellofemoral pain have been investigated in adults. A systematic review that included more than 37,000 participants found that physical activity has positive effects on reducing pain, improving disability, and improving quality of life in adults, although with low-quality evidence (Geneen 2017). Conversely, the evidence related to physical activity and education as treatments for chronic musculoskeletal pain in children and adolescents is scarce. In our review, we found that physical activity may have a beneficial effect in reducing pain intensity compared with usual care. Recent systematic reviews in children and adolescents with chronic musculoskeletal pain also find similar results. Four systematic reviews found that physical activity could reduce pain intensity at post-treatment assessment compared with the control groups (Calvo-Muñoz 2013; Fisher 2021; Klepper 2019; Michaleff 2014). We found that physical activity showed a potentially beneficial effect on disability when compared with usual care, similar to Fisher 2021. However, these findings disagree with previous systematic reviews that found that physical activity does not improve disability compared with the control groups (Calvo-Muñoz 2013; Klepper 2019; Michaleff 2014). Another review conducted a meta-analysis of Childhood Health Assessment Questionnaire (CHAQ) scores, used in our review to assess disability, and found a significant improvement in CHAQ scores for the physical activity group compared with the control groups (Kuntze 2018). Fisher 2021 also analysed health-related quality of life, and similar to the findings of this review, did not find any benefit from physical activity interventions compared with control.

Despite that, caution is needed when directly comparing the results of these systematic reviews with our results (Calvo-Muñoz 2013; Fisher 2021; Klepper 2019; Kuntze 2018; Michaleff 2014). None of them categorise the control groups as active medical care group or usual care group as in our review. This difference between the classification of the comparators groups can influence the understanding of the total effects of the interventions and the replicability of the results.

AUTHORS' CONCLUSIONS

Implications for practice

For children and adolescents with musculoskeletal pain

We found very low-certainty evidence that interventions based on physical activity may improve pain intensity, disability, and quality of life when compared with usual care, for children and adolescents with juvenile idiopathic arthritis.

We did not identify any evidence for physical activity compared with active medical care, education about physical activity, or physical activity plus education. Therefore, the use of these interventions in clinical practice for children and adolescents with chronic musculoskeletal pain needs to be evaluated.

For clinicians

We found very low-certainty evidence that physical activity interventions may be effective in reducing pain intensity and improving disability and quality of life in children and adolescents with juvenile idiopathic arthritis.

We did not find any studies evaluating educational interventions, and therefore, we do not know whether these interventions can have positive outcomes in this population. Therefore, treatment decisions should consider the best current evidence,

the professional's experience, and the child's or adolescent's preferences. There are other potential benefits to physical activity and exercise, not captured in this review, which should be considered when guiding clinical decisions for this group.

For policy makers

The very low certainty evidence for physical activity interventions for chronic musculoskeletal pain in children and adolescents prevents strong conclusions.

Currently, there is no evidence for interventions involving an educational component. The scarcity of evidence for chronic pain in children and adolescents is alarming, and funding for high-quality research in this area is needed.

For funders of the intervention

It is necessary to prioritise research calls, research grants, and universities' funders for the research of musculoskeletal pain in children and adolescents. Only then will it be possible to conduct large and high-quality clinical trials that provide better certainty of the evidence for the treatment of this condition.

Implications for research

General implications

We found very low-certainty evidence on whether physical activity potentially reduces pain intensity and improves disability and quality of life at postintervention assessment, compared with usual care. Due to the uncertainty of the evidence, further studies are likely to influence the estimates of effects. Further randomised controlled trials, with high-quality methodology and large sample size are urgently needed. Future studies should be sufficiently powered to detect between-group differences.

Design

All the included studies evaluated children and adolescents with juvenile idiopathic arthritis, with unclear generalisability to other painful chronic musculoskeletal conditions. We need randomised controlled trials that evaluate promising treatments in children with common chronic musculoskeletal pain conditions (e.g. back pain, neck pain, upper and lower limb pain). Future studies need sample sizes large enough to precisely estimate the effectiveness of interventions.

Future studies also need to be high-quality, aiming to reduce selection bias (i.e. allocation concealment), treatment expectations, detection bias, and to conduct intention-to-treat analysis. Future studies must be transparent, which can be achieved through prospective registration of trial protocols, and by reporting findings in accordance with reporting guidelines (e.g. CONSORT statement). For future interventions to result in high-certainty evidence, they must be developed with key stakeholders, be designed to provide real-world solutions, have biological or theoretical plausibility in terms of how the intervention may work, and be described accurately and in sufficient detail to enable treatments to be replicated in clinical practice (e.g. in accordance with the TIDieR checklist). To improve the quality of details about the intervention, trialists can use the Consensus on Exercise Reporting Template (CERT (Slade 2016)) and the Consensus on Therapeutic Exercise Training (CONTENT (Hoogeboom 2012)) as extensions of the TIDieR checklist. Thus, some core elements should be considered when designing interventions (Skivington 2021):

- Evaluate the context, as it can directly influence the effects of the intervention;
- Base the intervention on a theory that can explain the main mechanisms and components of the intervention, and that can guide future studies and implementation strategies;
- Include the participation of stakeholders in the development of the intervention, with the aim to achieve positive health impacts on public policies;
- Identify the main uncertainties of the intervention to guide the clinical implications, clinical decisions, and limitations regarding the intervention;
- If necessary, make adjustments and refinements to the intervention, guided by the initial theory, and according to how it was standardised in the protocol;
- Evaluate the costs of the intervention at all stages, in order to answer the most important questions for decision makers.

These are key elements in the design of the intervention, and should be evaluated at all stages, i.e. in the development of the intervention, during the assessment of feasibility and acceptability, and during the evaluation and implementation of the intervention (Skivington 2021). These studies should also provide long-term follow-up data (up to 12 months) to determine the maintenance of the effects of interventions, and should assess outcomes recommended by the Paediatric Pain Assessment in Clinical Trials in children and adolescents (PedIMMPACT) consensus (McGrath 2008; Palermo 2021). Finally, researchers need to answer questions that are helpful in real-life situations to children, adolescents, and their families, practitioners, and decision-makers, rather than questions that can be answered with higher levels of certainty (Skivington 2021). Therefore, children, adolescents, practitioners, and policymakers should be involved from the early stages of the interventions. Future studies must also investigate how to translate the intervention into practice, whether it will be acceptable, implementable, cost-effective, scalable, and transferable between contexts. Only by taking these actions can the certainty of evidence be increased.

Measurement (end points)

Few studies have adopted the PedIMMPACT criterion. This would have improved the comparability across studies. It is important to better understand pain-related psychological outcomes, by using appropriate measurements (e.g. anxiety and depression). Physical activity levels were not measured in any of the included studies. This is an important outcome when evaluating physical activity interventions, because it is an indicator of sedentary behaviour, which is a health risk factor. It is also essential to understand whether physical activity interventions can improve physical activity levels in children and adolescents with chronic musculoskeletal pain, as the pain experience is often accompanied by fear of movement and activity avoidance.

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The following people conducted the editorial process for this article:

- Sign-off Editor (final editorial decision): Christopher Eccleston, University of Bath, UK
- Managing Editor (conducted editorial checks and supported editorial team): Anna Erskine (Oxford University Hospitals (OUH) NHS Foundation Trust, Oxford, UK)
- Assistant Managing Editor (selected peer reviewers, collated peer-reviewer comments, provided editorial guidance to authors, edited the article): Kerry Harding (Oxford University Hospitals (OUH) NHS Foundation Trust, Oxford, UK)
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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Sandstedt 2013

Study characteristics	
Methods	Randomised controlled trial
Participants	64 participants with juvenile idiopathic arthritis Settings: no information about recruitment procedures was mentioned Recruitment year: not reported

Sandstedt 2013 *(Continued)*

	Country: Sweden Inclusion criteria: polyarticular or extended oligoarticular arthritis, treated with methotrexate, TNF blockers and/or prednisone, and in need of repeated corticosteroid injections of joints in the lower extremities Exclusion criteria: not reported Intervention provider: not reported Delivery: not reported Duration of participation in the intervention: 6 months Frequency of intervention: 3 times/week Duration of intervention: 20 minutes
Interventions	1. Physical exercise group (intervention group, N = 33): an exercise programme with pictures, instructions, and a 12-week diary were given to the exercise group at the first test occasion, along with performance instructions. The programme consisted of 100 two-footed jumps with a rope, muscle strength core exercises, and muscle strength exercises with a load (0.5 kg to 2 kg) for the arms and shoulders, and 10 x 3 repetitions three times a week for 12 weeks. The number of repetitions performed was documented. Physical exercise in leisure time outside the programme was documented in both groups in two 12-week activity diaries. 2. Control group (N = 21): not reported
Outcomes	All the outcomes were measured at the baseline, 3 months after treatment, and after 6 months Pain intensity: Child Health Questionnaire Disability: Childhood Health Assessment Questionnaire Quality of life: Child Health Questionnaire Range of motion: plastic goniometer Balance: Balance Reach Test Muscle strength: handheld dynamometer Activity level: step-test
Notes	Conflicts of interest: none Funding source: Norrbacka Eugenia Foundation, The Research and Development Foundation of Göteborg and Bohuslän

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomization was performed by lot..."
Allocation concealment (selection bias)	Unclear risk	The methods of allocation were not mentioned.
Performance bias (treatment expectations)	Unclear risk	The study did not provide information about assessing treatment expectations between groups at baseline.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	"The same physiotherapist, who was blinded to the previous measurement, performed all measurements."

Sandstedt 2013 *(Continued)*

		Review authors' comment: however, some of the outcomes (i.e. pain intensity, disability and quality of life) were self-reported, thus the participants were the assessors and were not blinded to the group allocation.
Incomplete outcome data (attrition bias) All outcomes	High risk	> 20% dropouts (randomised = 64, dropout = 16; figure 1)
Intention-to-treat analysis	High risk	The study did not mention any intention-to-treat method for analysing the data. However, the number of participants analysed in the outcomes is different from the number randomised.
Selective reporting (reporting bias)	Unclear risk	No mention of protocol and published report does not include enough information to make a judgment.
Other bias (groups' similarity at baseline)	High risk	Table 2 shows differences between groups at baseline.

Sieczkowska 2022

Study characteristics	
Methods	Randomised controlled trial
Participants	21 juvenile systemic lupus erythematosus patients and 30 juvenile idiopathic arthritis patients Settings: participants were recruited from the Pediatric Rheumatology Unit and Rheumatology Division of the university and tertiary referral hospital in São Paulo, Brazil. Recruitment year: 2020 Country: Brazil Inclusion criteria: juvenile systemic lupus erythematosus and according to the American College of Rheumatology (ACR) criteria; children and adolescents with juvenile idiopathic arthritis according to the International League of Associations for Rheumatology (ILAR) criteria; receiving treatment or follow-up at our university hospital; and aged 10 years to 19 years Exclusion criteria: cardiovascular involvement (e.g. arrhythmias, arterial hypertension, heart failure, conduction disturbances, myocarditis, or pericarditis); undernourishment; kidney or pulmonary chronic diseases; or engagement in any form of exercise for at least three months prior to and during the study Intervention provider: not reported Delivery: not reported Duration of participation in the intervention: 3 months Frequency of intervention: 3 times/week Duration of intervention: not reported
Interventions	1. Home-based exercise programme: the home-based exercise programme consisted of a 12-week, three times a week aerobic and bodyweight exercise training programme, which is thoroughly described elsewhere. Training sessions were divided into two parts. Initially, the warm-up included predominantly aerobic exercises, such as jumping jacks, skipping, and mobility and flexibility exercises. The second part included bodyweight exercises for the major muscle groups, such as squats, lunges, pushups, crunches, and planks. One weekly session was conducted with online live supervision with the trainer, whereas the other two weekly sessions were unsupervised, but participants were instructed to provide feedback to the trainer immediately after completion of the training session. Supervision and monitoring was conducted via WhatsApp® or Google Meets®, according to the participant's preference. Progression occurred every four weeks by increasing the number of sets (3 to 4), repetitions (10

Sieczkowska 2022 *(Continued)*

	to 15, duration (30 to 45 s), or both. The exercises were modified every four weeks. Sessions included 1 to 5 participants at a time, and adherence to the exercise programme was monitored on a session basis by a member of the research staff. Participants received instructional videos, photos, and 'gifs' describing and illustrating the exercise programme. 2. Control group: participants in the control group were asked to maintain their usual activities, and asked to communicate if there was any change in their routine during the time of the study.
Outcomes	All the outcomes were measured just before the start of the training programme, and immediately after the end of the training programme. Mental health: Strengths and Difficulties Questionnaire Health-related quality of life: Pediatric Quality of Life Inventory—PedsQL 4.0 Generic Core Scale Sleep quality: Pittsburgh sleep quality index (PSQI)
Notes	Conflicts of interest: none Funding source: the authors received no financial support for the research, authorship, or publication of the article.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"After completing all questionnaires, patients were randomized to either intervention or control group."
Allocation concealment (selection bias)	Unclear risk	The methods of allocation were not mentioned.
Performance bias (treatment expectations)	Unclear risk	The study did not provide information about assessing treatment expectations between groups at baseline.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	The study did not report any information about blinding the outcome assessment. However, some of the outcomes (i.e. quality of life) were self-reported, thus the participants were the assessors, and the participants were not blinded to the group allocation.
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% dropout and reasons for dropouts were described (randomized = 32, dropout = 2)
Intention-to-treat analysis	High risk	"During the follow-up period, two juvenile systemic lupus erythematosus and two juvenile idiopathic arthritis patients lost interest in the intervention before starting it and were not analyzed as intention-to-treat, two juvenile systemic lupus erythematosus in the control group did not complete the follow-up questionnaires, two juvenile idiopathic arthritis patients discontinued intervention for personal reasons. Therefore, 21 juvenile systemic lupus erythematosus patients and 30 juvenile idiopathic arthritis patients remained and were evaluated". Review authors' comment: the study conducted a per protocol analysis.
Selective reporting (reporting bias)	Low risk	The study report the clinical trial registration.
Other bias (groups' similarity at baseline)	Low risk	The groups were similar regarding demographic factors and value of main outcome measures.

Takken 2003

Study characteristics	
Methods	Randomised controlled trial
Participants	54 participants with JIA Settings: 54 participants (38 girls, 16 boys) diagnosed with JIA were recruited from the paediatric rheumatology out-patient clinics of the Wilhelmina Children's Hospital, University Medical Center Utrecht, the Netherlands, and the University Hospital Groningen, the Netherlands Recruitment year: not reported Country: the Netherlands Inclusion criteria: diagnosed with JIA by a medical specialist (European League Against Rheumatism criteria, or International League of Associations for Rheumatology criteria); a phase of remission without medication of no longer than 6 months in the absence of joint pain, tenderness, or morning stiffness, and an erythrocyte sedimentation rate within normal limits. All participants had received a local or systemic arthritis-related therapy consisting of nonsteroidal anti-inflammatory drugs, or disease-modifying anti-rheumatic drugs,or immunosuppressive medication,or steroids (or a combination) in the last 6 months prior to inclusion Exclusion criteria: a systemic disease with fever, low haemoglobin level, and a general feeling of malaise; exercise contraindication by a medical specialist; a recipient of a bone marrow transplant; not feeling confident in water Intervention provider: instructed community physiotherapist Delivery: face-to-face Duration of participation in the intervention: 6 months Frequency of intervention: 1 time/week Duration of intervention: 60 minutes
Interventions	1. Experimental group (N = 27): the participants participated in an aquatic group (2 to 4 children/group) exercise programme, 1 hour/week, supervised by an instructed community physical therapist. The programme was available on paper and on instructional videotape, and consisted predominantly of aerobic exercises. The training started with a warm-up, followed by aerobic conditioning, a short rest period, and then a second conditioning session. The training ended with a cool-down. The warm-up, rest, and cool-down periods consisted of low intensity swimming, aquarobics, play, flexibility exercises, or ball games. The conditioning sessions consisted mainly of high intensity swimming, diving, walking through the water, aqua jogging, or splashing with their legs. The duration and intensity of both conditioning sessions increased stepwise throughout the programme. 2. Assessment-only group (control group, N = 27): no information besides the assessment was provided. All participants received their usual care and medical treatment during the study.
Outcomes	All the outcomes were measured just before the start of the training programme, 3 months after the start, and immediately after the end of the training programme. Disability: Childhood Health Assessment Questionnaire, Juvenile Arthritis Functional Assessment Scale Quality of life: Juvenile Arthritis Quality of Life Questionnaire Joint status: number of tender and swollen joints and the range of motion Join mobility: Paediatric Escola Paulista de Medicina Range of Motion Scale VO_2 peak Activity level: 6-minute walking test

Takken 2003 *(Continued)*

Notes	Conflicts of interest: none Funding source: no funding was reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"and individually randomly assigned to the assessment-only group (control-group) or the training group (experimental-group) by an off-site data manager."
Allocation concealment (selection bias)	Unclear risk	The methods of allocation were not mentioned.
Performance bias (treatment expectations)	Unclear risk	The study did not provide information about assessing treatment expectations between groups at baseline.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	"The investigators and subjects were not blinded for the group allocation of each subject". Review authors' comment: in addition, some of the outcomes (i.e. disability and quality of life) were self-reported, thus, the participants were the assessors and were not blinded to the group allocation.
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% dropouts, but study did not describe the reasons for dropout (randomised = 54, dropout = 1)
Intention-to-treat analysis	High risk	"Since he still met the 75% criteria of 20 sessions, his data were not excluded from the analysis." Review authors' comment: the study conducted a per protocol analysis.
Selective reporting (reporting bias)	Unclear risk	No mention of protocol and published report does not include enough information to make a judgment.
Other bias (groups' similarity at baseline)	Low risk	The groups were similar regarding demographic factors and value of main outcome measures.

Tarakci 2012

Study characteristics

Methods	Single-blinded randomised controlled trial
Participants	93 participants with juvenile idiopathic arthritis Settings: the participants were recruited from the paediatric rheumatology outpatient clinic of the Department of Pediatric Rheumatology of the Istanbul University Faculty of Cerrahpasa Medicine Recruitment year: July 2011 to October 2015 Country: Turkey Inclusion criteria: a total of 81 participants with juvenile idiopathic arthritis (44 girls and 37 boys), age range 5 years to 17 years, participated in this study. Juvenile idiopathic arthritis was diagnosed in accordance with the International League of Associations for Rheumatology criteria.

Tarakci 2012 *(Continued)*

	Exclusion criteria: because the land-based home exercise programme was performed under parental supervision at home, the presence of active joints in the exacerbation period was an exclusion criterion. The other exclusion criteria were neurological disease, metabolic disorder, decompensated organ failure, intra-articular steroid injection, or surgery in any joint, > 2 hours habitual regular weekly exercise (aerobic exercises, such as swimming/cycling, callisthenic exercise, or strengthening exercise), and if they were unable to cooperate with exercise or measurement. Intervention provider: physiotherapist Delivery: face-to-face and unsupervised sessions Duration of participation in the intervention: 12 weeks Frequency of intervention: 4 times/week Duration of intervention: 45 minutes
Interventions	1. Exercise group (N = 47): completed a 12-week land-based, home exercise programme. The programme consisted of warm-up (active assistive or active range of motion exercises); strengthening exercises (active resistive range of motion exercises with theraband for gluteus medius, gluteus maximus, iliopsoas, quadriceps femoris, hamstrings, tibialis anterior, deltoid, triceps, biceps, forearm muscles, hand muscles); stretching exercises (pectorals, hamstrings, hip flexors, tensor facia lata, Achilles tendons (moderate tension and duration of 20 to 30 s); postural exercises (rhomboids, lower and middle trapezius, latissimus dorsi, serratus anterior, and back extensors training); functional activities (walking, squat, and stair-climbing); repetition (1 set of 8 to 10 repetitions, increase gradually to 10 to 15 repetitions for strengthening, 1 set of 3 repetitions, increase gradually to 5 repetitions for stretching). The duration of the programme was 20 to 45 minutes. Participants were supervised once a week by physical therapists in the hospital. The exercises were performed daily for 3 days as a home programme under parental supervision. 2. Control group (N = 46): assigned to a waiting list until the end of the study
Outcomes	Pain intensity: 10-cm visual analogue scale (Childhood Health Assessment Questionnaire) Disability: Childhood Health Assessment Questionnaire Quality of life: Pediatric Quality of Life Inventory Activity level: 6-minutes walking test
Notes	Conflicts of interest: none Funding source: no funding was reported

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The randomization was performed using Microsoft Excel."
Allocation concealment (selection bias)	Unclear risk	"We used concealed allocation in the randomization." Review authors' comment: insufficient information about method of allocation
Performance bias (treatment expectations)	Unclear risk	The study did not provide information about assessing treatment expectations between groups at baseline.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	"The assessor (ET) was blind to which group the patients had been allocated and applied a standard procedure in both groups." Review authors' comment: however, some of the outcomes (i.e. pain, disability and quality of life) were self-reported, thus, the participants were the assessors and were not blinded to the group allocation.

Tarakci 2012 *(Continued)*

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	< 20% dropouts, but reasons for dropout were described (randomised = 93, dropout = 12)
Intention-to-treat analysis	High risk	"The data of the patients who completed more than 75% of the exercise programme were included in the outcome measures after 12 weeks." Review authors' comment: the study conducted a per protocol analysis
Selective reporting (reporting bias)	Unclear risk	No mention of protocol and published report does not include enough information to make a judgment.
Other bias (groups' similarity at baseline)	Low risk	The groups were similar regarding demographic factors and value of main outcome measures.

JIA: juvenile idiopathic arthritis; s: second(s)

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Ammerlaan 2017	Adult population
Andias 2018	Multi-component interventions
Andias 2022	Multi-component interventions
Arman 2019	Not active medical care, waiting list, or usual care
Armbrust 2015	Multi-component interventions
Armbrust 2016	Multi-component interventions
Azab 2022	Not active medical care, waiting list, or usual care
Aziz 2017	Not active medical care, waiting list, or usual care
Baadjou 2014	Not chronic musculoskeletal pain
Batistão 2019	Not chronic musculoskeletal pain
Baydogan 2015	Not active medical care, waiting list, or usual care
Bayraktar 2019	Not RCT or cross-over RCT
Blitz 2017	Not RCT or cross-over RCT
Budde 2018	Not chronic musculoskeletal pain
Catania 2017	Not RCT or cross-over RCT
Connelly 2019	Not physical activity, exercise, or education
Dekker 2016	Multi-component interventions

Study	Reason for exclusion
Dissing 2016	Multi-component interventions
Eid 2016	Multi-component interventions
El Miedany 2019	Not physical activity, exercise, or education
Elnaggar 2016	Multi-component interventions
Elnaggar 2021	Not active medical care, waiting list, or usual care
Epps 2005	Multi-component interventions
Hechler 2014	Not physical activity, exercise, or education
Hicks 2006	Not chronic musculoskeletal pain
Hornsby 2019	Not RCT or cross-over RCT
Horsak 2019	Not chronic musculoskeletal pain
Ibrahim 2020	Multi-component interventions
Kashikar-Zuck 2013	Not physical activity, exercise, or education
Kashikar-Zuck 2018	Multi-component interventions
Kisling 2021	Not physical activity, exercise or education
Lalloo 2022	Not chronic musculoskeletal pain
Leininger 2017	Not RCT or cross-over RCT
Lelieveld 2010	Multi-component interventions
Mendonça 2013	Not active medical care, waiting list, or usual care
Moretti 2016	Adult population
O'Higgins 2019	Multi-component interventions
Prado 2021	Adult population
Schulz 2014	Multi-component interventions
Shaygan 2021	Not physical activity, exercise, or education
Shear 2022	Multi-component interventions
Singh-Grewal 2006	Not RCT or cross-over RCT
Singh-Grewal 2007	Not active medical care, waiting list, or usual care
Stephens 2008	Not active medical care, waiting list, or usual care
Stinson 2010	Multi-component interventions

Study	Reason for exclusion
Sunthornsup 2021	Multi-component interventions
Takken 2008	Not RCTor cross-over RCT
Tarakci 2020	Not physical activity, exercise or education
Zapata 2015	Not active medical care, waiting list, or usual care
Østlie 2011	Not RCTor cross-over RCT

RCT: randomised controlled trial

Characteristics of studies awaiting classification *[ordered by study ID]*

Stavrakidou 2018

Methods	Randomised controlled trial
Participants	30 participants with juvenile idiopathic arthritis. Settings: not reported at the moment Country: not reported at the moment Inclusion criteria: children with juvenile idiopathic arthritis, with Medical Doctor's global assessment (MDVAS) < 2 Exclusion criteria: not reported at the moment
Interventions	Tele-rehabilitation group: each child from the tele-rehabilitation group participated, additionally at home-exercise programme, in a 30-minute tele-session (using personal computers, at home) with a qualified paediatric physiotherapist, twice a week, for 12 weeks, performing their exercises under the supervision and guidance of the specialist Control group: not reported at the moment
Outcomes	Not reported at the moment
Notes	Conflicts of interest: not reported at the moment Funding source: not reported at the moment Adverse events: not reported at the moment

ILAR: International League of Associations for Rheumatology

Characteristics of ongoing studies *[ordered by study ID]*

ACTRN12616000665437

Study name	Smartwatch to implement quality of life, drug-therapy & physical activity in children with Juvenile Idiopathic Arthritis: a randomised controlled trial
Methods	Randomised controlled trial
Participants	58 participants with juvenile idiopathic arthritis

ACTRN12616000665437 *(Continued)*

	Settings: not reported at the moment Country: Australia Inclusion criteria: children and adolescents aged between 10 and 18 years old; diagnosed with juvenile idiopathic arthritis according to ILAR criteria; no previous use of Apple-Watch; resident in Australia Exclusion criteria: concomitant musculoskeletal disease, central or peripheral nerve disease; heart failure; severe visual impairments; if DMARD and/or biological therapy are used, not having started these drug therapies within 6 months of enrolling in the trial; where assistive drugs therapy administration is required daily by medical staff
Interventions	1. Customised smart watch programme (intervention group): discrete prompts/messages will set up during the day through the smart-watch device to inform the child with juvenile idiopathic arthritis to record daily pain level fluctuations and to document when the prescribed drugs have been taken by simply 'tapping' the smart-watch. Three discreet prompts per day will be automatically sent to the child with JIA to record pain, at waking, midday and evenings. When daily physical activity targets of 10.000 steps set by the research are achieved, the child will be informed. The physical activity targets will be set by the chief investigator for each participant for a period of 6 months 2. Control group: The standard watch will be provided to the JIA children randomly allocated to the control group. The watch supplied to the control group will have same appearance as the smart watch (in the trial group); however it will not have any 'smart' functionality. The standard watch screen will only provide the time.
Outcomes	Quality of life: Pediatric Quality of Life Inventory Pain intensity: iVAS app Pain intensity: visual analogue scale Exercise adherence: ActivPal
Starting date	03/04/2017
Contact information	Dr Andrea Coda: Andrea.Coda@newcastle.edu.au
Notes	Conflicts of interest: not reported at the moment Funding source: no funding was reported at the moment Adverse events: not measured

NCT05114343

Study name	Effectiveness and Feasibility of a Home-based Exercise Program for Adolescents With Juvenile Idiopathic Arthritis
Methods	Randomised controlled trial
Participants	30 participants with juvenile idiopathic arthritis Settings: not reported at the moment Country: Brazil

NCT05114343 *(Continued)*

	Inclusion criteria: adolescents (under 18 years) patients with juvenile idiopathic arthritis
Interventions	1. Exercise group: participants will be instructed to perform 3 sessions of weight-bearing exercise per week, for 12 weeks. Exercise intensity and duration will be low-to-moderate in the first 4 weeks, and will progressively increase during the programme. Participants will be supported by educational materials, a heart rate monitor, and by means of periodic contact with an exercise specialist via video and phone calls, and text messages. 2. Usual care (control group): participants in the control group will receive usual care and general instructions about physical activity.
Outcomes	Disability: Childhood Health Assessment Questionnaire (CHAQ) Health-related quality of life: Pediatric Quality of Life Inventory (PedsQL) Physical activity and sedentary behavior: accelerometer (activPAL)
Starting date	December 2021
Contact information	tiagopecanha@usp.br
Notes	Conflicts of interest: not reported at the moment Funding source: no funding was reported at the moment Adverse events: not measured

NCT05220384

Study name	Motivational, Movement and SelfManagement Training for Adolescents in Pain
Methods	Randomised controlled trial
Participants	198 participants with chronic pain Settings: not reported at the moment Country: Hungary Inclusion criteria: age between 12-18 years; experiencing pain at least 3 months; good reading, writing and listening skills in Hungarian language; self-sufficient; access to internet and phone; no active cancer.
Interventions	1. Personalized In-person therapy: this is approximately 30 min in-person, semi-structured, semi-personalized physical activity-focused Motivational Interviewing treatment with self-management techniques. (This therapy is an add-on to the "usual therapy" that is given to adolescents who present at the hospital.) During the interactive treatment, a self-management workbook will be filled out by the adolescent for the purpose of further data collection. This in-person therapy at the hospital is followed by two booster sessions via phone at the 1st-week post-meeting date and 1-month post-meeting date. 2. Generalized, Video-based therapy: this is a series of three videos comprising a structured activity focused on Motivational Interviewing treatment with self-management techniques. The video's theme follows the semi-structured interview elements to ensure that it is a true sham of the in-person one. (This therapy is an add-on to the "usual therapy" that is given to adolescents who present at the hospital.) This first video is going to be watched by adolescents at the hospital. During the interactive video treatment, a self-management workbook will be filled out by the adolescent for the

NCT05220384 *(Continued)*	
	purpose of further data collection. The second video is going to be sent to the participants via e-mail on the 1st-week post-meeting date and the third video is on the 1-month post-meeting date.
Outcomes	Self-efficacy: Child Self-Efficacy Scale Pain intensity: Visual Analog Scale Anxiety and depression: Revised Children's Anxiety and Depression Scale Anxiety: State-Trait Anxiety Inventory for Children Disability: Paediatric Pain Disability Index Pain: Pain Stages of Change Questionnaire for Adolescents and for Parents
Starting date	31/01/2022
Contact information	adam.szilvia@emk.semmelweis.hu
Notes	Conflicts of interest: not reported at the moment Funding source: no funding was reported at the moment Adverse events: not measured

DATA AND ANALYSES

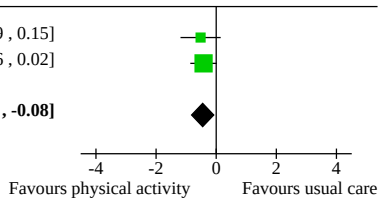
Comparison 1. Physical activity vs. usual care

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Pain intensity (postintervention)	2	118	Std. Mean Difference (IV, Random, 95% CI)	-0.45 [-0.82, -0.08]
1.2 Disability	3	205	Mean Difference (IV, Random, 95% CI)	-0.27 [-0.51, -0.02]
1.2.1 Disability (postintervention)	3	170	Mean Difference (IV, Random, 95% CI)	-0.37 [-0.56, -0.19]
1.2.2 Disability (long-term follow-up)	1	35	Mean Difference (IV, Random, 95% CI)	0.13 [-0.40, 0.66]
1.3 HRQoL (postintervention)	4	237	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-1.05, 0.33]
1.3.1 HRQoL (postintervention)	4	201	Std. Mean Difference (IV, Random, 95% CI)	-0.46 [-1.27, 0.35]
1.3.2 HRQoL (long-term follow-up)	1	36	Std. Mean Difference (IV, Random, 95% CI)	0.06 [-0.61, 0.73]

Analysis 1.1. Comparison 1: Physical activity vs. usual care, Outcome 1: Pain intensity (postintervention)

Study or Subgroup	physical activity Mean	SD	Total	usual care Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Sandstedt 2013 (1)	-71.8	28.45	22	-56.7	28.45	15	30.4%	-0.52 [-1.19 , 0.15]
Tarakci 2012 (2)	18.26	23.88	43	29.34	28.45	38	69.6%	-0.42 [-0.86 , 0.02]
Total (95% CI)			**65**			**53**	**100.0%**	**-0.45 [-0.82 , -0.08]**

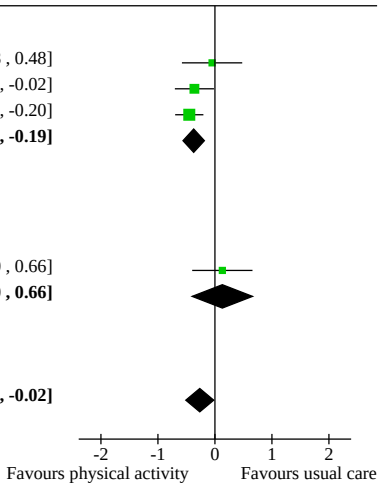
Heterogeneity: Tau² = 0.00; Chi² = 0.06, df = 1 (P = 0.81); I² = 0%
Test for overall effect: Z = 2.40 (P = 0.02)
Test for subgroup differences: Not applicable



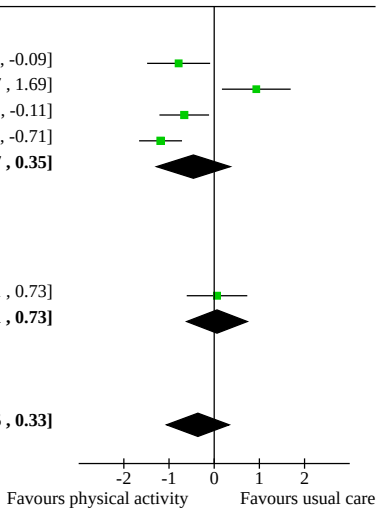
Footnotes
(1) Child Health Questionnaire
(2) Childhood Health Assessment Questionnaire

Analysis 1.2. Comparison 1: Physical activity vs. usual care, Outcome 2: Disability

Study or Subgroup	physical activity Mean	SD	Total	usual care Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.2.1 Disability (postintervention)								
Sandstedt 2013	0.41	0.79	20	0.46	0.79	15	16.1%	-0.05 [-0.58 , 0.48]
Takken 2003	0.47	0.45	27	0.83	0.79	27	28.6%	-0.36 [-0.70 , -0.02]
Tarakci 2012	0.19	0.34	43	0.64	0.71	38	39.1%	-0.45 [-0.70 , -0.20]
Subtotal (95% CI)			**90**			**80**	**83.9%**	**-0.37 [-0.56 , -0.19]**
Heterogeneity: Tau² = 0.00; Chi² = 1.81, df = 2 (P = 0.40); I² = 0%								
Test for overall effect: Z = 3.89 (P < 0.0001)								
1.2.2 Disability (long-term follow-up)								
Sandstedt 2013	0.5	0.79	20	0.37	0.79	15	16.1%	0.13 [-0.40 , 0.66]
Subtotal (95% CI)			**20**			**15**	**16.1%**	**0.13 [-0.40 , 0.66]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.48 (P = 0.63)								
Total (95% CI)			**110**			**95**	**100.0%**	**-0.27 [-0.51 , -0.02]**
Heterogeneity: Tau² = 0.02; Chi² = 4.89, df = 3 (P = 0.18); I² = 39%								
Test for overall effect: Z = 2.13 (P = 0.03)								
Test for subgroup differences: Chi² = 3.08, df = 1 (P = 0.08), I² = 67.6%								



Analysis 1.3. Comparison 1: Physical activity vs. usual care, Outcome 3: HRQoL (postintervention)



Study or Subgroup	physical activity Mean	SD	Total	usual care Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
1.3.1 HRQoL (postintervention)								
Sandstedt 2013 (1)	-70.6	14.16	22	-59.2	14.16	14	19.3%	-0.79 [-1.48 , -0.09]
Sieczkowska 2022 (2)	-64.5	14.02	14	-78	14.16	16	18.6%	0.93 [0.17 , 1.69]
Takken 2003 (3)	10.6	5.2	27	14.34	5.9	27	20.9%	-0.66 [-1.21 , -0.11]
Tarakci 2012 (2)	-85.58	13.31	43	-62.42	24.41	38	21.6%	-1.19 [-1.66 , -0.71]
Subtotal (95% CI)			**106**			**95**	**80.4%**	**-0.46 [-1.27 , 0.35]**
Heterogeneity: Tau² = 0.59; Chi² = 21.69, df = 3 (P < 0.0001); I² = 86%								
Test for overall effect: Z = 1.11 (P = 0.27)								
1.3.2 HRQoL (long-term follow-up)								
Sandstedt 2013	70.6	14.16	22	69.7	14.16	14	19.6%	0.06 [-0.61 , 0.73]
Subtotal (95% CI)			**22**			**14**	**19.6%**	**0.06 [-0.61 , 0.73]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.18 (P = 0.86)								
Total (95% CI)			**128**			**109**	**100.0%**	**-0.36 [-1.05 , 0.33]**
Heterogeneity: Tau² = 0.52; Chi² = 25.30, df = 4 (P < 0.0001); I² = 84%								
Test for overall effect: Z = 1.02 (P = 0.31)								
Test for subgroup differences: Chi² = 0.94, df = 1 (P = 0.33), I² = 0%								

Footnotes

(1) Measured on the Child Health Questionnaire; higher scores = better quality of life

(2) Measured on the PedsQL; higher scores = better quality of life

(3) Measured on the Juvenile Arthritis Quality of Life Questionnaire; lower scores = better quality of life

ADDITIONAL TABLES

Table 1. Description of interventions and comparators

mStudy	Participants conditions	Description of intervention	Description of control group
Sandstedt 2013	Children and adolescents (9 to 21 years old), diagnosed with juvenile rheumatoid arthritis	**Intervention group:** physical exercises **Mode of delivery:** not reported **Delivered by:** not reported **Conducted at:** not reported **Programme features:** an exercise programme with pictures, instructions, and a 12-week diary was given to the exercise group at the first test occasion, along with performance instructions. The programme consisted of 100 2-footed jumps with a rope, muscle strength core exercises, and muscle strengthening exercises with a load (0.5kg to 2 kg) for the arms and shoulders, and 10 repetitions for 3 series, 3 times a week for 12 weeks. **Duration:** at least 20 minutes, three times a week for 12 weeks	**Control group:** not reported **Mode of delivery:** not reported **Delivered by:** not reported **Conducted at:** not reported **Programme features:** not reported **Duration:** not reported
Sieczkowska 2022	Adolescents (10 to 19 years old) diagnosed with juvenile idiopathic arthritis or juvenile systemic	**Intervention group:** home-based exercises **Mode of delivery:** remote **Delivered by:** not reported	**Control group:** usual care **Mode of delivery:** not applicable

Table 1. Description of interventions and comparators *(Continued)*

	lupus erythematosus	**Conducted at:** not reported **Programme features:** an exercise programme, consisting of a 12-week, three times a week, aerobic and bodyweight exercise training programme. Training sessions were divided into warm-up with predominantly aerobic exercises; followed by bodyweight exercises for the major muscle groups. One weekly session was conducted online with live supervision with the trainer; the other two weekly sessions were unsupervised. **Duration:** not reported	**Delivered by:** not applicable **Conducted at:** not applicable **Programme features:** participants were asked to maintain their usual activities, and communicate if there was any change in their routine during the study **Duration:** not applicable
Takken 2003	Children and adolescents (5 to 13 years old) diagnosed with juvenile rheumatoid arthritis	**Intervention group:** water-based exercises **Mode of delivery:** face-to-face **Delivered by:** physical therapists **Conducted at:** outpatient clinic **Programme features:** two to four children per group; in heated community-based pools. The programme was available on paper and on instructional videotape, and consisted predominantly of aerobic exercises. The training started with a warm-up (low-intensity swimming, aquarobics, play, flexibility exercises or ball games; cool-down, and short rest period); followed by aerobic conditioning (high-intensity swimming, diving, walking through the water, aqua jogging or splashing with the legs; and short rest period); a second conditioning part, ending with cool-down and short rest period. The duration and intensity of both conditioning sections increased stepwise throughout the programme. **Duration:** 60 minutes, once a week for 6 months	**Control group:** assessment-only **Mode of delivery:** not reported **Delivered by:** not reported **Conducted at:** outpatient clinic **Programme features:** assessment-only **Duration:** not reported
Tarakci 2012	Children and adolescents (5 to 17 years old) diagnosed with juvenile rheumatoid arthritis	**Intervention group:** land-based home exercises **Mode of delivery:** mixed (face-to-face and unsupervised sessions) **Delivered by:** physical therapists **Conducted at:** outpatient clinic **Programme features:** an individual exercise programme that included a range of motion, strengthening, stretching, and posture exercises, performed daily, at home. Exercise programme started with active assistive, or active range of motion exercises; later shifting to active, or active resistive range of motion exercises. The strengthening exercises were performed for upper and lower extremity muscles, using a theraband. Stretching was performed with moderate tension, for 20 to 30 s. Functional	**Control group:** waiting-list control **Mode of delivery:** not applicable **Delivered by:** not applicable **Conducted at:** outpatient clinic **Programme features:** participants were enrolled in the waiting list until the end of the study; they were interviewed by telephone once a month, and received information

Table 1. Description of interventions and comparators *(Continued)*

	activities, such as walking, squats, and stair climbing, were also included in the programme. **Duration:** 45 minutes, 1 supervised and 3 unsupervised sessions per week for 12 weeks	about their clinical status. **Duration:** not applicable

APPENDICES

Appendix 1. CENTRAL search strategy

#1 MeSH descriptor: [Musculoskeletal Pain] this term only

#2 MeSH descriptor: [Complex Regional Pain Syndromes] explode all trees

#3 MeSH descriptor: [Chronic Pain] this term only

#4 MeSH descriptor: [Fibromyalgia] this term only

#5 MeSH descriptor: [Neuralgia] explode all trees

#6 MeSH descriptor: [Arthritis, Juvenile] this term only

#7 ((((chronic or long-term or musculoskeletal or joint*) N3 pain*) or fibromyalgia or arthritis)):ti,ab,kw (Word variations have been searched)

#8 MeSH descriptor: [Adolescent] this term only

#9 MeSH descriptor: [Child] this term only

#10 ((child* or boy* or girl* or teenage* or adolescen* or schoolchild* or juvenil*)):ti,ab,kw (Word variations have been searched)

#11 #1 or #2 or #3 or #4 or #5 or #6 or #7

#12 #8 or #9 or #10

#13 MeSH descriptor: [Adult] explode all trees

#14 #12 not #13

#15 MeSH descriptor: [Exercise] explode all trees

#16 MeSH descriptor: [undefined] explode all trees

#17 MeSH descriptor: [Patient Education as Topic] this term only

#18 MeSH descriptor: [Physical Education and Training] this term only

#19 MeSH descriptor: [Exercise Therapy] explode all trees

#20 ((educat* or exercise* or physical activit*)):ti,ab,kw (Word variations have been searched)

#21 #15 or #16 or #17 or #18 or #19 or #20

#22 #11 and #14 and #21

Appendix 2. MEDLINE search strategy

1 MUSCULOSKELETAL PAIN/

2 exp Complex Regional Pain Syndromes/

3 Chronic Pain/

4 Fibromyalgia/

5 exp Neuralgia/

6 Arthritis, Juvenile/

7 (((chronic or long-term or musculoskeletal or joint*) adj3 pain*) or fibromyalgia or arthritis).tw.

8 1 or 2 or 3 or 4 or 5 or 6 or 7

9 adolescent/ or child/

10 (child* or boy* or girl* or teenage* or adolescen* or schoolchild* or juvenil*).tw.

11 9 or 10

12 exp ADULT/ or YOUNG ADULT/

13 11 not 12

14 exp Exercise/

15 health education/ or patient education as topic/ or "physical education and training"/

16 exp Exercise Therapy/

17 (educat* or exercise* or physical activit*).tw.

18 14 or 15 or 16 or 17

19 8 and 13 and 18

20 randomized controlled trial.pt.

21 controlled clinical trial.pt.

22 randomized.ab.

23 placebo.ab.

24 drug therapy.fs.

25 randomly.ab.

26 trial.ab.

27 or/20-26

28 exp animals/ not humans.sh.

29 27 not 28

30 19 and 30

Appendix 3. Embase search strategy

1 MUSCULOSKELETAL PAIN/ (10644)

2 exp Complex Regional Pain Syndromes/ (8811)

3 Chronic Pain/ (58972)

4 Fibromyalgia/ (19777)

5 exp Neuralgia/ (98987)

6 (((chronic or long-term or musculoskeletal or joint*) adj3 pain*) or fibromyalgia or arthritis).tw. (356993)

7 juvenile rheumatoid arthritis/ (18817)

8 1 or 2 or 3 or 4 or 5 or 6 or 7 (463062)

9 adolescent/ (1433601)

10 child/ (1568112)

11 (child* or boy* or girl* or teenage* or adolescen* or schoolchild* or juvenil*).tw. (1982131)

12 10 or 11 (2514766)

13 adult/ or aged/ or middle aged/ or young adult/ (7911597)

14 12 not 13 (1757071)

15 exp exercise/ (319450)

16 health education/ (87262)

17 patient education/ (109481)

18 physical education/ (10126)

19 exp kinesiotherapy/ (72932)

20 (educat* or exercise* or physical activit*).tw. (1155573)

21 15 or 16 or 17 or 18 or 19 or 20 (1363634)

22 8 and 14 and 21 (1928)

23 random$.tw. (1487437)

24 factorial$.tw. (36457)

25 crossover$.tw. (72743)

26 cross over$.tw. (30722)

27 cross-over$.tw. (30722)

28 placebo$.tw. (296792)

29 (doubl$ adj blind$).tw. (199004)

30 (singl$ adj blind$).tw. (24054)

31 assign$.tw. (380818)

32 allocat$.tw. (146728)

33 volunteer$.tw. (246062)

34 Crossover Procedure/ (61996)

35 double-blind procedure.tw. (198)

36 Randomized Controlled Trial/ (586195)

37 Single Blind Procedure/ (37896)

38 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 (2234197)

39 (animal/ or nonhuman/) not human/ (5495622)

40 38 not 39 (1976649)

41 22 and 40 (226)

Appendix 4. CINAHL search strategy

S34 S21 AND S33

S33 S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32

S32 (MH "Clinical Trials+")

S31 PT Clinical trial

S29 TX ((singl* n1 blind*) or (singl* n1 mask*)) or TX ((doubl* n1 blind*) or (doubl* n1 mask*)) or TX ((tripl* n1 blind*) or (tripl* n1 mask*)) or TX ((trebl* n1 blind*) or (trebl* n1 mask*))

S28 TX randomi* control* trial*

S27 (MH "Random Assignment")

S26 TX random* allocat*

S25 TX placebo*

S24 (MH "Placebos")

S23 (MH "Quantitative Studies")

S22 TX allocat* random*

S21 S11 AND S13 AND S20

S20 S14 OR S15 OR S16 OR S17 OR S18 OR S19

S19 ((educat* or exercise* or physical activit*))

S18 (MH "Therapeutic Exercise+")

S17 (MH "Physical Education and Training")

S16 (MH "Patient Education")

S15 (MH "Health Education")

S14 (MH "Exercise")

S13 S10 not S12

S12 (MH "Adult")

S11 S1 OR S2 OR S3 OR S4 OR S5 OR S6

S10 S7 OR S8 OR S9

S9 ((child* or boy* or girl* or teenage* or adolescen* or schoolchild* or juvenil*))

S8 (MH "Child")

S7 (MH "Adolescence")

S6 ((((chronic or long-term or musculoskeletal or joint*) N3 pain*) or fibromyalgia or arthritis))

S5 (MH "Arthritis, Juvenile Rheumatoid")

S4 (MH "Neuralgia+")

S3 (MH "Fibromyalgia")

S2 (MH "Chronic Pain")

S1 (MH "Complex Regional Pain Syndromes+")

Appendix 5. PsycINFO search strategy

((MAINSUBJECT.EXACT.EXPLODE("Complex Regional Pain Syndrome (Type I)") OR MAINSUBJECT.EXACT("Chronic Pain") OR MAINSUBJECT.EXACT("Fibromyalgia") OR MAINSUBJECT.EXACT.EXPLODE("Neuralgia")

OR (((chronic OR long-term OR musculoskeletal OR joint*) N3 pain*) OR fibromyalgia OR arthritis)) AND (child* OR boy* OR girl* OR teenage* OR adolescen* OR schoolchild* OR juvenil*)

AND (MAINSUBJECT.EXACT.EXPLODE("Exercise") OR MAINSUBJECT.EXACT("Health Education") OR MAINSUBJECT.EXACT("Physical Education") OR (educat* OR exercise* OR physical activit*)))

AND (SU.EXACT("Treatment Effectiveness Evaluation") OR SU.EXACT.EXPLODE("Treatment Outcomes") OR SU.EXACT("Placebo") OR SU.EXACT("Followup Studies") OR placebo* OR random* OR "comparative stud*"

OR clinical NEAR/3 trial* OR research NEAR/3 design OR evaluat* NEAR/3 stud* OR prospectiv* NEAR/3 stud* OR (singl* OR doubl* OR trebl* OR tripl*) NEAR/3 (blind* OR mask*))

Appendix 6. PEDro search strategy

Abstract & Title – child*

Therapy – Education or Fittess training

Problem- Pain

Subdiscipline- musculoskeletal

Topic – chronic pain

Method – clinical trial

Appendix 7. LILACS search strategy

(fibromyalgia or arthritis or chronic pain$ or long term pain$ or musculoskeletal pain$ or joint$ pain$) [Words]

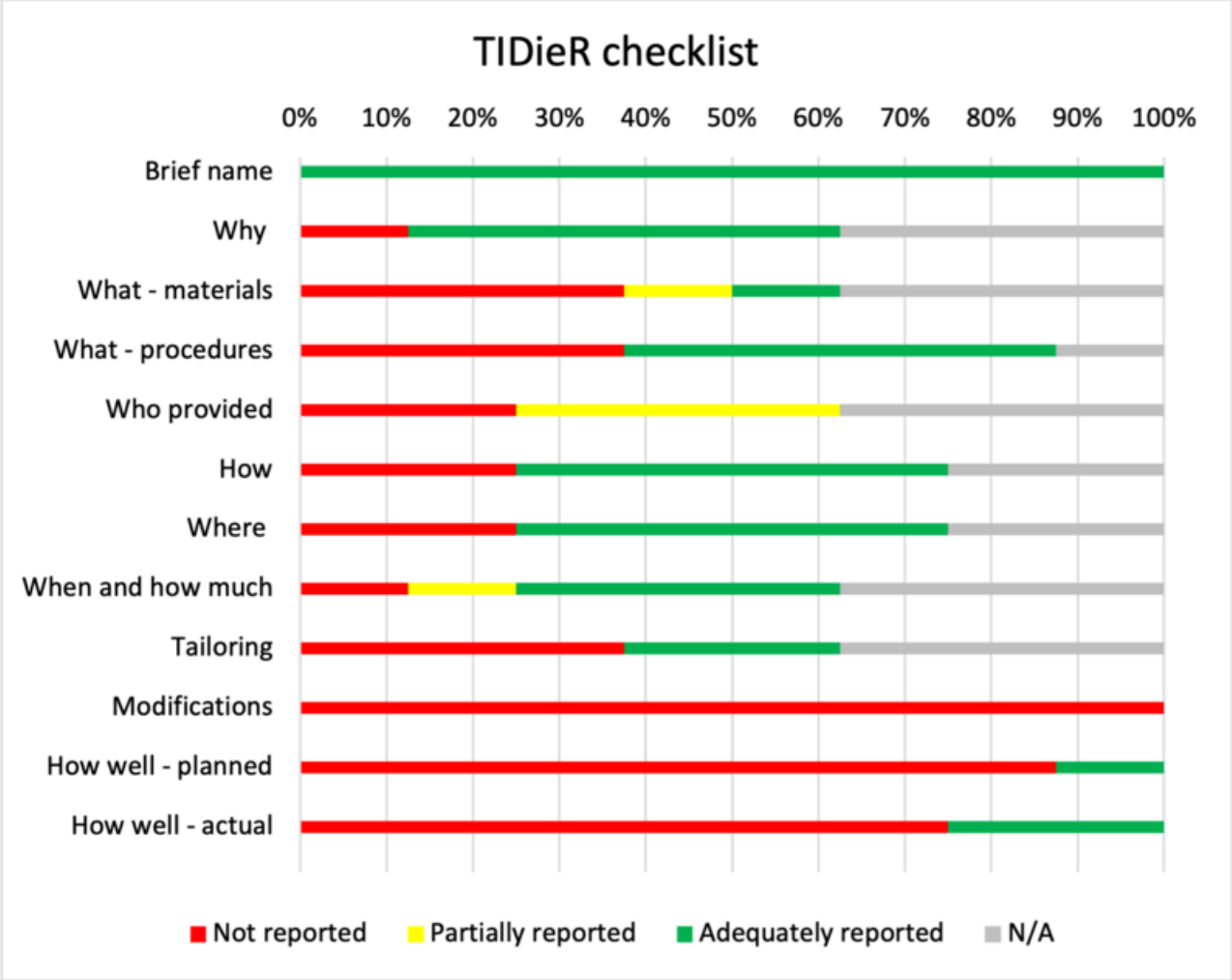
and (child$ or adolescen$) and (educat$ or exercise$ or physical activit$) [Words]

and randomised OR randomized OR randomisation OR randomization OR trial OR placebo OR blind OR "phase 3" OR "phase III"

Appendix 8. TIDieR checklist

Figure 4

Figure 4. TIDieR checklist



Appendix 9. Summary results for search methods

Database searched	Date searched	Number of results	Date searched	Number of results	Date searched	Number of results
CENTRAL	19 Feb 2020	406	21 Mar 2022	62	13 Oct 2022	25
MEDLINE	19 Feb 2020	207	21Mar 2022	42	13 Oct 2022	10
Embase	19 Feb 2020	226	21 Mar 2022	22	13 Oct 2022	7
CINAHL	19 Feb 2020	249	21 Mar 2022	59	13 Oct 2022	24
PsycINFO	19 Feb 2020	235	21 Mar 2022	29	13 Oct 2022	6
PEDro	19 Feb 2020	5	21 Mar 2022	3	19 Oct 2022	0
LILACS	19 Feb 2020	16	21 Mar 2022	0	19 Oct 2022	0

(Continued)

Total	**923**	**217**	**72**
After duplicates deleted	**851**	**191**	**65**

HISTORY

Protocol first published: Issue 2, 2020

CONTRIBUTIONS OF AUTHORS

MNL: contributed to the design of the protocol, screened and selected studies, appraised the quality, and extracted data from selected papers, entered data, analysed and interpreted the data, and wrote the main review.

TPY: provided expertise in conducting systematic reviews and assisted with study screening and selection, data extraction, risk of bias assessment, data entry, analysis, interpretation, wrote the protocol, and revised the writing of the main review.

NEO: served as methodological expert, and advised on writing all stages of the protocol and review.

EF: served as methodological and content expert, and advised on writing all stages of the protocol and review.

ZAM: served as methodological and content expert, and advised on writing all stages of the protocol and review.

PVS: screened and selected studies, assessed the risk of bias of, and extracted data from selected papers.

CMW: served as methodological expert, and advised on writing all stages of the protocol and review.

SJK: contributed to the design of the protocol, served as methodological expert, and advised on writing all stages of the protocol and review, contributed to decisions on inclusion when further consultation was required.

DECLARATIONS OF INTEREST

MNL: none known

TPY: none known

NEO: none known. Since NEO is an author as well as PaPaS Co-ordinating Editor, we acknowledge the input of Christopher Eccleston, who acted as Sign-off Editor for this review. NEO had no input into the editorial decisions or processes for this review.

EF: EF won a grant from WHO to deliver the systematic review that informed the guidelines on management of chronic pain in children and adolescents cited in this review. EF did not receive the funds personally, did not benefit financially from the payment, or have access to or control of the funds.

ZAM: ZAM was involved in conducting one study that was potentially eligible for inclusion in this review

PVS: none known

CMW: CMW works as a health professional, Hunter New England Local Health District, Lambton, NSW, Australia

SJK: SJK has research grant funding from the National Health and Medical Research Council, which supports their research and salary. SJK is employed by the University of Sydney as Professor of Allied Health.

SOURCES OF SUPPORT

Internal sources

- None, Other

External sources

- National Institute for Health Research (NIHR), UK

  Cochrane Infrastructure funding to the Cochrane Pain, Palliative and Supportive Care Review Group (PaPaS)

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We made some modifications in the Background section, under How the intervention might work, to improve the justification for education about physical activity, to clarify the mechanisms by which educational interventions could act, and what could be important to investigate it. We also did some minor revisions in Why it is important to do this review.

In the Methods section, we made minor revisions in Types of studies, to clarify the choice for the searches. In the protocol, we specified the comparisons as active medical care, waiting-list, and usual care (which includes minimal interventions). However, waiting-list controls are often accompanied by some level of care (e.g. continue with normal activities), so we incorporated waiting-list as usual care in the review. We added the searches dates and the MeSH terms for Electronic searches, and made minor revisions in Measures of treatment effect. We improved the criterion for low risk of bias in selective reporting to be more transparent in our judgement. We modified Data synthesis, summarising the list of comparisons, and added three more summary of findings tables for the active medical care group. Finally, we updated the Quality of the evidence with the latest methods used in the Cochrane Pain, Palliative and Supportive Care Review Group.

INDEX TERMS

Medical Subject Headings (MeSH)

*Arthritis, Juvenile; Chronic Disease; *Chronic Pain [therapy]; Exercise; *Musculoskeletal Pain [therapy]; Quality of Life

MeSH check words

Adolescent; Child; Humans