

# Exercise interventions and patient beliefs for people with hip, knee or hip and knee osteoarthritis: a mixed methods review

## Review information

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### Authors

Michael Hurley<sup>1</sup>, Kelly Dickson<sup>2</sup>, Rachel Hallett<sup>3</sup>, Robert Grant<sup>3</sup>, Hanan Hauari<sup>4</sup>, Nicola Walsh<sup>5</sup>, Claire Stansfield<sup>6</sup>, Sandy Oliver<sup>4</sup>

<sup>1</sup>School of Rehabilitation Sciences, Faculty of Health, Social Care and Education, St George's, University of London and Kingston University, London, UK

<sup>2</sup>Social Science Research Unit, UCL Institute of Education, London, UK

<sup>3</sup>Center for Health and Social Care Research, St George's, University of London and Kingston University, London, UK

<sup>4</sup>EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London, London, UK

<sup>5</sup>University of the West of England, Bristol, UK

<sup>6</sup>EPPI-Centre, Social Science Research Unit, UCL Institute of Education, University College London, London, UK

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### Contact person

**Michael Hurley**

Professor of Rehabilitation

School of Rehabilitation Sciences, Faculty of Health, Social Care and Education

St George's, University of London and Kingston University

2nd Floor Grosvenor Wing

Crammer Terrace, Tooting

London

SW17 0RE

UK

E-mail: Michael.Hurley@sgul.kingston.ac.uk

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### What's new

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## Abstract

### Background

Chronic peripheral joint pain due to osteoarthritis (OA) is extremely prevalent and a major cause of physical dysfunction and psychosocial distress. Exercise is recommended to reduce joint pain and improve physical function, but the effect of exercise on psychosocial function (health beliefs, depression, anxiety and quality of life) in this population is unknown.

### Objectives

To improve our understanding of the complex inter-relationship between pain, psychosocial effects, physical function and exercise.

### Search methods

Review authors searched 23 clinical, public health, psychology and social care databases and 25 other relevant resources including trials registers up to March 2016. We checked reference lists of included studies for relevant studies. We contacted

key experts about unpublished studies.

## Selection criteria

To be included in the quantitative synthesis, studies had to be randomised controlled trials of land- or water-based exercise programmes compared with a control group consisting of no treatment or non-exercise intervention (such as medication, patient education) that measured either pain or function and at least one psychosocial outcome (self-efficacy, depression, anxiety, quality of life). Participants had to be aged 45 years or older, with a clinical diagnosis of OA (as defined by the study) or self-reported chronic hip or knee (or both) pain (defined as more than six months' duration).

To be included in the qualitative synthesis, studies had to have reported people's opinions and experiences of exercise-based programmes (e.g. their views, understanding, experiences and beliefs about the utility of exercise in the management of chronic pain/OA).

## Data collection and analysis

We used standard methodology recommended by Cochrane for the quantitative analysis. For the qualitative analysis, we extracted verbatim quotes from study participants and synthesised studies of patients' views using framework synthesis. We then conducted an integrative review, synthesising the quantitative and qualitative data together.

## Main results

Twenty-one trials (2372 participants) met the inclusion criteria for quantitative synthesis. There were large variations in the exercise programme's content, mode of delivery, frequency and duration, participant's symptoms, duration of symptoms, outcomes measured, methodological quality and reporting. Comparator groups were varied and included normal care; education; and attention controls such as home visits, sham gel and wait list controls. Risk of bias was high in one and unclear risk in five studies regarding the randomisation process, high for 11 studies regarding allocation concealment, high for all 21 studies regarding blinding, and high for three studies and unclear for five studies regarding attrition. Studies did not provide information on adverse effects.

There was moderate quality evidence that exercise reduced pain by an absolute percent reduction of 6% (95% confidence interval (CI) -9% to -4%, (9 studies, 1058 participants), equivalent to reducing (improving) pain by 1.25 points from 6.5 to 5.3 on a 0 to 20 scale and moderate quality evidence that exercise improved physical function by an absolute percent of 5.6% (95% CI -7.6% to 2.0%; standardised mean difference (SMD) -0.27, 95% CI -0.37 to -0.17, equivalent to reducing (improving) WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) function on a 0 to 100 scale from 49.9 to 44.3) (13 studies, 1599 participants)). Self-efficacy was increased by an absolute percent of 1.66% (95% CI 1.08% to 2.20%), although evidence was low quality (SMD 0.46, 95% CI 0.34 to 0.58, equivalent to improving the ExBeliefs score on a 17 to 85 scale from 64.3 to 65.4), with small benefits for depression from moderate quality evidence indicating an absolute percent reduction of 2.4% (95% CI -0.47% to 0.5%) (SMD -0.16, 95% CI -0.29 to -0.02, equivalent to improving depression measured using HADS (Hospital Anxiety and Depression Scale) on a 0 to 21 scale from 3.5 to 3.0) but no clinically or statistically significant effect on anxiety (SMD -0.11, 95% CI -0.26 to 0.05, 2% absolute improvement, 95% CI -5% to 1% equivalent to improving HADS anxiety on a 0 to 21 scale from 5.8 to 5.4; moderate quality evidence). Five studies measured the effect of exercise on health-related quality of life using the 36-item Short Form (SF-36) with statistically significant benefits for social function, increasing it by an absolute percent of 7.9% (95% CI 4.1% to 11.6%), equivalent to increasing SF-36 social function on a 0 to 100 scale from 73.6 to 81.5, although the evidence was low quality. Evidence was downgraded due to heterogeneity of measures, limitations with blinding and lack of detail regarding interventions. For 20/21 studies, there was a high risk of bias with blinding as participants self-reported and were not blinded to their participation in an exercise intervention.

Twelve studies (with 6 to 29 participants) met inclusion criteria for qualitative synthesis. Their methodological rigour and quality was generally good. From the patients' perspectives, ways to improve the delivery of exercise interventions included: provide better information and advice about the safety and value of exercise; provide exercise tailored to individual's preferences, abilities and needs; challenge inappropriate health beliefs and provide better support.

An integrative review, which compared the findings from quantitative trials with low risk of bias and the implications derived from the high-quality studies in the qualitative synthesis, confirmed the importance of these implications.

## Authors' conclusions

Chronic hip and knee pain affects all domains of people's lives. People's beliefs about chronic pain shape their attitudes and behaviours about how to manage their pain. People are confused about the cause of their pain, and bewildered by its variability and randomness. Without adequate information and advice from healthcare professionals, people do not know what they should and should not do, and, as a consequence, avoid activity for fear of causing harm. Participation in exercise programmes may slightly improve physical function, depression and pain. It may slightly improve self-efficacy and social function, although there is probably little or no difference in anxiety. Providing reassurance and clear advice about the value of exercise in controlling symptoms, and opportunities to participate in exercise programmes that people regard as enjoyable and relevant, may encourage greater exercise participation, which brings a range of health benefits to a large population of people.

## Plain language summary

### The health benefits of exercise for people with chronic hip and knee pain from osteoarthritis

Researchers conducted a review of the effect of exercise on physical, emotional and mental health for people with long

lasting (chronic) knee or hip joint pain from osteoarthritis. The studies examined were from Europe, North America, Asia and Australasia, and included clinical settings, home exercise and sessions at leisure facilities. Studies included men and women aged 45 years and over.

### What is chronic joint pain and what is exercise?

Chronic knee and hip pain from osteoarthritis (breakdown of the bone and cartilage, causing pain and stiffness) is a common cause of physical disability, anxiety, depression, poor quality of life and social problems (such as feeling a burden). Exercise is recommended to reduce pain and disability, and improves people's health beliefs, depression, anxiety and quality of life. We wanted to improve understanding of the relationships between pain, movement ability, psychological issues such as depression and anxiety, how chronic pain affects social relationships, and exercise.

### What happens to people with chronic knee or hip pain who take part in exercise programmes?

A search of medical databases up to March 2016 found 21 studies with 2372 people which considered pain, movement or both alongside psychological and social outcomes when people with pain and stiffness in their knee, hip, or both took part in exercise. Participation in exercise programmes probably slightly improves pain, physical function, depression, and ability to connect with others, and little or no difference in anxiety. It may improve belief in one's own abilities, and social function.

The studies confirmed that:

- people who exercised rated their pain to be 1.2 points lower on a scale of 0 to 20 after about 45 weeks (score: 5.3 with exercise compared with 6.5 with no exercise (control), an improvement of 6%).
- physical function improved by about 5% over 41 weeks (exercise group improved by 5.6 points on a scale of 0 to 100 (44.3 with exercise compared with 49.9 with control)).
- people's confidence in what they could do increased by 2% after 35 weeks (exercise group improved by 1.1 points on a scale of 17 to 85 (65.4 with exercise compared with 64.3 with control)).
- people who exercised were 2% less depressed, or half a point on a scale of 0 to 21, after 35 weeks (3.0 points with exercise compared with 3.5 with control).
- exercise made people feel less anxious about themselves by 2%, a 0.4 drop on a 0 to 21 scale, after 24 weeks (5.4 points with exercise compared with 5.8 with control).
- exercise resulted in social interaction improving by 7.9 points over 36 weeks on a scale of 0 to 100, giving a change of 8% (81.5 with exercise compared with 73.6 with control).

The quality of the evidence was generally moderate, but low for confidence in ability, mental health and social function. This is mainly due to varied measures, making comparison more difficult, and because people taking part knew they were exercising so may have been influenced by expectations of improvement. The studies did not report side effects. Studies lasted for different durations, so we do not know if changes occurred quickly and were maintained, or whether improvements were gradual throughout the studies. Some studies took measurements later after the programme than others.

Additionally, 12 studies investigated people's opinions, beliefs and experiences of exercise, and whether exercise changed these. The quality of evidence was high overall. Initially people were confused about the characteristics of their pain, which shaped their feelings, behaviours and decisions about relieving pain. People thought movement and exercise was good for joints, but movement caused pain and they worried this might cause them harm. Lack of information from medical professionals meant people avoided physical activity and exercise for fear of causing damage.

Overall, people who had taken part in exercise programmes had positive experiences, helping increase their beliefs that exercise could improve pain, physical and mental health, and general quality of life.

Providing reassurance and exercise advice, challenging poor health beliefs, and providing enjoyable exercise programmes may encourage participation and benefit the health of many people.

## Background

### Description of the condition

Severe peripheral joint pain, often labelled as osteoarthritis (OA), is extremely prevalent worldwide ([Bedson 2004](#); [Woolf 2003](#)), and a major cause of disability and healthcare expenditure ([Gupta 2005](#); [Leardini 2004](#); [March 1997](#); [Vos 2012](#)). In the UK, nearly 20% of people aged over 50 years have severe disabling knee or hip pain ([Jinks 2004](#); [Peat 2001](#)), also labelled as OA ([Bedson 2004](#)), which slowly worsens over time, compromising quality of life and independence ([Dawson 2005](#)). The economic burden of joint pain/OA is significant ([Gupta 2005](#)). Annually 15% of people aged over 50 years consult their general practitioners (GP) for knee pain ([Jinks 2004](#)). Estimated figures for 2010 indicated that OA totalled GBP16.8 billion in direct (formal medical care) and indirect (lost working days, informal care) costs ([Arthritis Research UK 2017](#)). The personal experiencing and psycho-socioeconomic consequences of chronic joint pain will increase as people live longer, adopt sedentary lifestyles and obesity rises ([Underwood 2004](#)). By 2020, OA is projected to be the fourth leading cause of disability across the world ([Woolf 2003](#)).

### Description of the intervention

Exercise is recommended to reduce joint pain and improve physical function ([Fransen 2015](#); [NICE 2008](#); [Zhang 2008](#)). In addition, successful completion of a challenging exercise programme can highlight to people their capabilities; challenge inappropriate health beliefs; disrupt detrimental behaviour (fear-avoidance); and teach people that exercise

is a safe, beneficial, and active coping strategy they can use to improve self-efficacy (confidence in one's ability to perform a specific health behaviour or task) and self-reliance, and reduce helplessness and disability ([Hurley 2010](#); [Keefe 1996a](#); [Penninx 2002](#)). Unfortunately, as there is no summary of the evidence describing the reciprocity between pain, physical and psychosocial function and the utility of exercise on addressing these problems, the importance of these inter-relationships remains underappreciated, and potential treatment options underutilised.

Information and advice about the role of exercise in the management of joint pain form part of most self-management ([Miles 2011](#); [Newman 2004](#)) and physiotherapy programmes ([Walsh 2009](#)). The aim is to effect behavioural change, that is, encourage people to exercise regularly, but the most effective way to deliver exercise advice that will bring about this behavioural change and get people exercising regularly is unclear ([Hurley 2009](#)). Didactic programmes, explaining the benefits of exercise for joint pain management using verbal or written information, may enlighten people, but they do not detail how to start exercising, what (not) to do, when, how or how much, and fail to convince people who have experienced many years of activity-related pain that moderate-intensity exercise will not aggravate their condition ([Larmer 2014a](#)). Consequently, didactic programmes may have limited ability to improve health beliefs, self-confidence, self-efficacy, coping and affect behavioural change. To people with joint pain, exercise remains a burdensome, time-consuming, effortful concept that causes pain.

Programmes that include a participatory exercise component may encourage regular exercise more effectively ([Griffiths 2007](#)). On these programmes, participants gain first-hand experience of what exercises to do; how to do them; that exercise is not harmful; and how exercise can be used to reduce pain; and this improves their physical function, health beliefs, anxiety, depression and potentially their general quality of life ([Hurley 2007](#); [Hurley 2010](#)). Again, without a systematic review of the evidence on the effectiveness of exercise education delivery, the best way to bring about participation in regular exercise is unclear; wasting time, effort and resources, and potentially missing effective treatment options.

It is important to consider a range of different exercise interventions: National Institute for Health and Care Excellence (NICE) guidelines recommend muscle strengthening in the area affected, and aerobic exercise, with stretching and manipulation, is also advocated, particularly for hip OA ([NICE 2014](#)). Interventions to consider might therefore be land-based or water-based, and may focus on a single aspect of fitness such as strength training, aerobic exercise or balance, for example, or a combination of these. A programme may be delivered to groups or one-to-one, and may be carried out at a specialised facility or at home, in classes or individually, and frequency and intensity demanded may vary from one study to another.

## How the intervention might work

### *Conceptual framework*

#### Relationship between chronic pain, physical function and psychosocial function

Chronic joint pain and disability are the most common symptoms of OA, and attract the most attention. Because OA and joint pain are often regarded as the benign, untreatable, inevitable consequences of ageing, the psychosocial sequelae (anxiety, depression, health beliefs, behaviours, quality of life, participation and dependency) are often underestimated by healthcare professionals and lay people. However, this overlooks the complex, reciprocal relationship between pain, physical functioning and psychosocial functioning where each affects and is affected by the others ([Hurley 2003](#); [Figure 1](#)). For example, chronic joint pain is bewildering and distressing because it has no obvious cause, increases insidiously and is unaccountably episodic. People's reactions to pain are highly variable and influenced by the beliefs, meanings and explanations they attach to it.

#### Relationship between health beliefs and psychosocial outcomes

Beliefs about the cause, prognosis and effectiveness of treatment are key determinants of illness behaviour and response to treatment ([Main 2002](#); [Turk 1996](#)). People commonly believe joint pain is the inevitable, incurable consequence of ageing, caused or exacerbated by activity, evoking feelings of helplessness, anxiety, depression and "fear-avoidance" behaviour ([Figure 2](#)), when people avoid physical activity for fear of causing additional pain and damage ([Keefe 1996a](#)). However, avoiding activity results in greater muscle weakness, joint instability and stiffness, exacerbated pain, disability and dependency ([Dekker 1992](#)). Challenging these erroneous health beliefs is vital for successful pain management. Inappropriate health beliefs and behaviours can be altered by positive experiences that show people how active coping strategies such as exercise can reduce pain and improve physical functioning, self-efficacy, anxiety, helplessness, catastrophising and depression ([Keefe 1996b](#); [Main 2002](#); [Turk 1996](#)). Appreciating the complex inter-relationship between clinical symptoms and psychosocial effects of joint pain could provide additional strategies for better joint pain management.

Better appreciation of the complex reciprocal relationship between pain, psychosocial effects and physical functioning would help us understand better the consequences of joint pain, identify the most effective ways of teaching the value of exercise, and develop more efficient models of care for people experiencing chronic joint pain. This is best achieved by a systematic review of the relevant literature to establish what interventions are most effective, and to quantify the size of the treatment effect produced. However, the complex reciprocity between joint pain, psychosocial impact, physical functioning and exercise will be influenced by many factors that are difficult to measure as they depend on nebulous, labile, personal beliefs, experiences, emotions, preferences and prejudices. A systematic review asking questions on effectiveness and synthesising outcome evaluations only would miss important facets and cannot accommodate information from qualitative studies better placed to assess pain, the psychosocial effects of pain and the benefits of exercise. These are best captured using methods that synthesise quantitative (systematic reviews) with



qualitative studies of people's views and experiences ([Lorenc 2008](#); [Oliver 2008](#); [Rees 2006](#); [Thomas 2004](#)).

Appreciating the views, beliefs, experiences and preferences of target populations for an intervention provides greater insight into how an intervention achieves its effects, why it may not be as effective as anticipated and may expose gaps in our understanding. This enables us to adapt existing, or develop new, healthcare interventions that best address people's needs ([Harden 2004](#); [Oliver 2008](#); [Rees 2006](#)).

### Why it is important to do this review

This review focused on exercise-based rehabilitation programmes, defined as programmes that had an active participatory exercise component (for management of OA and the psychosocial variables affected by the condition). Establishing the effect of exercise-based rehabilitation programmes on the psychosocial impact of chronic joint pain will increase our understanding about how and why these interventions are effective and identify the effective elements of exercise programmes.

To meet the aims, the review will answer the following questions.

- What are the effects of exercise-based rehabilitation programmes on physical and psychosocial functioning for people with chronic knee or hip (or both) pain?
- What are people's experiences, opinions and preferences regarding exercise-based rehabilitation programmes and the advice they receive about exercise?
- What implications can be drawn from the qualitative synthesis of people's views to inform the appropriateness and acceptability of exercise-based rehabilitation programmes for people living with OA?

## Objectives

### Overarching objective

To improve our understanding of the complex inter-relationship between pain, psychosocial effects, physical function and exercise.

### Specific aims and objectives

To systematically review the evidence on the impact of physical exercise on people's pain, physical and psychosocial functioning including:

- identifying the most effective formats for delivering exercise advice;
- explaining why some exercise interventions may be more effective than others;
- recommending exercise formats and content by constructing a "toolbox" that describes the most effective exercise interventions for healthcare providers and patients to use.

These was achieved by conducting:

- a synthesis of quantitative data on the benefits and harm of exercise interventions for improving pain, physical functioning and psychosocial functioning;
- a synthesis of qualitative data on participant's experiences, opinions and preferences of physical exercise;
- a synthesis integrating the quantitative and qualitative data (an integrative review) to assess the extent to which existing evaluated interventions address the needs and concerns of people living with OA.

## Methods

### Criteria for considering studies for this review

#### *Types of studies*

To be included in the review, quantitative clinical trials of exercise programmes had to have used individual or cluster randomised allocation. Qualitative studies reporting the views and opinions of participants of exercise-based programmes had to have reported methods of data collection and data analysis, and people's perspectives, beliefs, feelings, understanding, experiences or behaviour about exercise or advice on exercise that were presented as data (e.g. direct quotes from participants or description of findings). There were no limits on location or language; however, quantitative clinical trials or qualitative studies had to be published after 1985 because of the paucity of well-designed and well-reported relevant studies prior to 1985.

#### *Types of participants*

We included studies with men, women, or both, aged 45 years or older, with a clinical diagnosis of OA (as defined by the study) or self-reported chronic hip or knee (or both) pain (defined as more than six months' duration).

#### *Types of interventions*

Exercise-based rehabilitation programmes could consist of any type of land-based or aquatic-based exercise programme aiming to improve OA symptoms delivered in hospitals or the community. Programmes could vary in content (e.g. range of motion, aerobics, Tai Chi) and their delivery mode (classes or individual therapy), length, frequency or intensity. The comparator (control group) could consist of no treatment, waiting list group or any non-exercise intervention (e.g. medication, lifestyle/diet changes, information on OA).

#### *Types of outcome measures*

The major outcomes of interest were pain, physical function, self-efficacy, depression, anxiety, quality of life and adverse

effects of exercise.

For quantitative synthesis, randomised controlled trials (RCT) had to have measured either pain or function and at least one psychosocial outcome (self-efficacy, depression, anxiety, quality of life). Quality of life related to a range of factors, which the World Health Organization (WHO) identifies as "physical health, psychological state, level of independence, social relationships, personal belief and their relationship to salient features of their environment" ([WHO 1997](#)).

The qualitative synthesis studies had to have reported people's opinions and experiences of exercise (e.g. their views and beliefs about the utility of exercise in the management of chronic pain, or barriers to adherence to exercise advice).

## Search methods for identification of studies

### Electronic searches

In July 2012, we searched electronic databases using comprehensive strings of thesaurus and free-text terms for the key features:

- **condition:** chronic knee and hip pain (e.g. 'osteoarthritis/chronic joint pain');
- **intervention:** 'exercise,' physical activity, aerobic, walking, Tai Chi, physiotherapy.

The two strings were combined to identify reports that contained terms for both features (population AND topic). An example of the thesaurus and free-text strings applied to PubMed is provided in [Appendix 1](#).

These search strategies were applied to 23 clinical, public health, psychology and social care databases ([Appendix 2](#)), 25 other resources by handsearching ([Appendix 2](#)), and references of included studies. We contacted key experts/authors to identify any other potentially relevant studies.

We conducted follow-up searches in March 2014 and March 2016 to ensure any further trials that had been published and which met criteria could be included in the review.

### Searching other resources

We checked references of included studies by:

- checking where included studies had been cited, using Google Scholar;
- checking references of selected reviews in the topic area that the research team were aware of from a systematic review of reviews on adult social care; outcomes concurrently being undertaken at the EPPI-Centre;
- asking key experts/authors of included studies.

We engaged with experts from the research, advocacy and policy sectors in the field of OA rehabilitation. They informed key stages in the review including: advising on the scope, informing the search strategy, reviewing the final report and disseminating the research findings.

## Data collection and analysis

### Selection of studies

Review authors applied inclusion and exclusion criteria to titles and abstracts. We obtained full-text reports for studies that appeared to meet the criteria. We extracted data and information from these studies and entered them into a database and reapplied the inclusion and exclusion criteria. We included studies that met the inclusion criteria in the review. All review authors involved in study screening (KD, HH, MH, NW) took part in a moderation exercise where results were discussed to ensure consistency in applying the review inclusion/exclusion criteria. For the initial title and abstract screening, we carried out a "double screening" of 200 papers before continuing with independent screening. For the screening of full reports, a second review author independently applied the criteria on 10% of the reports. A 90% agreement rate was required before proceeding to independent screening. Review authors (KD, HH, MH, NW) independently screened the remaining sample of potential studies. Where a review author (e.g. HH) was unable to reach a decision, consensus was reached through discussion with a second review author (e.g. KD) or, if required, a third review author (MH or NW). In two cases where there was doubt over whether a study should be included ([Jenkinson 2009](#); [Thomas 2002](#)), we contacted authors but received no reply and the studies unfortunately had to be excluded as a result.

### Data extraction and management

We used EPPI-Reviewer software to manage the review ([Thomas 2002](#)). Four review authors (KD, HH, MH, NW) extracted descriptive details from the full reports using a prepiloted data collection form. If a review author was an author of one of the included studies, they were not involved in any decisions regarding data extraction from that study.

We extracted the following information from all studies:

- aims and focus of the research;
- study design;
- details about the intervention including:
  - format: written, didactic, non-participatory/participatory, lay/professional led, individual/group therapy, etc.;
  - content: type, frequency, intensity, etc.;
  - setting: hospital/outpatient/community/home-based, etc.;
- details about the study populations and settings as per the PROGRESS-Plus framework ([Kavanagh 2008](#)):
  - broad social determinants of health and well-being (e.g. ethnicity, occupation, gender, education, socioeconomic

status);

- characteristics that impinge on health and well-being by attracting discrimination, such as age;
- other contextual features pertinent to the experiences of living with knee and hip pain, such as housing.

### Quantitative outcome data

For quantitative outcome measurements, whenever possible, we extracted raw scores. Where trials reported pain or function using more than one outcome measure tool, we extracted data according to the following hierarchy: Western Ontario McMaster Universities Osteoarthritis Index (WOMAC), Arthritis Impact Measurement Scale (AIMS), visual analogue scale (VAS) and other. Similarly, preference was given to standardised psychosocial outcomes. A summary of data collected for included studies is reported in the [Characteristics of included studies](#) table.

### Qualitative "views" data

For qualitative studies that include "views" data, whenever possible, we extracted participant's quotes first, followed by and distinguished from authors' descriptions and analysis of participants' views. We followed the conceptual framework to support the identification of factors potentially impacting on participation in and experiences of exercise ( [Figure 2](#)). A summary of data collected for included qualitative studies is reported in [Appendix 3](#).

### *Assessment of risk of bias in included studies*

In pairs, four review authors (HH, KD, MH, NW) independently assessed the risk of bias for all included studies using the Cochrane tool for assessing risk of bias addressing the following criteria ([Higgins 2011a](#)).

#### Sequence generation

The methods used to generate the allocation sequence were categorised as:

- low risk of bias (risk of bias avoided or addressed (or both)) if a random component in the sequence generation process was described (e.g. referring to a random number table);
- high risk of bias (risk of bias not adequately addressed) if the authors described a non-random component in the sequence generation process (e.g. sequence was generated by hospital or clinic record number);
- unclear risk of bias (uncertain risk) if the sequence generation process was not specified.

#### Allocation sequence concealment

The method used to conceal the allocation sequence in sufficient detail to determine whether intervention allocation could have been foreseen in advance of, or during, recruitment, or changed after assignment, categorised as:

- low risk of bias if an appropriate method was used to conceal allocation (e.g. central allocation including telephone, web-based and pharmacy-controlled randomisation; sequentially numbered, opaque, sealed envelopes) from personnel enrolling participants;
- high risk of bias if appropriate method to conceal allocation was not guaranteed;
- unclear risk of bias if methods used to conceal allocation were not specified.

#### Blinding

As it is very difficult to blind providers and recipients to exercise programmes. We assessed the methods used to blind study participants and researchers to the intervention that participants received.

Blinding of **participants** as:

- low risk of bias if the authors described methods taken to blind study participants to the intervention;
- high risk of bias if there were no attempts to blind study participants to the intervention;
- unclear risk of bias if methods taken to blind study participants were not specified.

Blinding of **outcome assessment** as:

- low risk of bias if the authors stated explicitly that the primary outcome variables were assessed blindly;
- high risk of bias if the outcomes were not assessed blindly and this was likely to affect results;
- unclear risk of bias if not specified in the paper.

#### Completeness of outcome data

The individual attrition rate for intervention and control groups, whether exclusions were reported and whether the authors conducted an in intention-to-treat analysis were categorised as:

- low risk of bias if there were no missing data or missing outcome data were balanced in numbers across intervention groups, with similar reasons for those missing data and unlikely to alter the results of the study;
- high risk of bias if missing outcome data were likely to bias the results;
- unclear risk of bias if not specified in the paper.

#### Reporting bias

Outcome reporting was categorised as:

- low risk of bias if evidence outcomes were selectively reported (e.g. all relevant outcomes in the methods section were reported in the results section);
- high risk of bias if some important outcomes were omitted;
- unclear risk of bias if not specified in the paper.

## Other bias

Other potential sources of bias were categorised as:

- low risk of bias if there was no evidence of other risk of biases, and
- high risk of bias if there were concerns of other sources of bias affecting the results.

Any disagreements were resolved by discussion and, if necessary, by consulting a fifth review author.

## Assessment of rigour in qualitative studies

We assessed the quality and methodological rigour of "views studies" using a tool developed at the EPPI-Centre ([Harden 2004](#)), which considers whether the findings were grounded in the data and reflected people's views. The development of the criteria was informed by those engaged in ensuring increased transparency and explicit methods for assessing the quality of qualitative research ([Boulton 1996](#); [Cobb 1987](#); [Mays 1995](#); [Popay 1998](#)), and was adapted in accordance with the Cochrane Qualitative Research Methods Group guidance on adopting a quality appraisal framework ([Hannes 2011](#)).

We assessed each study according to the extent to which they provide explicit description of:

- aims and objectives;
- methodology, including systematic data collection methods;
- participants;
- context, detailing factors important for interpreting the results;
- data analysis to establish dependability and validity.

Two review authors (KD, HH) judged the quality of studies containing people's views based upon judgements about the 'dependability' and 'credibility' of the study's findings. Any disagreements were resolved by discussion and, if necessary, by consulting a third review author.

## Dependability

The sampling frame, methods of data collection and analysis were categorised as:

- high quality (low risk of bias/error) if thorough attempts were made to increase rigour in the sampling, data collection and analysis;
- medium quality if some steps were taken to increase rigour in the sampling, data collection and analysis;
- low quality if minimal steps were taken or it was unclear what attempts study authors made to avoid methodological bias and error in conducting the study.

## Credibility

Credibility was categorised as:

- high quality (low risk of bias/error) if the findings were well grounded/supported by the data, contributed either depth or breadth of findings (in relation to their ability to answer the review question) and privileged the perspectives and experiences of people living with OA;
- medium quality if studies met the same criteria as high-quality studies, but were only fairly well grounded in the data;
- low quality if studies were 'limited' on any of the above criteria.

Any disagreements were resolved by discussion and by consulting with a third review author (SO).

As one of the aims of the review was to synthesise people's experiences and preferences in relation to exercise to better understand the factors that might contribute to the success of exercise-rehabilitation programmes, we did not exclude studies failing to meet a minimum quality threshold (i.e. those scoring low for both dependability and credibility). Instead, we used the quality assessment to assess the contribution of each study to the development of explanations and relationships.

## Measures of treatment effect

### Continuous data

For continuous data measured by the same scale or unit, we calculated mean differences (MD) with 95% confidence intervals (CI). For similar outcomes measured by a different scale or units, we used standardised mean differences (SMD) with 95% CIs.

We presented highly skewed continuous data in tables.

Where standard errors (SE) were reported instead of standard deviations (SD), we used Review Manager 5 to calculate the effect size estimate ([RevMan 2014](#)). In one study, the SD was calculated from the SE. Where there were no SDs or SEs reported, we estimated the mean SD from available studies, as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011b](#)).

### Dichotomous data

For dichotomous (binary) data, we calculated risk ratios (RR) with 95% CIs, or converted odds ratios (OR) to SMDs, using the Cox-Snell formula, and where appropriate we combined results from different trials.

## Unit of analysis issues

We identified the level at which randomisation occurred (e.g. individual participants, cluster-randomised trials, repeated



measures) at the data extraction stage and addressed the following issues if they arose:

- **cluster-randomised trials:** using intraclass correlation coefficient (ICC) estimates the design effect was calculated and the variance inflated accordingly;
- **multiple interventions per participant:** we analysed studies that compared the effect of two or more types exercise-based rehabilitation programmes with a control condition;
- **multiple follow-up:** for trials that measured outcomes at multiple time points, we selected the longest follow-up.

### *Dealing with missing data*

We recorded the amount of missing data, reasons, pattern (missing completely at random, missing at random, missing not at random) and how the missing data were handled (ignored, last observation carried forward, statistical modelling, etc.) ([Carpenter 2008](#)). We performed sensitivity analyses to assess the impact of the missing data on study findings and considered the implications to the review in the [Discussion](#).

### *Assessment of heterogeneity*

All pooled analyses used the  $I^2$  statistic to assess the percentage of total variation caused by heterogeneity of the trials ([Higgins 2003](#)). We assessed statistical heterogeneity across studies by visual inspection of the forest plot and using the  $\chi^2$  test with a significance level of  $P$  less than 0.10, and the  $I^2$  test and tentatively assign  $I^2$  statistic value of:

- low heterogeneity: less than 49%;
- moderate heterogeneity: 50% to 74%;
- high heterogeneity: 75% to 100% ([Higgins 2003](#)).

We assessed clinical heterogeneity by analysing subgroups by type of OA (knee, hip, or a combination; age; gender and severity of symptoms; see [Subgroup analysis and investigation of heterogeneity](#)).

When there was moderate heterogeneity ( $\chi^2$   $P$  less than 0.10 and  $I^2$  value 50% to 74%), we used a random-effects model. When there was no clinical and no important statistical heterogeneity ( $I^2$  less than 49%), we combined results using a fixed-effect model. We considered the potential cause of heterogeneity by conducting subgroup and sensitivity analyses as described below.

In the qualitative studies, differences in study setting and sample (e.g. gender, age, type and severity of OA/chronic pain) informed the qualitative synthesis and were used to explain variation in the study's findings.

### *Assessment of reporting biases*

We constructed funnel plots (effect size versus SE) to assess publication bias, if a sufficient number of trials was found (about 10: [Sterne 2004](#)). Where possible, we compared the outcomes and comparisons reported in the papers against trial protocols to detect unreported results that may indicate reporting bias.

Assessment of reporting biases were not applied to qualitative studies.

### *Data synthesis*

The methods used to synthesise data were driven by the research question, types of studies/data included, the detail and quality of reporting in these studies and their heterogeneity. The synthesis of study findings was informed by the conceptual framework and the type of interventions identified. If there was a wide variety of approaches and patient populations, we used a random-effects model in the meta-analyses.

#### *Quantitative synthesis*

Where possible, we used standard methods for statistical meta-analysis to synthesise data using Review Manager 5 ([RevMan 2014](#)). We used an SMD approach, which scales each outcome at endpoint by its SD, due to the diversity of psychosocial measures. We conducted a fixed-effect meta-analysis for combining data where it was reasonable to assume studies had estimated the same underlying treatment effect (i.e. in trials examining the same intervention, and the trials' populations and methods were judged sufficiently similar). If there was substantial statistical heterogeneity, we used random-effects models, presented as mean treatment effect with 95% CIs.

### *Subgroup analysis and investigation of heterogeneity*

We investigated whether subpopulations responded differently to an exercise-based rehabilitation programme by comparing the responses of different subgroups to the exercise programme. Theoretically, participants who *only* experience chronic hip pain may respond differently to exercise programmes than people who *only* experience knee pain, and both respond differently to people with hip *and* knee pain. Other a priori planned subgroup analyses included age, gender and severity of symptoms as defined by the studies included in the review.

For trials, we tested for heterogeneity across subgroup results and computed an  $I^2$  statistic. We used random-effects models to analyse variation in the mean effects in the different subgroups using meta-regression techniques to reduce false-positive results when comparing subgroups in a fixed-effect model ([Higgins 2011b](#)). Post-hoc subgroups analyses were considered to be exploratory analyses.

### *Sensitivity analysis*

If aspects of a trial (e.g. atypical intervention, methodology, missing information) appeared to unduly influence the review's findings, we conducted sensitivity analyses to assess the influence of that study and reported them in a summary table.

For qualitative studies, we considered whether individual and contextual factors explained variation in the type of views

identified.

## Qualitative synthesis

We synthesised studies of people's views using the framework synthesis used in previous EPPI-Centre reviews ([Lorenc 2008](#); [Oliver 2008](#)). A framework synthesis accommodates a range of different types of studies and can be conducted relatively quickly by a team of review authors.

We extracted verbatim quotes from study participants and author description of findings from the result sections of included studies. We read the text reported in the discussions and conclusions during this data extraction process; however, these sections contained author's conclusions and implications but did not present any new data and, therefore, were not used to inform the synthesis.

Two review authors (KD, HH) independently read through reports and extracted data from the studies. Data were matched against the conceptual framework. As these were broad themes ([Figure 1](#)), we used a thematic analysis to identify subthemes. This enabled the existing conceptual framework to be used as the basis for the synthesis, which was then developed further by the introduction of themes from the studies ([Figure 3](#)). The themes' codes acted as an index to navigate the data and allowed the literature to be subdivided into manageable sections ready for in-depth analysis. Each element of the framework was individually interrogated in turn, tabulating the data under key themes to present distilled summaries.

Both review authors then compared their individual coding. They considered the extent to which each subtheme was mutually exclusive and how they understood the data in relation to their individual coding, reflecting on the review questions' emphasis on participants' meanings and experiences ensuring that the coding did not go beyond the original context of the study. In some cases, both review authors went back to the original studies to check their understanding. Similar themes were then grouped and condensed until a smaller number of subthemes emerged. In some cases, themes originally coded under one broad theme (e.g. environmental factors) had a better fit with another broad theme (e.g. psychological factors). The discussion continued until a consensus was reached on which a priori themes were supported by the data, and whether new themes identified by the review authors did actually map to the pre-existing broad theme. The result was a finalised list of themes. A diagram of these themes was generated to provide an illustration of the themes and subthemes in the synthesis ([Figure 3](#)). Overall drawing together what can be learnt from the tables and summaries and finding associations between themes and providing explanations for those findings across the included studies supported us to illuminate people's responses to aspects of arthritis and approaches to self-management. This approach has provided a clear path from the original research data, to individual study authors' descriptions and analyses to the findings of the qualitative review synthesis ([Appendix 4](#)).

## Synthesis integrating quantitative and qualitative findings (integrative review)

Two review authors (SO, KD) reread the qualitative synthesis and generated implications from people's views on what they considered important in supporting their engagement in exercise. After consulting with other review authors (MH, NW), we made refinements until consensus was reached on an agreed set of implications. The implications were generated into a coding tool and two review authors (KD, HH) critically re-examined the intervention descriptions as reported in the 21 RCTs included in the quantitative synthesis to identify whether they addressed each of the implications.

Having identified which components were contained within each intervention, we aimed to assess the extent to which each component was present in the intervention by answering: 'yes,' 'no/not stated' or 'partially.' Two review authors independently conducted this assessment and then paired up to compare findings and check accuracy of extracted data. Decisions about the extent of a component's presence were based on the trial authors' descriptions and reporting. Detailed information to support 'yes' or 'partially' was required and decisions were recorded on EPPI-Reviewer. Disagreements were discussed until consensus was reached with the option of referring to a third review author (SO) for resolution if agreement could not be made.

After coding agreements were finalised, the findings were mapped onto a matrix, as previously used in EPPI-Centre systematic reviews, enabling the integration of controlled trials and view studies to be 'juxtaposed' ([Candy 2011](#)). The matrices in the integrative synthesis map the presence of components within the RCTs with the studies' effect sizes and contextual detail on recruitment and intervention description previously extracted as part of the quantitative synthesis. This enabled us to visibly illustrate and interrogate patterns in the findings, supporting the generation of a comparative descriptive narrative addressing the following questions.

- Which components of (in)effective interventions correspond with views expressed by participants?
- Does this match suggest why or how the intervention (does not) work?
- What components appear in effective interventions but not in ineffective interventions?
- Does the 'views' synthesis suggest these components are significant from a participant perspective?
- Does addressing the psychosocial effects of joint pain improve pain and physical functioning?

## Clinical relevance

The social science review authors (KD, HH, SO) conducted the synthesis of qualitative studies and drew implications from that for interventions and the final synthesis across the statistical meta-analysis and qualitative study synthesis. In each case coreview authors, including two who were both clinicians and coauthors of a trial and two qualitative studies (MH, NW), checked the coherence of the emerging findings. Their responses prompted a reinspection of themes in terms of their roots in the primary studies, their language, their relationship to each other and to the conceptual framework, and the quotes chosen to support the themes. Inaccuracies were corrected, and language and interpretations refined.

## Summary of evidence

We prepared a 'Summary of findings' table for the quantitative and qualitative syntheses. For quantitative trials, we used the methods and recommendations described in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Schünemann 2011](#)), using GRADEpro software ([GRADEpro 2008](#)). Similarly, we created a 'Summary of qualitative evidence' to summarise the key findings and be informed by the assessment of rigour, detailing the extent to which the findings are trustworthy, based on their dependability and credibility, in answering the review question.

## Results

### Description of studies

#### *Results of the search*

Searches of bibliographic databases and websites, including the update searches to March 2016, yielded 26,455 potentially relevant citations. [Figure 4](#) describes the flow of these records through the screening process. After removing 8266 duplicates, we screened 18,189 titles and abstracts using prespecified eligibility criteria of which 17,668 were excluded. Of the 521 potential reports, 24 were unobtainable and we obtained 497 for full-text screening. Applying the same criteria used at the title and abstract screening stage, we excluded a further 464 studies. We included 33 studies in the data and analyses consisting of 21 in the quantitative synthesis and 12 in the qualitative synthesis.

#### *Included studies*

Twenty-one trials (2372 participants) met the criteria for inclusion in the quantitative synthesis and 12 studies met the criteria for inclusion in the qualitative synthesis. Of the 21 studies identified for the quantitative synthesis, four had three treatment arms and so were split in the meta-analyses ([French 2013](#); [Focht 2005](#); [Hurley 2007](#); [Keefe 2004](#)), and were treated as 25 'comparisons' as recommended in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011b](#)). The three-arm studies had two entries for some outcomes in the [Data and analyses](#) table. Where this was the case, the first arm referred to intervention group and the second arm to intervention group, as outlined in the [Characteristics of included studies](#) table.

Further details are provided in the [Characteristics of included studies](#) table.

Twelve qualitative studies of people's views, opinions and experiences were included ([Appendix 3](#)).

### Setting

Studies were published between 1998 and 2016. All studies were conducted in high-income countries. This included nine trials based in the US ([Baker 2001](#); [Cheung 2014](#); [Focht 2005](#); [Keefe 2004](#); [Mikesky 2006](#); [Park 2014](#); [Schlenk 2011](#); [Sullivan 1998](#); [Wang 2009](#)); three in Australia ([Bennell 2014](#); [Bennell 2016](#); [Fransen 2007](#)); and one each in Ireland ([French 2013](#)), the UK ([Hurley 2007](#)), the Netherlands ([Hopman-Rock 2000](#)), South Korea ([Kim 2012](#)), Turkey ([Aglamis 2008](#)), Canada ([Péloquin 1999](#)), Taiwan ([Kao 2012](#)), Norway ([Fernandes 2010](#)), and Hong Kong ([Yip 2007](#)).

All the studies providing qualitative data were published from 2005 onwards. This date reflected the development of qualitative methodology and its widening uptake being relatively recent developments, and earlier studies found through the search were of insufficient quality to include. Four studies were based in the UK ([Campbell 2001](#); [Hendry 2006](#); [Hurley 2010](#); [Morden 2011](#)), three in New Zealand ([Fisken 2016](#); [Larmer 2014b](#); [Moody 2012](#)); and one each in Australia ([Hinman 2016](#)), Canada ([Stone 2015](#)), Sweden ([Thorstensson 2006](#)), Iceland ([Petursdottir 2010](#)), and the Netherlands ([Veenhof 2006](#)).

All included papers were written in English.

### Design

Twenty studies evaluating the effectiveness of exercise programmes used individual participant randomised controlled designs and one study used a cluster randomised control design ([Hurley 2007](#)). Seventeen trials had two arms ([Aglamis 2008](#); [Baker 2001](#); [Bennell 2014](#); [Bennell 2016](#); [Cheung 2014](#); [Fernandes 2010](#); [Fransen 2007](#); [Hopman-Rock 2000](#); [Kao 2012](#); [Kim 2012](#); [Mikesky 2006](#); [Park 2014](#); [Péloquin 1999](#); [Schlenk 2011](#); [Sullivan 1998](#); [Wang 2009](#); [Yip 2007](#)), and four studies had three arms ([Focht 2005](#); [French 2013](#); [Hurley 2007](#); [Keefe 2004](#)). Seven studies compared exercise with a usual care control arm ([Hurley 2007](#); [Kao 2012](#); [Keefe 2004](#); [Kim 2012](#); [Péloquin 1999](#); [Schlenk 2011](#); [Yip 2007](#)), nine trials with an attention control ([Baker 2001](#); [Bennell 2014](#); [Bennell 2016](#); [Fernandes 2010](#); [Focht 2005](#); [Mikesky 2006](#); [Park 2014](#); [Sullivan 1998](#); [Wang 2009](#)), and five studies with a 'wait list' control ([Aglamis 2008](#); [Cheung 2014](#); [Fransen 2007](#); [French 2013](#); [Hopman-Rock 2000](#)).

All the studies included in the qualitative synthesis sought the views of people living with OA on aspects ranging from health beliefs to their experiences of exercise. Seven studies aimed to examine factors associated with exercise adherence, compliance and take up through the concepts of motivation and facilitators and barriers to participation in exercise ([Campbell 2001](#); [Fisken 2016](#); [Hendry 2006](#); [Petursdottir 2010](#); [Stone 2015](#); [Thorstensson 2006](#); [Veenhof 2006](#)). In the remaining five studies, the aims were to explore people's views of arthritis and exercise as a treatment ([Hurley 2010](#)), models of lay management ([Morden 2011](#)), and perceptions of an exercise intervention ([Hinman 2016](#); [Larmer 2014b](#); [Moody 2012](#)). Six studies included participants who had taken part in a formal evaluation of an exercise intervention, from which participants were drawn for in-depth interviews; these participants were actively engaged in exercise ([Campbell 2001](#); [Hinman 2016](#); [Hurley 2010](#); [Moody 2012](#); [Thorstensson 2006](#); [Veenhof 2006](#)). In the remaining six studies with no exercise intervention, participants' engagement in exercise ranged from sedentary

to actively engaged in exercise and everyday activities ([Fisken 2016](#); [Hendry 2006](#); [Larmer 2014b](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#)).

## Study size

The sample size of studies varied; the largest study randomly assigned 418 people ([Hurley 2007](#)), while the smallest randomly assigned only 21 people ([Schlenk 2011](#)). Overall, 11 studies had a sample size of fewer than 100 participants ([Aglamis 2008](#); [Baker 2001](#); [Cheung 2014](#); [Fransen 2007](#); [Hopman-Rock 2000](#); [Keefe 2004](#); [Kim 2012](#); [Park 2014](#); [Schlenk 2011](#); [Sullivan 1998](#); [Wang 2009](#)), and 10 studies had sample size between 102 and 418 participants ([Bennell 2014](#); [Bennell 2016](#); [Fernandes 2010](#); [Focht 2005](#); [French 2013](#); [Hurley 2007](#); [Kao 2012](#); [Mikesky 2006](#); [Péloquin 1999](#); [Yip 2007](#)).

The largest qualitative views study had a sample size of 29 participants ([Hurley 2010](#)), and the smallest contained six participants ([Hinman 2016](#)), with remaining sample sizes ranging from 12 to 22 participants ([Campbell 2001](#); [Fisken 2016](#); [Hendry 2006](#); [Larmer 2014b](#); [Moody 2012](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#); [Thorstensson 2006](#); [Veenhof 2006](#)).

## Outcomes

### Pain

Of the 21 studies included in the review, only one did not measure pain ([Schlenk 2011](#)); it was still included because of its measurement of function. Nine studies used the WOMAC ([Aglamis 2008](#); [Baker 2001](#); [Cheung 2014](#); [Fernandes 2010](#); [Focht 2005](#); [Fransen 2007](#); [Hurley 2007](#); [Mikesky 2006](#); [Wang 2009](#)), five studies used the VAS Pain ([Bennell 2014](#); [Bennell 2016](#); [Hopman-Rock 2000](#); [Kim 2012](#); [Yip 2007](#)), and two studies used the AIMS ([Keefe 2004](#); [Sullivan 1998](#)). The study by [French 2013](#) used a 'numerical rating scale' to measure pain severity during daytime activities and at night. In addition, [Park 2014](#) used the McGill Pain Questionnaire, [Péloquin 1999](#) used the Doyle's Joint Index and [Kao 2012](#) used a health-related quality of life measure for body pain.

### Physical function

Eighteen studies measured function. Thirteen studies used the WOMAC ([Aglamis 2008](#); [Baker 2001](#); [Bennell 2014](#); [Bennell 2016](#); [Cheung 2014](#); [Fernandes 2010](#); [Focht 2005](#); [Fransen 2007](#); [French 2013](#); [Hurley 2007](#); [Mikesky 2006](#); [Schlenk 2011](#); [Wang 2009](#)); two used AIMS subscales ([Péloquin 1999](#); [Sullivan 1998](#)); one used a health-related quality of life measure ([Kao 2012](#)); one used gait speed tests, the six-minute walk test and Berg Balance Scale ([Park 2014](#)); and one used a modified Health Assessment Questionnaire (HAQ) ([Yip 2007](#)).

### Self-efficacy

Eleven studies measured self-efficacy ([Bennell 2014](#); [Bennell 2016](#); [Focht 2005](#); [Hopman-Rock 2000](#); [Hurley 2007](#); [Keefe 2004](#); [Kim 2012](#); [Schlenk 2011](#); [Sullivan 1998](#); [Yip 2007](#); [Wang 2009](#)). Measures included those designed specifically for people living with OA (e.g. the Arthritis Self-Efficacy Scale), or focused on beliefs about ability to exercise.

### Depression and anxiety

Three studies measured anxiety and depression using the Hospital Anxiety and Depression Scale (HADS) ([Fransen 2007](#); [French 2013](#); [Hurley 2007](#)). Two studies measured depression, anxiety and stress using the 21-item Depression, Anxiety, Stress Scales ([Bennell 2014](#); [Bennell 2016](#)). Three studies measured depression only, two used the Center for Epidemiologic Studies Depression Scale (CES-D) ([Mikesky 2006](#); [Wang 2009](#)), and one study translated a "depression self-rated measure for use in Korean" ([Kim 2012](#)).

### Health-related quality of life

Five studies used the 36-item Short Form (SF-36) measure of health-related quality of life providing individual scores for four mental health-related subscales (e.g. emotional role, vitality, social functioning and mental health) ([Aglamis 2008](#); [Baker 2001](#); [Fernandes 2010](#); [Focht 2005](#); [Kao 2012](#)).

### Sleep quality

One study measured sleep quality using the Pittsburgh Sleep Quality Index ([Cheung 2014](#)).

## Population characteristics

### Symptoms

Fourteen studies recruited participants with knee OA only ([Aglamis 2008](#); [Baker 2001](#); [Bennell 2016](#); [Cheung 2014](#); [Focht 2005](#); [Hurley 2007](#); [Kao 2012](#); [Keefe 2004](#); [Mikesky 2006](#); [Péloquin 1999](#); [Schlenk 2011](#); [Sullivan 1998](#); [Wang 2009](#); [Yip 2007](#)), three studies recruited participants with hip OA only ([Bennell 2014](#); [Fernandes 2010](#); [French 2013](#)), and four studies included participants with hip OA or knee OA (or both) ([Fransen 2007](#); [Hopman-Rock 2000](#); [Kim 2012](#); [Park 2014](#)).

Participants in six of the studies reporting people's views had a diagnosis or experienced chronic pain in the knee only ([Campbell 2001](#); [Hendry 2006](#); [Hinman 2016](#); [Hurley 2010](#); [Morden 2011](#); [Thorstensson 2006](#)), and six studies recruited participants living with OA of the lower limbs ([Fisken 2016](#); [Larmer 2014b](#); [Moody 2012](#); [Petursdottir 2010](#); [Stone 2015](#); [Veenhof 2006](#)).

### Gender

Three trials recruited only women ([Aglamis 2008](#); [Cheung 2014](#); [Kim 2012](#)), while the remaining were mixed samples.



In the qualitative studies, one study recruited only women ([Fisken 2016](#)). Eleven studies enrolled both men and women with women outnumbering men in all but two of the studies ([Hinman 2016](#); [Thorstensson 2006](#)).

### Ethnicity

Only one trial, conducted in the US, reported the ethnicity of participants (eight African-American, three Hispanic/Latino and 91 Anglo-American; [Sullivan 1998](#)). [Cheung 2014](#) reported that 86% of participants were white and [Park 2014](#) reported that 61.8% of participants were non-Hispanic white, but neither study provided details of ethnicity of the remainders of their samples.

The majority of the qualitative studies did not explicitly state the ethnicity of participants. Of the three studies that reported ethnicity, participants were of black African, black Caribbean, Maori, Samoan, Indian or white ethnic backgrounds ([Fisken 2016](#): six New Zealand European, two Maori, three others; [Hurley 2010](#): three black African, five black Caribbean, one Indian and 20 Caucasian; [Larmer 2014b](#): 14 New Zealand European, one Samoan).

### Description of intervention

#### Types of exercise programmes

Of the 20 studies evaluating land-based exercise programmes, seven studies combined strength training with different forms of aerobic exercise ([Aglamis 2008](#); [Focht 2005](#); [Hurley 2007](#); [Keefe 2004](#); [Péloquin 1999](#); [Schlenk 2011](#); [Sullivan 1998](#)), eight delivered strength-based resistance training programmes ([Baker 2001](#); [Bennell 2014](#); [Bennell 2016](#); [Fernandes 2010](#); [French 2013](#); [Hopman-Rock 2000](#); [Kao 2012](#); [Mikesky 2006](#)), three provided Tai Chi ([Fransen 2007](#); [Wang 2009](#); [Yip 2007](#)), and two provided yoga ([Cheung 2014](#); [Park 2014](#)). One study provided water-based exercise ([Kim 2012](#)).

Thirteen studies had interventions with an educational component. Seven studies delivered educational interventions aimed at enhancing coping strategies and self-efficacy ([Bennell 2016](#); [Fernandes 2010](#); [Hurley 2007](#); [Keefe 2004](#); [Park 2014](#); [Schlenk 2011](#); [Yip 2007](#)); five studies provided one-off sessions on a range of topics such as types of OA, risk factors, pain management of OA, problem solving and self-efficacy ([Aglamis 2008](#); [Hopman-Rock 2000](#); [Kao 2012](#); [Kim 2012](#); [Sullivan 1998](#)); and one study provided patient information leaflets about OA ([French 2013](#)).

Activities carried out within the exercise programmes varied across the studies. More common interventions included walking or cycling (or both) for aerobic exercise, and isotonic exercises (i.e. incorporating movement) such as knee extensions and step-ups for strength training. Combinations of different exercise protocols were widely utilised, and the attributes of these (exercises, sets and repetitions, location and frequency of exercise sessions) varied from study to study.

#### Format and setting

Twelve studies delivered exercise interventions in a group format ([Cheung 2014](#); [Fransen 2007](#); [Hopman-Rock 2000](#); [Hurley 2007](#); [Kao 2012](#); [Keefe 2004](#); [Kim 2012](#); [Mikesky 2006](#); [Park 2014](#); [Sullivan 1998](#); [Wang 2009](#); [Yip 2007](#)). Seven studies delivered exercise as one-to-one sessions either at home or at a facility ([Baker 2001](#); [Bennell 2014](#); [Bennell 2016](#); [Focht 2005](#); [French 2013](#); [Péloquin 1999](#); [Schlenk 2011](#)). Two studies comprised of group-based sessions and an individual physical therapy ([Fernandes 2010](#); [Hurley 2007](#)). It was unclear in one study in which format the exercise was delivered ([Aglamis 2008](#)). In six studies, the interventions contained elements of behaviour-graded exercise with an individualised exercise programme for each participant ([Aglamis 2008](#); [Baker 2001](#); [Fernandes 2010](#); [French 2013](#); [Hurley 2007](#); [Kao 2012](#)).

Only two of the qualitative studies involved a water-based exercise intervention ([Moody 2012](#); [Larmer 2014b](#)), four studies were land-based exercise interventions ([Campbell 2001](#); [Hinman 2016](#); [Hurley 2010](#); [Veenhof 2006](#)), two studies were home-based ([Campbell 2001](#); [Hinman 2016](#)), and two studies were in primary care/community settings ([Hurley 2010](#); [Veenhof 2006](#)).

#### Intervention providers

Fifteen studies delivered the exercise interventions by trained professionals who were fitness/exercise instructors or physiotherapists ([Aglamis 2008](#); [Bennell 2014](#); [Bennell 2016](#); [Cheung 2014](#); [Fernandes 2010](#); [French 2013](#); [Hopman-Rock 2000](#); [Hurley 2007](#); [Kao 2012](#); [Keefe 2004](#); [Kim 2012](#); [Mikesky 2006](#); [Park 2014](#); [Schlenk 2011](#); [Sullivan 1998](#)). In two studies involving Tai Chi used instructors who were qualified Tai Chi Masters ([Fransen 2007](#); [Wang 2009](#)), and one study used a nurse specially trained to deliver Tai Chi ([Yip 2007](#)). The remaining three studies did not state who delivered the interventions ([Baker 2001](#); [Focht 2005](#); [Péloquin 1999](#)).

#### Excluded studies

A total of 395 studies did not meet the eligibility criteria and were excluded from the review. For brevity, a sample of 62 excluded studies and their reasons are shown in the [Characteristics of excluded studies](#) table.

#### Risk of bias in included studies

The risk of bias is summarised in [Table 1](#) and also shown in the 'Risk of bias' graph in [Figure 3](#) and the 'Risk of bias' summary in [Figure 5](#).

The assessment of the quality of the design and risk of bias of the quantitative studies included in this review are presented in the [Characteristics of included studies](#) table and [Table 1](#).

#### Allocation (selection bias)

Six studies had a high or unclear level of allocation bias. The methods used to generate the randomisation were unclear and therefore introduced a risk of bias in five of the 21 studies ([Hopman-Rock 2000](#); [Kao 2012](#); [Keefe 2004](#); [Kim 2012](#); [Schlenk 2011](#)). Allocation in one study was partly based on people with more severe Alzheimer's being unsuited to the intervention thus introduced bias, and the procedure for allocation may have given some participants an increased chance of choosing a particular condition, creating high risk of bias ([Park 2014](#)).

Allocation concealment was poorly described, giving a high risk of bias in 11 studies ([Focht 2005](#); [Hopman-Rock 2000](#); [Kao 2012](#); [Keefe 2004](#); [Kim 2012](#); [Mikesky 2006](#); [Park 2014](#); [Péloquin 1999](#); [Schlenk 2011](#); [Sullivan 1998](#); [Yip 2007](#)). The remaining studies were at low risk of allocation concealment.

### ***Blinding (performance bias and detection bias)***

Twenty of the studies did not conduct blinding of participants due to the difficult nature of blinding to exercise interventions. However, one study used an innovative sham treatment design, with participants not identifying beyond numbers expected by chance whether their treatment was sham or genuine (James test), thus reducing risk of bias for participants ([Bennell 2014](#)), although exercise participants were not blinded to their intervention. Eight of the studies did not blind the outcome assessors and so had a high risk of bias ([Baker 2001](#); [French 2013](#); [Kao 2012](#); [Keefe 2004](#); [Kim 2012](#); [Schlenk 2011](#); [Sullivan 1998](#); [Yip 2007](#)). All studies utilised participant self-report scales, and since there were no attempts to blind participants in 20 of the 21 studies, this may have led to reporting bias.

### ***Incomplete outcome data (attrition bias)***

Three studies had a high risk of bias for incomplete outcome data ([Kao 2012](#); [Park 2014](#); [Yip 2007](#)). Five studies were at unclear risk of bias ([Aglamis 2008](#); [Kim 2012](#); [Mikesky 2006](#); [Péloquin 1999](#); [Sullivan 1998](#)). The remaining studies were at low risk of attrition bias.

### ***Selective reporting (reporting bias)***

All the studies reported all the outcomes mentioned in their methods sections giving them all a low risk of bias in selective reporting.

### ***Other bias***

One study was at unclear risk of other bias as the authors reported no statistically significant baseline differences between groups but did not report the values ([Schlenk 2011](#)). The remaining studies were at low risk of other bias.

### ***Threats to rigour of qualitative studies***

Rigour of qualitative studies

See [Table 1](#); [Table 2](#).

### ***Dependability of qualitative studies***

See [Table 1](#).

### ***Sampling***

Eleven of the 12 studies were judged to have made a thorough attempt ([Campbell 2001](#); [Hendry 2006](#); [Hinman 2016](#); [Veenhof 2006](#)) or took several steps ([Fiskén 2016](#); [Hurley 2010](#); [Larmer 2014b](#); [Moody 2012](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#)), to increase rigour in the sampling process ([Table 2](#)). Studies attempted to sample a diverse range of participants to represent geographic or socioeconomic diversity, or both. Participant recruitment strategies included sampling from the wider community, two or more GP surgeries or through existing evaluations of exercise programmes. Only one study was judged as making a 'few steps' because of lack of detail in their reporting ([Thorstensson 2006](#)).

### ***Data collection***

Five studies were judged to have made a thorough attempt to increase rigour in the collection of data ([Hendry 2006](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#); [Thorstensson 2006](#)) ([Table 2](#)). These studies described how they put interviewees "at ease," such as offering people a choice of interview venue (e.g. at home or in the workplace). Two studies also attempted to enhance the validity of their study by using more than one method of data collection to triangulate their findings, for example by conducting indepth interviews and a focus group ([Hendry 2006](#)) or diary study ([Morden 2011](#)). The remaining seven studies had taken several steps to increase rigour of data collection ([Campbell 2001](#); [Fiskén 2016](#); [Hinman 2016](#); [Hurley 2010](#); [Larmer 2014b](#); [Moody 2012](#); [Veenhof 2006](#)). These studies also used indepth or semi-structured interviews methods with the option of raising "off topic schedule" issues of relevance to participants ([Table 2](#)).

### ***Data analysis***

Six studies had made a thorough attempt ([Hendry 2006](#); [Hinman 2016](#); [Morden 2011](#); [Petursdottir 2010](#); [Thorstensson 2006](#); [Veenhof 2006](#)), and a further six studies had made several attempts ([Campbell 2001](#); [Hurley 2010](#); [Fiskén 2016](#); [Larmer 2014b](#); [Moody 2012](#); [Stone 2015](#)) to increase rigour in the analysis ([Table 2](#)). All studies used an established method for analysing qualitative data (e.g. thematic analysis, constant comparative approach or grounded theory approaches) involving two or more researchers coding and comparing their analysis. Studies judged to have made a thorough attempt adopted additional strategies designed to increase validity and dependability such as presenting emerging findings to interviewees or peers to obtain further feedback and refine their analysis.

*Supported by/grounded in the data*

All studies were judged to have been at least well grounded ([Hinman 2016](#); [Hurley 2010](#); [Hendry 2006](#); [Larmer 2014b](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#); [Thorstensson 2006](#)) or fairly well grounded ([Campbell 2001](#); [Fisken 2016](#); [Moody 2012](#); [Veenhof 2006](#)) with supporting data ([Table 2](#)). All studies provided a clear demarcation between participant's views and the author's description and interpretation of findings, with quotes from participant to show how the authors arrived at their findings.

**Breadth and depth**

Six studies provided both breadth and depth in their findings ([Campbell 2001](#); [Hendry 2006](#); [Hinman 2016](#); [Hurley 2010](#); [Stone 2015](#); [Thorstensson 2006](#)) ([Table 2](#)). Three reported indepth findings but did not cover a wide range of themes (i.e. depth but little breadth) ([Moody 2012](#); [Morden 2011](#); [Veenhof 2006](#)). The remaining three studies described a range of barriers and facilitators relevant to answering the review question, but did not report them indepth ([Fisken 2016](#); [Larmer 2014b](#); [Petursdottir 2010](#)).

**Perspectives**

The remaining quality criteria assessed the extent to which studies privileged the perspectives and experiences of older people living with knee or hip OA (or both) ([Table 2](#)). Studies were rated highly, being judged as privileging older people's perspectives "somewhat" ([Fisken 2016](#); [Hurley 2010](#); [Moody 2012](#); [Morden 2011](#); [Thorstensson 2006](#); [Veenhof 2006](#)) or "a lot" ([Campbell 2001](#); [Hendry 2006](#); [Hinman 2016](#); [Larmer 2014b](#); [Petursdottir 2010](#); [Stone 2015](#)).

**Dependability and credibility of qualitative studies**

None of the studies included in the qualitative synthesis were at low quality when assessing their dependability or credibility ([Table 1](#)). All studies took steps to ensure methodological reliability by reducing threats to rigour and were judged to be of high ([Campbell 2001](#); [Hendry 2006](#); [Hinman 2016](#); [Hurley 2010](#); [Larmer 2014b](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#); [Thorstensson 2006](#)) or medium ([Fisken 2016](#); [Moody 2012](#); [Veenhof 2006](#)) quality (dependability). All studies provided useful evidence to answer the review question on participant's experiences of exercise-based rehabilitation programmes; nine studies were judged at high quality ([Hendry 2006](#); [Hinman 2016](#); [Hurley 2010](#); [Moody 2012](#); [Morden 2011](#); [Petursdottir 2010](#); [Stone 2015](#); [Thorstensson 2006](#); [Veenhof 2006](#)), and three studies were judged at medium quality ([Campbell 2001](#); [Fisken 2016](#); [Larmer 2014b](#)) ([Table 1](#)).

**Studies by review authors**

One qualitative study ([Hurley 2010](#)) and three strands of a quantitative study ([Hurley 2007](#)) were authored by a member of the review team. Assessment of these papers was carried out by other members of the team. As any contributor would be a named author, it was not possible to achieve a completely independent review.

**Effects of interventions****1. Quantitative synthesis: effectiveness of exercise programmes**

**Extraction of statistics.** In the meta-analyses the four three-arm studies that compared two active arms to a control had their control groups artificially regarded as being split in half (labelled (a) and (b)) to avoid double-counting ([Focht 2005](#); [French 2013](#); [Hurley 2007](#); [Keefe 2004](#)) (according to [Higgins 2011b](#)), giving 21 comparisons in the meta-analyses ('Analysis 1.1' to 'Analysis 1.10').

**Assumptions.** One trial provided 95% CIs of various outcomes (WOMAC, global assessment, chair stand, CES-D, SF-36, six-minute walk test, balance and self-efficacy) over repeated measurements weekly to 12 weeks, then at 24 and 48 weeks' follow-up ([Wang 2009](#)). There was no loss to follow-up, so the stable CIs can be interpreted as stable SDs, and so we assumed this to be the case wherever SDs at endpoint were not provided, and substituted the baseline statistics. One trial reported baseline and change, which were suggestive of a mostly symptom-free sample of participants with small mean changes, which led us to assume constant SDs ([Mikesky 2006](#)).

One trial provided outcomes in terms of mean change from baseline and t-statistics, and to convert this to SDs at endpoint requires information on the baseline-endpoint correlation, which is rarely given in RCT publications ([Wang 2009](#)). Testing different values with the statistics from the three studies suggested that the correlation was between 0.5 and 0.7, and so we assumed it to be 0.6 wherever required.

**Subgroup analyses.** We were unable to carry out subgroup analyses by age, gender and severity of symptoms due to the paucity of detail in the papers regarding these measures. However, we utilised subgroup analyses with respect to two trials with unusual characteristics. One trial used a depression scale in a long-established Korean translation, and had an unusually large SMD, so we analysed it in its own subgroup ([Kim 2012](#)). One trial reporting SF-36 quality of life using a validated Turkish translation reported unusually high improvements in the active group and unusually large deteriorations in the control group ([Aglamis 2008](#)). It was unclear why this study was so unlike the others reporting SF-36 and so we analysed it in its own subgroup.

**Major outcomes****Pain**

Nine trials reported WOMAC pain (11 comparisons; 1058 participants), and their pooled effect showed exercise had a statistically significant effect on pain reduction and had low heterogeneity (SMD -0.33, 95% CI -0.46 to -0.21;  $I^2 = 23\%$ ; [Analysis 1.1](#)). Other pain outcomes, reported by 10 trials (12 comparisons), also favoured exercise but their pooled effect was not statistically significant and had moderate heterogeneity (SMD -0.07, 95% CI -0.19 to 0.05;  $I^2 = 69\%$ ). Pooling the

pain results from all 19 trials (23 comparisons) showed exercise had a statistically significant effect on pain reduction with moderate heterogeneity (SMD -0.20, 95% CI -0.28 to -0.11,  $I^2 = 62\%$ ).

### Physical function

The 13 trials (16 comparisons; 1599 participants) reporting WOMAC function had a statistically significant pooled effect favouring exercise (lower WOMAC function score represented greater function) with moderate heterogeneity (SMD -0.27, 95% CI -0.37 to -0.17;  $I^2 = 45\%$ ; [Analysis 1.2](#)).

### Self-efficacy

Eleven trials (13 comparisons; 1138 participants) reported nine different outcome measures of self-efficacy, so meta-synthesis was challenging. The pooled effect showed exercise increased self-efficacy and the trials had low heterogeneity (SMD 0.46, 95% CI 0.34 to 0.58;  $I^2 = 54.9\%$ ; [Analysis 1.3](#)). [Focht 2005](#) reported two different measures, six-minute walk and stair climb. To avoid duplication from the same sample, we used the six-minute walk data as this was the more common measure.

### Depression

Six trials (8 comparisons; 806 participants) indicated exercise had no effect on depression (SMD -0.09, 95% CI -0.24 to 0.05;  $I^2 = 0\%$ ; [Analysis 1.4](#)). The inclusion of [Kim 2012](#) (70 participants) resulted in an effect; heterogeneity increased markedly but remained low (SMD -0.16, 95% CI -0.29 to -0.02;  $I^2 = 36\%$ ).

### Anxiety

Four trials (six comparisons; 704 participants) reported anxiety; their pooled effect suggested exercise did not affect anxiety (SMD -0.11, 95% CI -0.26 to 0.05,  $I^2 = 0\%$ ; [Analysis 1.5](#)).

### Quality of life

#### *SF-36 social function*

Four trials (five comparisons) showed exercise had a statistically significant benefit for social function (MD 6.58, 95% CI 2.78 to 10.38;  $I^2 = 0\%$ ; [Analysis 1.9](#)). [Aglamis 2008](#) had a large statistically significant effect (MD 58.30, 95% CI 34.58 to 82.02). The overall finding was not affected if [Aglamis 2008](#) was included, but heterogeneity increased substantially (MD 7.87, 95% CI 4.12 to 11.62,  $I^2 = 75\%$ ; 576 participants).

### Adverse effects of exercise

None of the studies reported adverse effects of exercise.

### Minor outcomes

#### Stress

Two trials (two comparisons; 206 participants) measured stress, which decreased following exercise (MD -4.76, 95% CI -7.57 to -1.95; [Analysis 1.6](#)).

### Quality of life

#### *SF-36 mental health*

Although the pooled effect of four trials (five comparisons) appeared statistically significant (MD 2.90, 95% CI 0.15 to 5.65,  $I^2 = 36\%$ ; [Analysis 1.7](#)), the low heterogeneity of the studies except for one unusual outlier means this result should be treated with some caution. In one trial (25 participants), exercise improved SF-36 mental health substantially alongside very small SDs; the reason for this was unclear (MD 32.90, 95% CI 23.07 to 42.73) ([Aglamis 2008](#)). Including [Aglamis 2008](#) with the other trials raised the pooled effect, but heterogeneity increased substantially (MD 5.07, 95% CI 2.43 to 7.72,  $I^2 = 87\%$ ; 576 participants).

#### *SF-36 emotional role*

There was a non-significant, uncertain effect in four trials (five comparisons) that measured SF-36 emotional role (MD 1.76, 95% CI -6.63 to 10.14,  $I^2 = 54\%$ ; [Analysis 1.8](#)); heterogeneity was moderate. [Aglamis 2008](#) had a large statistically significant effect (MD 72.80, 95% CI 47.14 to 98.46). Including [Aglamis 2008](#) increased the estimate of the pooled effect but it remained uncertain, although heterogeneity increased substantially (MD 11.43, 95% CI -4.06 to 26.71,  $I^2 = 87\%$ ; 576 participants).

#### *SF-36 vitality*

Four trials (five comparisons) showed exercise had a statistically significant beneficial effect on SF-36 vitality (MD 3.90, 95% CI 0.55 to 7.25,  $I^2 = 15\%$ ; [Analysis 1.10](#)). [Aglamis 2008](#) had a large improvement in vitality (MD 51.90, 95% CI 34.74 to 69.06), but the overall finding was not affected when this study was included, although heterogeneity increased substantially (MD 5.67, 95% CI 2.38 to 8.96,  $I^2 = 85\%$ ; 607 participants).

### Sleep

One trial measured sleep ([Cheung 2014](#); 36 participants) and there was no statistically significant difference in sleep quality (MD -1.10, 95% CI -2.54 to 0.34; [Analysis 1.11](#)).

## 2. Qualitative synthesis: people's views on exercise and exercise programmes

This section summarises the findings from 12 studies that reported the perspectives and experiences of older people living with knee or hip (or both) OA and exercise ([Campbell 2001](#); [Fisken 2016](#); [Hendry 2006](#); [Hinman 2016](#); [Hurley](#)



2010; Larmer 2014b; Moody 2012; Morden 2011; Petursdottir 2010; Stone 2015; Thorstensson 2006; Veenhof 2006).

The use of a framework synthesis enabled the findings from each of the studies to populate the main concepts outlined in the conceptual framework and supported the identification of additional themes and subthemes, enriching our understanding of the relationship between health beliefs, the psychosocial impact of arthritis and the role of exercise in mediating those impacts (Figure 6). The synthesis was organised according to the final, more detailed conceptual framework and presented themes related to older people's views within the four conceptual areas: (I) symptoms; (II) health beliefs and views on management; (III) psychological factors; and (IV) social and environmental factors influencing engagement in physical activity. CERQual assessments of the findings were carried out, and the findings and assessments are summarised in Table 3.

Some of the exercise activities were clearly comparable with studies in the quantitative analysis: Hurley 2010, Moody 2012, and Veenhof 2006 all drew their samples from people taking part in studies included in the quantitative analysis. Participants in Hendry 2006 and Morden 2011 had not necessarily taken part in exercise, while participants in Campbell 2001, Petursdottir 2010, and Thorstensson 2006 had taken part in exercise programmes, but these were not described in sufficient detail to compare them with programmes in the quantitative studies.

### I. Symptoms: pain, muscle weakness, physical function

In six studies, people's descriptions and experiences of pain and its impact dominated their narratives of living with OA because it affected most areas of their daily life, in a variety of ways (Campbell 2001; Hendry 2006; Hurley 2010; Morden 2011; Petursdottir 2010; Stone 2015). Although pain varied greatly within and between people, most described pain as being episodic, very unpredictable (Hurley 2010; Petursdottir 2010; Morden 2011) with its severity varying greatly from day to day (Campbell 2001; Hendry 2006; Hurley 2010; Petursdottir 2010; Morden 2011; Moody 2012; Morden 2011). For many people, the impact of pain on their physical function, mobility and wider aspects of their lives made arthritis a life-changing condition, whose symptoms gradually increased over time (Campbell 2001; Hendry 2006; Hurley 2010): "...it got worse and worse and I started falling down..." (Campbell 2001, p.155). They talked about how this made even the most common activities of daily life difficult to perform; "I'm always in pain and agony, every movement is a chore. Sometimes, I just stare at my stairs, dreading what comes next" (Stone 2015). "...I can't walk as fast or as far as I used to because my knee hurts..." (Hendry 2006, p.560); "...getting out of bed, getting going, turning over in bed, waking up in the night...getting in and out of the car is a nightmare..." (Hurley 2010, p.5). People had adjusted their daily activities and routines to cope with their pain and reduced physical capabilities (Petursdottir 2010; Morden 2011): "...re-arranging the order of kitchen shelving or altering walking routes to avoid hills if they found them problematic..." (Morden 2011, p.194).

### Capacity to exercise

Six studies commented on how pain, joint stiffness, fatigue, comorbidity and people's perceptions of their physical fitness restricted the type and amount of exercise people could do (Campbell 2001; Hendry 2006; Hurley 2010; Moody 2012; Petursdottir 2010; Thorstensson 2006). People who reported feeling pain and fatigue afterwards felt less able to exercise (Hurley 2010); "...anything that would jog or jar my knee would really hurt...it's hard to get going on a bike and very painful..." (Hendry 2006, p.560). The severity of symptoms and their perceived physical capacity not only limited people's ability to exercise, but also affected their ability to carry out sustained and regular exercise (Campbell 2001; Moody 2012). The hope of reducing pain could be a motivating factor in increasing the likelihood of exercise. However, the variability of pain often meant people could not get into a regular exercise routine, but had to "adapt their exercise pattern to their levels of pain" (Petursdottir 2010, p.1020). Some people avoided exercise because of the additional time, effort and fatigue associated with exercise: "...the effort to get clean afterward is really hard...you just don't have the energy to take a shower..." (Petursdottir 2010, p.20); "...that's why I missed some of them. I couldn't go [to] more than one because I was just so tired the next day..." (Moody 2012, p.67). Some people also said old age limited what they could do and prevented exercise from helping them; "...I've reached an age where exercise doesn't help...I just get tired; I'm not fit and agile enough to do exercises..." (Hendry 2006, p.560). The physical and mental impact of comorbidity common in elderly people was also cited as a reason for impairing people's ability and desire to exercise (Campbell 2001; Hendry 2006).

### Impact of exercise on the effects of osteoarthritis

Ten studies described the impact exercise could have on people's physical symptoms (Campbell 2001; Hendry 2006; Hinman 2016; Hurley 2010; Larmer 2014b; Moody 2012; Petursdottir 2010; Stone 2015; Thorstensson 2006; Veenhof 2006). Some participants reported dramatic improvement in pain and physical function; "...the exercises we did at [centre] were helping and see I haven't had the pain...it was very helpful" (Hurley 2010, p.7), "the physiotherapist professionally guided me to feel less pain" (Stone 2015, p.14), "...exercise is the best thing for relieving pain..." (Hendry 2006), "at least 50% difference in the stiffness" (Larmer 2014b, p.91). However, other people found little or no benefit; "...exercise doesn't help my knees at all..." (Hendry 2006, p.561), or that exercise exacerbated pain; "In my case...the damage became worse, it only led to more pain instead of improvement" (Thorstensson 2006, p.56). Some people considered other treatment options to be more relevant; "it [the exercise] was beneficial and it helped in the short term. However, had I not received injections I would never have been able to work for so long. It is thanks to them that I have been able to work for the past five or six years or since I got osteoarthritis. That is a fact" (Thorstensson 2006, p.56).

For people who found exercise beneficial, the reduced pain resulted in improved physical functioning enabling people to perform common daily or recreational activities they had previously avoided or given up to avoid aggravating their symptoms. Such improvements returned a degree of normality to people's lives, "...for example, walking longer distances, there are

*limits, but nevertheless longer walks without experiencing pain. It is a huge difference. So it was very positive...it makes it possible to work more and you can do more enjoyable things too...*" (Thorstensson 2006, p.55); "...walking up stairs, I mean, at times I used to have to go up one step at a time, but then after the exercise I could just walk up the stairs and I was even beginning to try to walk normal..." (Hurley 2010, p.7); "The pain is different pain and I feel that I can do things easier now than I could a while back" (Hinman 2016, p.486).

Exercise was also perceived to have general health benefits including improvement in breathing, balance, sleeping and a reduction in falls (Campbell 2001; Moody 2012); "...since I started strengthening these muscles it seems I don't fall over so much which is good...it's so embarrassing..." (Campbell 2001, p.135); "...exercise has a good affect [effect] on everything including the heart" (Petursdottir 2010, p.1020). It was also possible for people to experience improved function and mobility but for pain to persist; "...exercise doesn't help pain but it gets it going, improves stiffness and mobility..." (Hurley 2010, p.562).

Many people stopped exercising after completing a programme (Campbell 2001; Hendry 2006; Hurley 2010; Thorstensson 2006 p.55), some because the perceived benefits were insufficient to warrant the time and effort invested; "...I was able to [exercise] pretty easily but it didn't appear to me to make a lot of difference...I carried them on during the time I was taking part in the programme although I've dropped them since..." (Campbell 2001, p.136).

## II. Health beliefs and views on the management of osteoarthritis

### Aetiology and prognosis of osteoarthritis

Four studies explored people's beliefs about the cause of OA (Campbell 2001; Hendry 2006; Hurley 2010; Morden 2011). Many people believed OA to be a normal part of the ageing process and a result of the 'wear and tear' on their joints incurred during occupational (Campbell 2001) and leisure activities or following injury (Hendry 2006; Hurley 2010; Morden 2011), "...I think it's just wear and tear. I think it's just accepted that you're going to get these things as you get older..." (Hurley 2010). Some people thought OA was hereditary and recalled relatives who had joint problems (Hurley 2010), others attributed it to excess bodyweight increasing the stress and strain on joints (Campbell 2001; Hendry 2006). Fatalistic views often made it difficult to convince people that things could be done to improve the prognosis of their symptoms; "...nothing will stop it getting worse I'm sure..." (Hurley 2010, p.5).

### Non-exercise management strategies

Three studies explored people's views of management strategies and found these were usually limited to medication (analgesia) and surgery (Campbell 2001; Hendry 2006; Hurley 2010), with little or no awareness of other management options, such as exercise (Hurley 2010). While many people believed medication could alleviate symptoms and used analgesia to manage severe pain, generally people disliked taking medication and often put up with pain; "I am not a one for taking a lot of tablets. I get a bit dubious, you know, so I just learnt to live with it for a bit" (Campbell 2001, p.134). People were reluctant to use medication because of concerns about the adverse effects, becoming "addicted" to medication and reduced effectiveness if taken regularly (pharmacological tolerance) (Campbell 2001; Hurley 2010); "...I do really try to keep off drugs because, you know, I mean I think that they all have side effects..." (Hurley 2010, p.5). People also avoided medication because they thought pain was a warning sign of further joint damage, and taking medication that suppressed this warning might make the problem worse; "...I'm not keen to take things because they're not going to cure it, and I mean to hide it is not strictly a good idea because you do things and it makes it worse..." (Hendry 2006, p.561).

One study described people's different attitudes towards surgery. Some people thought surgery the best way to correct the damaged caused by OA, eliminate pain, and restore mobility and function, others were more sceptical (Hurley 2010). People's views on surgery were influenced by the experiences of family and friends, reports in the media or the presence of comorbidities; "...I don't want knee surgery, I've seen it happen; I've seen people have it very successfully and I've seen it be a disaster" (Hurley 2010). Most people wanted to delay surgery for as long as possible; "...I'd have to be a lot worse than what I am now I think...well I mean if I've gone for thirty years I can go on for a few more..." (Hurley 2010, p.5).

People also reported using conservative, non-pharmacological interventions such as acupuncture, osteopathy, herbal remedies and supplements, on the recommendations of family, friends, advertisements and media reports. While some people believed these to be helpful, others were unconvinced, but often continued taking them in the hope that they would slow the progression of the disease (Hurley 2010).

### Advice and information from health professionals

Six studies reported the advice and information derived from health professionals (Campbell 2001; Hendry 2006; Hinman 2016; Hurley 2010; Petursdottir 2010; Stone 2015). People often formed beliefs about OA in the early stages of the diagnosis process, sometimes with little or no advice or information from health professionals, leaving them ill-informed about the aetiology of OA and appropriate management strategies (Campbell 2001; Hendry 2006; Hurley 2010; Petursdottir 2010; Stone 2015); "When I was first diagnosed, I didn't know what to think. I knew it wasn't good,... And no one warned me I didn't even know what to do...exercise was the farthest thing from my mind" (Stone 2015, p.6); "...[doctor] never said anything, that's why I have always thought it's not worth bothering about. He's not bothered so I am not bothered..." (Hurley 2010, p.5). Few people reported having received advice about exercise; "...I haven't had any advice about exercising and what exercises to do..." (Hendry 2006, p.561), or further guidance; "they [the physicians] are positive if you ask [for a referral to a physical therapist], but you have to ask" (Petursdottir 2010, p.1021).

Where information about exercise was provided, it was often vague, unclear and conflicting. Hendry and colleagues

reported one participant had been advised to exercise; "...my doctor told me to keep exercising and not to stop..." (Hendry 2006, p.561), while another participant had been discouraged from exercising, "...they [doctor] said, 'the walking's agitating you, your joints, so stop it'..." (Hendry 2006, p.561). Negative encounters with health professionals reinforced people's negative beliefs about exercise and their views that very little could be done; "So I go to the doctor and all he just simply done was put his hand on my knee, he said 'move your leg...you are getting old you've got rheumatism.' You see that was it I didn't take any more notice of it [the knee pain]" (Campbell 2001, p.135).

Conversely, provision of good advice and information positively influenced people's attitudes and behaviours towards exercise and its benefits (Campbell 2001; Hendry 2006; Hurley 2010; Petursdottir 2010; Stone 2015). Information was an important form of support that taught people about their condition and how to manage and cope with it (Hurley 2010); "...I learned so much from [the physiotherapist]...I learnt about pain management...it helped me understand arthritis much better..." (Hurley 2010, p.7). Many participants commented, "If my doctor tells me to [exercise], then I will" (Stone 2015). Information was viewed as invaluable when it came from someone people considered a knowledgeable healthcare professional who explained why the person was being asked to do something; tailored the advice to the recipient's individual context, experiences and condition; clearly specified what (not) to do; and that adhering to the advice brought benefits (Hendry 2006; Hurley 2010; Petursdottir 2010); "...I had to stick rigidly to what he had said, the weights that he had specified...the idea was to stretch it that little bit further than I normally would do in order to support the joint more...but too much would...cause more damage and not enough wouldn't do any good...I was quite impressed actually by his knowledge...and I did exactly what he said and I did notice an improvement, a definite improvement..." (Hendry 2006, p.563).

Improvement in people's symptoms and physical activity was often attributed to increased understanding and knowledge gained through information and practical advice delivered by healthcare professionals; "I was a bit sceptical at first and when the exercises came I thought 'hang on, this has got nothing to do with the knee as far I understand' being ignorant, you know. Now I sort of feel that 'hang on, yeah there is a difference' because the work has paid off" (Hinman 2016, p.486); "...now I think I handle it more wisely. I know better because I've been fortunate to get good instruction..." (Petursdottir 2010, p.1020).

### Health beliefs and managing osteoarthritis and exercise

Six studies examined people's beliefs about the potential role of exercise in managing OA (Campbell 2001; Hendry 2006; Hinman 2016; Hurley 2010; Petursdottir 2010; Thorstensson 2006). They suggested people's attitudes towards exercise in the management of OA were closely linked to their beliefs and perceptions about the aetiology of OA and symptoms. All six studies reported people holding some form of negative belief about the cause, prognosis and treatment of OA. People who believed OA was caused by immutable factors, such as ageing or hereditary, tended to be resigned to their problems, weakening their resolve to actively manage it (Campbell 2001); "...there is nothing that can be done about the OA; therefore, I do nothing..." (Petursdottir 2010, p.1021).

While some people considered exercise essential, others held doubts or anxieties about the benefits they might attain from exercise. "There's a basic level of exercise that I have to do to keep the joints flexible, so I can get up and move around" (Hendry 2006, p.562). In contrast, other people were anxious about the possible harm they could cause to themselves by exercising if the activity-related pain was a signal of causing further damage (Hurley 2010; Thorstensson 2006); "...I'm questioning whether exercise might exacerbate or ease it. I really don't know..." (Hurley 2010, p.5). These doubts and anxieties often meant people avoided exercise (Hurley 2010; Thorstensson 2006). Some people thought they might be too old to benefit from exercise (Campbell 2001); "...[exercise] might not help me because I'm getting old...I just think I'm too old really to improve..." (Campbell 2001, p.135). People who believed excess bodyweight to be a contributing factor to OA thought any improvement would depend on them losing weight (Campbell 2001; Hurley 2010).

Four of the six studies found that after exposure to exercise (either independently or as part of a programme) participants held mostly positive beliefs about the benefits of exercise (Hendry 2006; Hinman 2016; Hurley 2010; Thorstensson 2006); "...I now know that it is beneficial. I know that simply going for a walk every day is very good for me. In that way I have changed. Previously I was not even aware that it was necessary" (Thorstensson 2006, p.53); "I know now it's going to be for my benefit. I keep on doing these exercises...if I stop, pain comes on again, and I can't do any activities" (Hinman 2016, p.485); "So your movement is important; this is why I want to get back into a regular exercise routine, so I can do more to help myself" (Hendry 2006, p.562). Hurley and colleagues was the only study that explored people's beliefs before and after participation in an education- and exercise-based rehabilitation programme, and how and why their beliefs changed (Hurley 2010). Participants' initial fears about the danger of exercise were allayed after experiencing the benefits of exercise on their symptoms without exacerbating pain; "...I thought if I exercise I am going to make the pain worse...they have showed me that I can still exercise even though I have a bad knee..." (Hurley 2010, p.7). They retained their beliefs about the causes of OA, but prior pessimism that nothing could be done to help them was replaced by a more optimistic opinion about the role of exercise in helping them cope with and manage their problems; "...[exercise helps you understand] how to cope with pain...that exercise does help ease the pain and helps your mobility...but there is no cure for [arthritis], it's learning to live with it..." (Hurley 2010, p.7).

### Everyday activities (physical activity) versus structured exercise

Four studies highlighted people's differing views about how best to increase physical activity and function, whether it required formal exercise or whether common activities of daily living, such as walking, would suffice (Hendry 2006; Moody 2012; Petursdottir 2010; Thorstensson 2006). Some people did not distinguish between structured physical activity and everyday activities and therefore saw no need to take part in formal exercise. "...I get enough exercise leading an active



life..." (Hendry 2006, p.562); "...I really don't think that I need to take some exercise, but I just tell myself that I am going shopping and things like that..." (Thorstensson 2006, p.55), while others felt everyday activities were insufficient; "...day-to-day activity isn't enough to keep you mobile..." (Hendry 2006, p.562). People believed increased physical activity was beneficial and attempted to integrate more physical activity into their daily lives and activities; "...I try to walk more and more, to walk in the correct way and to climb stairs in the correct way and not to wear myself out..." (Thorstensson 2006, pp.53-4).

### III. Psychological factors

#### Impact of osteoarthritis on people's sense of "self"

Four studies contributed to an understanding of the impact of OA on people's sense of self (Hurley 2010; Morden 2011; Petursdottir 2010; Stone 2015). While some people acknowledged the importance of mental health and remaining positive and cheerful (Petursdottir 2010), OA could have a detrimental effect on people's sense of "self" (their view of themselves, their roles, etc.), caused 'biographical disruption' and necessitate them having to reconstruct a new narrative (purpose) for themselves (Morden 2011, p.194). Some people were able to adapt and keep a valued sense of self, other people found it challenging to accept the effects and limitations due to OA, and adapt their existing self-image. For example, one participant's sense of self as a male provider and head of the family was challenged because of his diminished function, so he renegotiated his sense of self taking on a new "identity" as a carer looking after the home and his grandchildren. Examining how people maintain acceptable social roles, remain 'competent moral actors' and preserve a sense of self may be central to understanding and self-managing in chronic illness (Morden 2011, p.194). People who felt they were incapacitated and in need of additional help evoked feelings of frustration, anger, depression, embarrassment and being a burden to others (Hurley 2010, p.3); "...I'm very upset with myself cos [because], you know, when you're used to being mobile and able to do things for yourself, now you have to depend on people to do it, it's not very nice is it?..." (Hurley 2010, p.5); "It definitely wears on you, on your mind because it stops you from doing what you want to do. Even if my body wanted to [exercise], my mind won't let me...I feel helpless and worthless" (Stone 2015, p.5). This caused unhappiness, particularly in younger people; "...I was extremely unhappy with myself. I couldn't work as hard as before, and I just could not understand why. It was one of the hardest things, to accept myself as what I had become..." (Petursdottir 2010, p.1019), but older people who attributed OA to ageing accepted its associated problems more readily; "...well, you have to face the fact that you are not young anymore, and you just have to slow down..." (Petursdottir 2010, p.1019).

#### Individual disposition

Two reports showed the strong influence personal adaptability and initiative had on exercise behaviour (Petursdottir 2010; Stone 2015). A positive outlook was seen as vital in not letting OA define and control people's lives or prevent them continuing with their everyday physical activities (Petursdottir 2010); "...I worked out new ways to cope, to keep my arthritis from getting in the way too much..." (Petursdottir 2010, p.1018). Low self-efficacy was also a factor highlighted in Stone 2015 as many participants felt "demotivated from physical activity as they did not believe they could successfully perform a task without exacerbating their current pain levels" (p.9). As one participant expressed: "Not only does it hurt when you [move], but it would hurt the next day. The pain never lets you forget...and believe me, I don't. The only thing I can do is not do it again. Avoid exercise, avoid the pain" (Stone 2015, p.9).

#### Psychological benefits of exercise

Participants in eight studies reported psychological/psychosocial benefits of individual or group exercise (Fisken 2016; Hendry 2006; Hurley 2010; Larmer 2014b; Moody 2012; Morden 2011; Petursdottir 2010; Thorstensson 2006). People made notable claims about improvements in their mental state; "...overall I have improved...it's a feeling of general well being really...I feel a lot better in myself, I mean mentally, mostly mentally..." (Hurley 2010, p.1020); "you just feel great when you've done it...you know, they say exercise releases happy something in your brain and it certainly does..." (Hendry 2006, p.560). "Keeps the body moving, takes your mind off it, it's good to be outside. Yea, keeping active, or else if you've got osteo [osteoarthritis], it can get you right down, if you stay inside you just mope about it" (p.15); "...[W]hen I've been walking for a while, the pain goes away, which makes me happy..." (Thorstensson 2006, p.55). Participating in a formal exercise programme was also reported to reduce anxiety and increase confidence to exercise (Hurley 2010).

Programmes that involved group exercise meant people came into contact with other people with OA giving them the opportunity to make friends, share stories and gain peer support, "...I like the gym referral scheme because you're in a group of people who all have problems..." (Hendry 2006, p.562), "...we formed very tightly knit group...we were all trying to help one another, you know" (Hurley 2010, p.7). Being part of a group and having shared experiences made exercise more appealing, and more likely to be perceived as fun and enjoyable rather than a chore (Moody 2012). Choosing independent forms of exercise still provided opportunities for participants to benefit from the social experience of exercise "...when I've been swimming, that it does me good. Plus, I just love it. I enjoy it. It's a social thing as well and I just get so much out of it...I've made new friends and I just find that completely satisfying..." (Morden 2011).

Observing improvements in other people participating in exercise programmes was a source of encouragement (Hurley 2010, p.8). Furthermore, group activities helped people realise they were not unique in their difficulties: "It's been an awful shock to get sick...It's been really really difficult, so coming and talking to other people, probably has been almost as beneficial as doing the exercise and realising that you're not the only one" (Larmer 2014b, p.91).

#### Influence of programme supervisors

In nine of the 12 studies, participants who undertook supervised exercise programmes commented on the importance of individual attributes of programme supervisors, usually physiotherapists (Campbell 2001; Hendry 2006;



[Hinman 2016](#); [Hurley 2010](#); [Larmer 2014b](#); [Moody 2012](#); [Petursdottir 2010](#); [Thorstensson 2006](#); [Veenhof 2006](#)). The qualities people liked and derived value from included understanding, tolerance, friendliness, taking a genuine interest in them, encouragement, support and the guidance they received. Good communication skills and a sense of being listened to were also important to them.

Specific instruction on how to exercise alleviated people's anxiety and concern about doing it wrong; "...the gym instructors advise you and give you confidence that you're not going to make things worse..." ([Hendry 2006](#), p.562) and they believed "...someone with a medical background is the best person to supervise exercise..." ([Hendry 2006](#), p.562). Participants appreciated this needed the encouragement from instructors who could, "...jolly you along..." ([Moody 2012](#), p.660) and "...I think it's really a lot, in fact an enormous amount, to do with the facilitator, she's both kind of encouraging and yielding and nurturing and understanding, but also was able to use a bit of steel and get us off our bums..." ([Hurley 2010](#), p.7). Participants were more likely to adhere to an exercise programme if they were 'actively involved in the whole process' working alongside the physiotherapist ([Veenhof 2006](#), p.275). Such partnerships were positive in that they led to feelings of accountability, of not wanting to let down who they were working with, "...I wasn't obligated to do it but I felt let's do my bit towards it, you know. I didn't want her to simply think that she was wasting her time..." ([Campbell 2001](#), p.134). People were motivated by instructors: "The most important thing is listening to the physio [physiotherapist] and doing the exercises because he motivated me to do the exercises" ([Hinman 2016](#), p.486). However, there was also the danger that people became reliant on the instructor to lead the exercise, losing this support when the programme was completed could "...undermine their motivation to exercise..." ([Hurley 2010](#), p.9).

#### IV. Social and environmental factors

##### Prioritising exercise

In seven studies, participants commented on how difficult they found it to exercise regularly ([Campbell 2001](#); [Hendry 2006](#); [Hinman 2016](#); [Hurley 2010](#); [Moody 2012](#); [Morden 2011](#); [Thorstensson 2006](#)). Many people admitted they did not consider exercise to be a priority citing the demands of work and family life as impinging on their decision not to exercise; "...my job's very important, really important at the moment..." ([Morden 2011](#), p.196), and they struggled to find time to incorporate exercise in their daily routine; "...one is so occupied that it is very easy not to find time for exercise. Everything else takes precedence..." ([Thorstensson 2006](#), p.56). People were often aware their "reasons" for not exercising were often excuses to not exercise and that the real reason was the time and effort of exercising; "...its just excuses really when it comes down to the basics. I mean I could get up in the morning and do it between 6 or 7 or something like that..." ([Campbell 2001](#), p.135). People who considered exercise an important and effective way of managing OA found ways to accommodate regular exercise/physical activity into their daily routines; "...I do the exercises upstairs when I get up in the morning...I find I might have a bit more time, because during the day you tend to let things slide..." ([Hurley 2010](#), p.7); "It's part of life...I get up in the morning, I have a cup of coffee, I take my blood pressure medication, then I go and do my exercises...and I don't have to leave home!" ([Hinman 2016](#), p.486).

##### The support of family and friends

Four studies looked at the role family and friends played in supporting participants' engagement with exercise ([Campbell 2001](#); [Fisken 2016](#); [Petursdottir 2010](#); [Stone 2015](#)). Receiving emotional support, encouragement, approval and reassurance was seen as essential in motivating people to begin and maintain regular exercise. Programmes that allowed a friend or family member to exercise alongside the programme participants were appreciated and meant information provided by healthcare professionals could be reinforced ([Hendry 2006](#)). One participant, in the study by [Stone 2015](#), explained, "One of my friends who knows about my arthritis asked me if I ever exercise." "Exercise?!" I said, "What could I do with exercise?!" Then she said she would work out with me if I wanted to. That was the first time I ever seriously thought about exercising" pp.15-6. While the participants in [Fisken 2016](#) noted that when, "you're not stuck at home all the time, it's a way of getting out" finding that, "it's important to be with other people, how other people cope and that you're not alone and there are other people you know, in similar situations" (p.15).

##### Social characteristics

Two studies briefly explored the influence age on people's exercise behaviour ([Fisken 2016](#); [Hendry 2006](#)). Age could act as barrier when participants considered exercise classes as unsuitable for older people: "It's got to be paced at our age range" ([Fisken 2016](#), p.14). The expectation that other exercisers would be young and very fit was challenged: "I imagined...all these fit people you know, bodies like Adonis...I thought that I would be old, that I would show myself up, but in fact it wasn't like that at all...the people who were sort of totally 100% fit were very few and far between" ([Hendry 2006](#), p.563).

##### Exercise facilities

Six studies investigated the acceptability and accessibility of exercise facilities ([Fisken 2016](#); [Hendry 2006](#); [Larmer 2014b](#); [Moody 2012](#); [Petursdottir 2010](#); [Thorstensson 2006](#)). For elderly people, on low incomes and without transport, the cost and location of accessible exercise facilities was important ([Moody 2012](#); [Thorstensson 2006](#)), as was their experience of the facilities. The venues had to be convenient so that people "...did not have to travel long distances..." ([Thorstensson 2006](#), p.55), and some people preferred to exercise at home while others found outdoors more convenient ([Hendry 2006](#)). Cost was mentioned as a barrier especially for older people on a low or fixed income; "...couldn't probably afford a big amount, twice a week..." ([Moody 2012](#)); "I mean some of them charge an awful lot to get in. When you go up to the pool it's \$2 and then you get charged \$5 to go into the aerobics, well that's really, sort of, you know, pay for the guys time, that person's time but when you're on a pension you haven't got that" ([Fisken 2016](#), p.14). Thus, some people valued non-paid-for forms of exercise, such as walking, rather than travelling to attend expensive gyms ([Petursdottir](#)

2010, p.2021). However, inclement weather conditions, such as in Iceland, could be a barrier to exercising outside "...high winds and icy conditions prevented outdoor activities such as walking..." (Petursdottir 2010, p.1021).

Participants in two studies of water-based exercise commented on their experience of the water itself (Fisken 2016; Larmer 2014b). In some cases they liked that the water kept them 'balanced' (p.14) and that the depth of the water "takes the impact off your joints...it gives you freedom" (p.14) (Fisken 2016). However, negative reactions to water could also be a barrier: "When I was in [name of pool] I stopped going because I got chlorine burns on my skin, from here (indicated chest level) right up" (Fisken 2016, p.14). Similarly in Larmer 2014b, when people exercised on their own initiative, attending local pools rather than the hydrotherapy pool, the cooler water temperatures meant that their symptoms were not alleviated to the same extent as they were in warmer water, and one person reported the colder water causing cramp. For ongoing effective relief, access to specialist hydrotherapy pools was therefore important.

### **Implications for effective exercise interventions derived from the qualitative synthesis**

From the synthesis of the qualitative studies reporting the views and opinions of people with OA, nine implications were derived that are important when delivering exercise-based interventions. Two review authors (MH and NW) who are physiotherapists grouped these into four main components:

*Healthcare professionals with good interpersonal skills should provide clear, succinct, consistent and convincing advice and information for people with OA, and emphasise the improvements achieved in others.*

- Implication 1: provide accurate information about cause of OA, its likely prognosis and management options.
- Implication 2: explain and demonstrate the benefits of exercise experienced by people with OA.
  - Provide opportunities to participate in physical activity/exercise people value, tailored to their individual abilities, needs and preferences.
- Implication 3: provide opportunities to exercise, discuss and obtain personalised advice and encouragement from a skilled practitioner.
- Implication 4: tailor exercise and advice to each person, taking into account severity of OA and under what circumstances exercise might improve, worsen or leave pain, physical (e.g. mobility, function) or psychosocial (self-efficacy, confidence) symptoms unchanged.
- Implication 5: offer opportunities for exercise that match personal preferences, as part of daily life or dedicated exercise classes delivered to individuals or groups.
  - Challenge, rather than reinforce, inappropriate health beliefs; in particular, explain and encourage the benefits of physical activity/exercise.
- Implication 6: challenge beliefs about causes of OA that might discourage exercise (e.g. wear and tear).
- Implication 7: explain value of pain relief in enabling people to perform controlled exercise/physical activity, and reassure people that exercising after taking 'regular' analgesia is not harmful.
  - Encourage family, friends and peer support, including value of shared learning/experiences from participation in group exercise classes.
- Implication 8: encourage support from family, friends and peers.
- Implication 9: provide practical support: use of equipment, teach correct exercises.

### **3. Synthesis integrating quantitative and qualitative findings**

The final synthesis is in two parts.

First, we identified components of effective exercise programmes by comparing the implications derived from the qualitative synthesis with the exercise programmes evaluated by well-designed RCTs with low risk of bias (Bennell 2014; Bennell 2016; Cheung 2014; Fernandes 2010; Fransen 2007; French 2013; Hurley 2007), all of which favoured exercise although not all were statistically significant (Table 4).

This showed that:

- six of these seven exercise programmes provided tailored advice about exercise (Implication 4) (Bennell 2014; Cheung 2014; Fernandes 2010; Fransen 2007; French 2013; Hurley 2007);
- the exercise programmes in five trials provided people with accurate information about cause, prognosis and management options, including exercise (Implication 1) (Bennell 2014; Bennell 2016; Fernandes 2010; French 2013; Hurley 2007), and opportunities to experience exercise with personalised advice and encouragement from a skilled practitioner (Implication 3: also provided by Cheung 2014);
- the programmes in two trials challenged health beliefs that might discourage exercise (Implication 6) (Fernandes 2010; Hurley 2007);
- programmes in three trials provided practical support for use of exercise equipment (Bennell 2014; Bennell 2016; Cheung 2014);
- none of the exercise programmes explicitly reported highlighting improvements experienced by people (Implication 2), offer participants personal preferences in the exercise undertaken (Implication 5), explaining to participants the value of pain relief in enabling people to perform controlled exercise (Implication 7), or encouraged support from other people (Implication 8).

Second, we compared exercise programmes evaluated by less well-designed RCTs, that is, with a medium/high risk of bias (Aglamis 2008; Baker 2001; Focht 2005; Hopman-Rock 2000; Kao 2012; Keefe 2004; Kim 2012; Mikesky 2006; Park 2014; Péloquin 1999; Schlenk 2011; Sullivan 1998; Wang 2009; Yip 2007), with the implications from the qualitative synthesis to identify components that have been incorporated into exercise programmes.

This showed that some exercise programmes:

- provided activities that matched personal preferences (Implication 5). [Focht 2005](#) allowed participants to choose whether they exercised at home, at a community facility, or combination of the two;
- incorporated peer or family support (Implication 8). Three trials reported supporting people to exercise ([Keefe 2004](#); [Kim 2012](#); [Mikesky 2006](#)). One trial used an aquatic exercise programme to provide peer support by including social time as part of the intervention when participants could become better acquainted ([Kim 2012](#)). One trial distributed a newsletter and T-shirts identifying the subject as a participant in the study, arranged group training sessions and an "exercise buddy" system to help people find training partners, and co-ordinated social gatherings ([Mikesky 2006](#)). One trial incorporated a "couples' skills training" component which provided training to patients and their spouses in a wide range of skills including communication, behavioural rehearsal and mutual goal setting ([Keefe 2004](#)).

This comparison shows how implications derived from the qualitative synthesis can be incorporated into interventions, but weaknesses in study designs mean that evidence of the effects is lacking.

## Discussion

### Summary of main results

This review highlighted the impact chronic joint pain associated with OA has on a wide range of physical and psychosocial variables of older people. In addition, we looked at whether, how and why exercise alleviated some of the impact of chronic pain/OA, and if exercise could help people to manage their condition better.

Meta-analyses of the quantitative studies provided moderate to low quality evidence that exercise slightly improved pain and function, and also offered a range of benefits on self-efficacy, depression and other psychosocial traits when the outcomes were measured using quantitative scales. These benefits may arise indirectly from a reduction in pain and improvement in function, or directly as a result of attending a rehabilitation programme that developed positive attitudes toward living with OA, support from clinicians and sharing experiences with people who have similar problems.

The qualitative synthesis provided an insight into people's experiences and beliefs about OA; how these beliefs were constructed; and how they shaped people's attitudes, behaviours and decisions about how to engage with and manage OA. The experience and impact of pain dominated the lives of people with OA because it affected most areas of their daily life in a variety of ways ([Figure 1](#); [Figure 2](#)). Pain, joint stiffness, fatigue, comorbidity and people's perceptions of their physical fitness restricted the type and amount of exercise they could do. The consequences of OA evoked anxiety and depression, undermined people's self-confidence, their social role and their sense of self. With little or no information or advice forthcoming from healthcare professionals, people attributed their condition to "wear and tear" on their joints, ageing processes, familial disposition or a combination of these. Moreover, the onset of pain with physical activity was often interpreted as causing additional joint damage, so people avoided activity for fear of causing additional harm.

Healthcare professionals were an important source of information, advice, reassurance and motivation. Clear instructions and advice from a trusted healthcare professional were important in allaying people's fears and anxieties about exercise, and convincing them exercise is safe and beneficial. The instructions and advice needed to be contextualised so that each person knew unequivocally what exercises to do, the correct way to do them, when and where to do them, what they should avoid doing, and what they might expect to experience and feel. Although some people did not find exercise helpful, most thought rehabilitation programmes that included an active participatory exercise regimen produced physical, emotional and psychosocial benefits.

The qualitative analysis revealed that people reported receiving support from family, friends and their peer group. In particular, exercise classes provided a sense of community, camaraderie and working together. Unfortunately, sustaining regular exercise was difficult. People exercised regularly if they perceived exercise to be important, fun and enjoyable. However, family and work commitments, time pressure and other health issues were often prioritised over exercise, and exercise was sometimes regarded as a burdensome chore. If the benefits derived from exercise were not considered a 'good return' for the time and effort people invested, exercise was discontinued.

The support and conditions required for each person to exercise varied greatly. Some people liked to exercise in groups, others preferred to exercise alone. Some people needed access to exercise facilities, special equipment and relied on supervisors to lead them. Others were intimidated by these and preferred exercising at home, particularly elderly women self-conscious about their age and body image, and considered activities such as walking sufficient exercise. Cost of exercise facilities or equipment was a barrier to exercise for people on low and fixed incomes.

### Overall completeness and applicability of evidence

Better understanding of the complex reciprocity of symptoms, health beliefs and behaviours of people with chronic joint pain ([Figure 1](#); [Figure 2](#)), and greater appreciation of how exercise can positively affect people's symptoms, beliefs and behaviours, might enable us to maximise the effectiveness of exercise programmes and encourage uptake so that more people might benefit. Although many studies demonstrate that exercise programmes improve pain and physical functioning in older people with OA, the effect of exercise on psychosocial outcomes has been less well investigated. In addition, little is known about the effect pain, disability and psychosocial dysfunction have on people's ability and willingness to participate in exercise programmes. These gaps in our understanding are evident from the large number of studies that we had to exclude from this review because they had not measured psychosocial outcomes. Of the studies that were included, although many were small studies, they were generally well designed and reported. However, the exercise programmes varied greatly in their content and focus (strength, endurance, balance/co-ordination, functional performance), 'dose' (exercise intensity, frequency, etc.), mode of delivery (classes, individual treatment, facility-based, home programme), duration of



intervention, time to follow-up after completion of the programme, study design and outcome measures. We considered using meta-regression to explain some of the heterogeneity ([Juhl 2014](#)), but the wide variety of outcome measures across the studies prevented this. Consequently, there were insufficient data to determine which aspects and features of exercise programmes are most effective at producing beneficial effects in specific outcome measures.

One of the most valuable aspects of qualitative research is to provide explanations and enhance our understanding. The views, opinions and beliefs reported in the studies in this review were consistent with other qualitative studies of people with OA, but which did not look specifically at exercise: perceptions of conservative treatment programmes for OA ([Smith 2014a](#)), the experience of living with OA ([Smith 2014b](#)), recognising and addressing emergent knee problems ([Maly 2009](#)), personal models of OA ([Hampson 1994](#)), and lay-beliefs regarding rheumatoid arthritis ([Donovan 1989](#)). The qualitative studies in this review were conducted in five high-income countries. Studies, and therefore understanding of people's views and behaviour, in low- and middle-income countries are lacking. Therefore, the opinions and beliefs of the participants in these included studies were shaped by the context of high-income countries, and may not be valid for other populations.

## Quality of the evidence

Overall the risk of bias of the RCTs comprising the quantitative synthesis was low, apart from blinding and allocation concealment, both of which are particularly challenging with exercise interventions. The descriptions of the trial design were generally clear, though some were complex and difficult to understand. We also found levels of ambiguity, particularly with regard to the success of blinding and provision of sufficient details about interventions. Many of the trials were relatively small (fewer than 50 participants per group) and had low power to detect medium effect sizes. Outcome measures were heterogeneous and often self-reported which are subject to recall bias and socially desirable biases. Most of the trials only reported changes immediately after completing an exercise programme, or had a short follow-up period (less than six months) after completion, so whether there were sustained benefits on chronic joint pain was unknown. Attrition rates were usually reported, but how many people withdrew because of adverse effects of exercise was rarely reported. This is important in understanding the acceptability of burdensome interventions that require investment of time and effort and could potentially cause discomfort, pain or harm. Intention-to-treat analyses were usually reported, but the handling of missing data was less well described, and exposed very small trials' attrition bias.

Most of the exercise programmes reported tailoring their exercise programmes to meet individual patients' capabilities and needs, which reflects current clinical practice ([Holden 2008](#); [Walsh 2009](#)), and suggests the programmes that informed our synthesis were clinically applicable.

In the first part of the integrative review, none of the exercise programmes *explicitly reported* highlighting improvements experienced by people (Implication 2), offered participants personal preferences in the exercise undertaken (Implication 5), explained to participants the value of pain relief (Implication 7), encouraged support from other people (Implication 8) or provided practical support for use of gym equipment (Implication 9). However, such advice and information is usually considered such an integral part of exercise programmes that the authors may have not consider it worth reporting, or editorial limitations often restrict what is included in the description of an intervention, or both. Such omissions will have influenced this finding of the integrative review.

Two trials with ostensibly high-quality designs had unusually large effect sizes and small sample sizes ([Aglamis 2008](#); [Kim 2012](#)). These studies showed large benefits of exercise on depression (SMD -0.88) ([Kim 2012](#)), SF-36 social function (MD 58.30), SF-36 mental health (MD 32.90) and SF-36 vitality (MD 51.90) ([Aglamis 2008](#)). As there was no obvious reason to exclude these studies, we conducted sensitivity analyses with these studies included and excluded. In general including the studies had little material effect on the overall conclusions, but borderline changes become more statistically significant, and an uncertain effect on depression attained statistical significance when Kim was included. Therefore, the magnitude of effect size should be treated with caution when these studies are included.

Similar to most other reviews of exercise interventions, none of the trials made an attempt to blind participants to their intervention. Devising placebo exercise requires considerable effort; the placebo itself may have an effect and people usually know what group (active or placebo) they are in. Moreover, in many complex health interventions that aim to affect behavioural change, the participant-supervisor interaction is integral to the success of the intervention. Our qualitative synthesis highlighted the close partnership formed between participants and supervisor which was very important in getting people with chronic joint pain to undertake activities they might consider harmful. Removing this important contextual component by blinding participants (or supervisors) would create a 'clinically inappropriate' intervention. All the trials attempted to blind the outcome assessors to each participant's treatment allocation. Whether these attempts were successful were not reported.

The quality of design and reporting of the qualitative studies included in this review was good. Researchers gave clear descriptions of their methodology and findings, and took measures to minimise bias such as ensuring they purposively recruited a representative cross-section of participants and prevented their values and opinions biasing their report and interpretation. Unfortunately, qualitative research is vulnerable to specific sources of bias: 'recall bias' is a particular problem for studies of older populations; 'volunteer bias' may lead to the recruitment of people who are enthusiastic about exercise and their opinions reflect their enthusiasm; 'socially desirable reporting' can affect interventions that require participants to invest a great deal of time and effort, and they may want to convince themselves this investment has been worthwhile or where strong bonds formed between participants and supervisors, participants may try to reflect well on the supervisor (or a combination of these). Despite the efforts made to minimise these sources of bias, it is unlikely they will have been eliminated completely. However, the study findings are generally consistent across several studies; they reported the views of people who did not find exercise beneficial, who were not enthusiastic about exercise and who admitted not sustaining



regular exercise after the end of an exercise programme. Thus, in general, the studies recruited and reflected the varied views and opinions of people with OA about exercise, increasing our confidence in their validity of the findings of the qualitative synthesis.

### Potential biases in the review process

We conducted a thorough search of the literature which was designed by the review authors with experience in this field, patient representatives, systematic reviewers and information scientists skilled in constructing and conducting searches. This maximised the chances of identifying relevant data from pertinent databases and other sources of relevant information, and resulted in a large number of potential sources of information (research papers, theses, reports, etc.) being identified. The search will have been affected by publication and selective reporting bias because psychosocial variables were usually secondary outcome measures, or if the intervention produced no change in the outcome, these outcomes may not have been reported in the abstract, as a keyword or in the final publication. Where this was suspected, we sourced and appraised the full-text paper to decide on its inclusion/exclusion in the review. This substantially increased the number of papers that had to be obtained and appraised before inclusion/exclusion, and resulted in the large number of papers screened and excluded (399 papers), which was necessary to ensure the thoroughness of the review process. Brief details of a representative sample (62 studies) of the excluded studies are provided.

We tried to contact the authors of two relatively large studies with 289 ([Jenkinson 2009](#)) and 600 ([Thomas 2002](#)) completing participants, but received no response and so they had to be excluded from the review. The absence of their information on anxiety and depression is unfortunate, since they could have contributed data to important outcomes that might have affected the uncertain findings of these outcomes.

Although we did not stipulate that papers had to be written in English to be included, all those meeting the criteria were in the English language. It is possible that research written up in other languages was not identified via searches, and it should be recognised that findings may not apply across all social and cultural contexts.

Our patient representative (JC) was involved at each stage of the review process to ensure our review question, process, data capture, processing, report and its conclusions are relevant to this patient population.

Two of the authors of the review, MH and NW, had been involved in work in this area, and coauthored papers included in the review ([Hurley 2007](#); [Hurley 2010](#)). To prevent bias, they did not evaluate their own quantitative paper ([Hurley 2007](#)), and neither were involved in any part of the data extraction and synthesis of the qualitative synthesis.

### Agreements and disagreements with other studies or reviews

Our quantitative synthesis (pain improvement SMD -0.33, 95% CI -0.46 to -0.21,  $I^2 = 23\%$ ; function improvement SMD -0.27, 95% CI -0.37 to -0.17,  $I^2 = 45\%$ ) corroborates other systematic reviews and meta-analyses that showed evidence that exercise improved pain and physical function for people with knee OA, although the quality of evidence for pain was compromised due particularly to risk of bias arising from lack of blinding in most studies. For knee OA, there was a 6% absolute reduction in pain and a 5.6% absolute improvement in function ([Fransen 2015](#): pain reduction: SMD -0.49, 95% CI -0.39 to 0.59; function improvement: SMD -0.52, 95% CI -0.39 to -0.64; [Juhl 2014](#): pain reduction: SMD 0.50, 95% CI -0.39 to 0.52,  $P = 0.001$ ; disability: SMD 0.49, 95% CI 0.35 to 0.63,  $P = 0.001$ ; [Uthman 2013](#): pain: SMD -0.69, 95% CI -1.04 to 0.35; function: SMD -0.63, 95% CI -1.16 to -0.10) and for hip OA ([Fransen 2014](#): pain reduction: SMD -0.38, 95% CI -0.55 to -0.20; function improvement: SMD -0.38, 95% CI -0.54 to -0.05). Evidence-based clinical guidelines that recommend exercise as a core intervention in the management of OA ([EULAR 2013](#); [Hochberg 2012](#); [McAlindon 2014](#); [NICE 2014](#)), although there is evidence that self-management interventions in OA are of little or no benefit ([Kroon 2014](#)). Heterogeneity of the interventions prevents us drawing conclusions about the type, duration, frequency, intensity or delivery mode of the most effective exercise programmes. Other reviews concluded that optimal exercise programmes consist of 12 sessions, delivered two or three sessions a week; that individual sessions, classes, facility-based or home-based programmes are all equally effective; and that a combination of exercises to increase strength, control, endurance, aerobic capacity and functional performance can address sensorimotor, physical and psychosocial dysfunction and deficits ([Fransen 2015](#); [Juhl 2014](#); [Roddy 2005](#); [Uthman 2013](#)). Our review included only one quantitative ([Kim 2012](#)) and two qualitative ([Larmer 2014b](#); [Moody 2012](#)) studies of aquatic exercise: this compared with six studies identified in a previous Cochrane Review of aquatic interventions for OA ([Bartels 2007](#)), published prior to both the studies we included. None of those six papers qualified for inclusion in this study, and it should be noted that [Bartels 2007](#) found studies to be of a low standard.

Although the quantitative synthesis demonstrated exercise was effective in producing a benefit and the meta-analysis estimated the magnitude of improvement, it did not inform us about the underlying mechanisms whereby exercise brings about improvement. It is very unlikely to occur by physiological increases in muscle function (i.e. strength, control, endurance, or a combination of these), as physiological changes require a greater stimulus than provided by relatively brief exercise programmes. Hurley and colleagues suggested that improvements in self-reported pain, physical functioning and psychosocial functioning are more likely due to alteration in the complex, inter-relationships between pain, physical functioning and psychosocial functioning, following the positive experiences of exercise influencing people's perception of health beliefs and their behavioural response to pain ([Hurley 2003](#); [Figure 1](#); [Figure 2](#)).

Knee pain is strongly associated with greater depression and anxiety ([Hawker 2011](#); [Phyomaung 2014](#)), and disability is related to perceptions about OA. [Bijsterbosch 2009](#) found that higher perceived negative consequences and lack of control of OA at baseline were associated with higher levels of disability at six years. Greater disability was also associated with the number of symptoms attributed to OA (which may simply indicate more severe cases), poor understanding of the condition, holding strong beliefs about its adverse impact and chronicity, and experiencing more negative emotions. If people interpret

knee pain as causing harm and damage, they will avoid physical activity for fear of causing additional pain and damage (fear-avoidance; [Figure 2](#)) ([Keefe 1996a](#); [Leeuwa 2007](#); [Maly 2009](#)). Over time, reduced activity will result in greater muscle weakness, pain and disability, and disrupt participation in meaningful activities, induce feelings of depression, anxiety, helplessness and loss of independence, and reduced quality of life, which will have a negative impact on clinical outcomes, physical functioning and psychosocial functioning ([Dekker 1992](#); [Hurley 1999](#); [van Baar 1998a](#)).

Lack of advice and information was associated with unhelpful perceptions and beliefs about the causes, consequences and prognosis of OA, and this was evident in study participants included in our qualitative synthesis. Challenging these unhelpful perceptions is vital for successful management. Inappropriate health beliefs and behaviours can be altered by positive experiences that show people how active coping strategies such as exercise can reduce pain and improve physical functioning, self-efficacy, anxiety, helplessness, catastrophising and depression ([Keefe 1996b](#); [Main 2002](#); [Turk 1996](#)).

Self-efficacy, a person's confidence in their ability to perform a specific health behaviour, is an important psychological trait for self-management of health ([Bandura 1977](#); [McAuley 2006](#); [Stretton 2005](#); [Taylor 2004](#)), although it does not necessarily lead to the behaviour in question. People with high self-efficacy are more active, less depressed and anxious, and report less pain than people with low self-efficacy. "Exercise self-efficacy" is a person's confidence in their ability to perform exercise, and plays an important role in the adoption of activities they may be unfamiliar with, and that they may be concerned might cause discomfort or pain. It builds their confidence in their ability to overcome barriers ([McAuley 1992](#); [McAuley 1993](#); [Rejeski 1998](#)), although the term is not without controversy ([Kroon 2014](#)). Exercise self-efficacy might be enhanced by informing people about the value of exercise in the management of OA (verbal persuasion), and through the positive experience of successfully completing a challenging exercise programme (master experiences): these are both mechanisms identified by [Bandura 1977](#) as ways in which self-efficacy can be increased, although he suggests verbal persuasion alone may have relatively little effect; it is better as a method to increase self-efficacy through use alongside another strategy. Combining verbal persuasion with other interventions is common. Rehabilitation programmes that integrate exercise and patient education improve people's understanding of the condition, its effects and prognosis, and the beneficial role of exercise as a treatment and self-management strategy in OA that can restore a sense of control, construct positive illness perceptions and hence improve clinical outcome ([Hurley 2009](#)).

Meta-analysis showed exercise statistically significantly improved self-efficacy ([Analysis 1.3](#)), which is reflected in participants' opinions of their ability to perform exercise and change their health beliefs that was evident in the qualitative synthesis. This may result from people coming to appreciate the benefits of exercise, their ability to perform exercise and understanding how they can use exercise to control their condition as a result of their positive experiences following participation on the exercise programmes.

Most of the trials included in the review reported short-term outcomes. One cohort followed for two and a half years showed initial benefits declined over time ([Hurley 2012](#)), which confirms other findings ([Pisters 2007](#)). Sustaining regular exercise does not appear to be motivated by the type of exercise involved, but rather is influenced by providing supervised, graded activity programmes that include self-management strategies, cognitive behavioural techniques, individualised exercise programmes and booster sessions after completing a programme ([Jordan 2010](#); [Pisters 2007](#)), and the important influence health beliefs have on people's participation in exercise ([Campbell 2001](#)). Our qualitative synthesis emphasised the importance people attach to the continued support and encouragement for the continued engagement with regular physical activity.

## Authors' conclusions

### Implications for practice

Chronic hip and knee pain affects all domains of people's lives. Beliefs about chronic pain shaped people's attitudes and behaviours about how to manage their pain. With little or no information or advice from healthcare professionals, people attributed their condition to "wear and tear" on their joints, ageing processes, familial disposition, or a combination of these. Moreover, the onset of pain with physical activity was often interpreted as causing additional joint damage, so people avoided activity for fear of causing additional harm. People's views about their symptoms, health beliefs and psychosocial experiences revealed implications for practice which covered providing information and demonstrating improvement, tailoring interventions to individuals, challenging unhelpful health beliefs and providing practical support. These findings have implications for clinical practice and topics and design of future research studies in this area.

From the meta-analysis of randomised controlled trial, which was rated as low-to-moderate quality using GRADE:

- older people with chronic knee or hip pain should be encouraged to participate in regular exercise since evidence indicates this slightly improves physical function, depression, pain and health-related quality of life. It may improve self-efficacy, stress, social function and mental health.

From the qualitative studies it is clear these programmes should:

- provide information about cause, prognosis and management options, including exercise;
- challenge beliefs that might discourage efforts to exercise;
- tailor advice about exercise taking into account severity of the arthritis and under what circumstances might exercise improve, worsen or leave symptoms and function unchanged;
- provide opportunities to exercise with personalised advice and encouragement from an experienced practitioner.

Relying on patients' views and experiences alone, the following components may be added:

- highlight the improvements exercise can bring to people with chronic joint pain/osteoarthritis;
- offer exercise that people prefer and enjoy, performed in exercise classes (individual or group) and encourage incorporation into daily life;
- explain the value of pain relief and reassure that masking pain with analgesics is not harmful;
- encourage support from peers, family and friends;
- provide practical support for use of equipment.

### Implications for research

Despite a relatively large number of studies of exercise, few studies have included psychosocial outcomes. Moreover, only a handful of studies were well designed, with low risk of biases, which allow us to be confident in drawing conclusions from their findings. Adverse effects were not reported, leaving us unable to draw conclusions about these. The syntheses, and in particular the integrative review, highlight the information that is missing about effectiveness from programmes that contain the elements of the implications from the qualitative synthesis but which still need rigorous evaluation from well-designed clinical trials. These are needed to produce robust conclusions about what are the most effective exercise programmes. This research could be categorised as needing to establish effectiveness, mechanisms of action and methodology, although there may be overlap in certain areas:

- investigate which components, combinations and settings within interventions are most effective (*effectiveness*);
- investigate how moderate treatment effects can be enhanced (*effectiveness*);
- determine how to sustain short-term benefits (*effectiveness*);
- confirm the effect of exercise on psychosocial effects including health beliefs, depression, anxiety, quality of life, etc., as primary outcomes (*effectiveness/mechanisms of action*);
- ensure better reporting of pertinent aspects of studies, such as populations, recruitment strategies and interventions (*methodology*);
- determine whether using advanced methods of data analysis (Bayesian structural equation modelling) could elucidate associations or causal relationships between pain, function and physical and psychosocial outcomes (*methodology*).

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### Contributions of authors

Roles and responsibilities	
Draft the protocol	MH, KD, NW, SO
Develop a search strategy	CS, KD
Search for trials	CS, KD, RH
Obtain copies of trials	HH, KD, RH
Select which trials to include	KD, HH, MH, NW, RH
Extract data from trials	KD, HH, NW, MH, RH, RG
Enter data into RevMan	KD, MH, HH, RH, RG
Carry out the analysis	KD, HH, RG
Interpret the analysis	KD, HH, RG, MH, NW, SO, RH
Draft the final review	KD, HH, MH, SO, NW, RG
Update the review	KD, MH, NW, RH, RG
CERQual	KD, RH

### Declarations of interest

MH: no conflicting interests to declare.

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NW: no conflicting interests to declare.

CS: no conflicting interests to declare.

SO: no conflicting interests to declare.