Exercise for osteoarthritis of the hip (Review)

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[Intervention Review]

Exercise for osteoarthritis of the hip

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ABSTRACT

Background

Current international treatment guidelines recommending therapeutic exercise for people with symptomatic hip osteoarthritis (OA) report are based on limited evidence.

Objectives

To determine whether land-based therapeutic exercise is beneficial for people with hip OA in terms of reduced joint pain and improved physical function and quality of life.

Search methods

We searched five databases from inception up to February 2013.

Selection criteria

All randomised controlled trials (RCTs) recruiting people with hip OA and comparing some form of land-based therapeutic exercise (as opposed to exercises conducted in water) with a non-exercise group.

Data collection and analysis

Four review authors independently selected studies for inclusion. We resolved disagreements through consensus. Two review authors independently extracted data, assessed risk of bias and the quality of the body of evidence for each outcome using the GRADE approach. We conducted analyses on continuous outcomes (pain, physical function and quality of life) and dichotomous outcomes (proportion of study withdrawals).

Main results

We considered that seven of the 10 included RCTs had a low risk of bias. However, the results may be vulnerable to performance and detection bias as none of the RCTs were able to blind participants to treatment allocation and, while most RCTs reported blinded outcome assessment, pain, physical function and quality of life were participant self reported. One of the 10 RCTs was only reported as a conference abstract and did not provide sufficient data for the evaluation of bias risk.

High-quality evidence from nine trials (549 participants) indicated that exercise reduced pain (standardised mean difference (SMD) -0.38, 95% confidence interval (CI) -0.55 to -0.20) and improved physical function (SMD -0.38, 95% CI -0.54 to -0.05) immediately

after treatment. Pain and physical function were estimated to be 29 points on a 0- to 100-point scale (0 was no pain or loss of physical function) in the control group; exercise reduced pain by an equivalent of 8 points (95% CI 4 to 11 points; number needed to treat for an additional beneficial outcome (NNTB) 6) and improved physical function by an equivalent of 7 points (95% CI 1 to 12 points; NNTB 6). Only three small studies (183 participants) evaluated quality of life, with overall low quality evidence, with no benefit of exercise demonstrated (SMD -0.07, 95% CI -0.23 to 0.36). Quality of life was estimated to be 50 points on a norm-based mean (standard deviation (SD)) score of 50 (10) in the general population in the control group; exercise improved quality of life by 0 points. Moderate-quality evidence from seven trials (715 participants) indicated an increased likelihood of withdrawal from the exercise allocation (event rate 6%) compared with the control group (event rate 3%), but this difference was not significant (risk difference 1%; 95% CI -1% to 4%). Of the five studies reporting adverse events, each study reported only one or two events and all were related to increased pain attributed to the exercise programme.

The reduction in pain was sustained at least three to six months after ceasing monitored treatment (five RCTs, 391 participants): pain (SMD -0.38, 95% CI -0.58 to -0.18). Pain was estimated to be 29 points on a 0- to 100-point scale (0 was no pain) in the control group, the improvement in pain translated to a sustained reduction in pain intensity of 8 points (95% CI 4 to 12 points) compared with the control group (0 to 100 scale). The improvement in physical function was also sustained (five RCTs, 367 participants): physical function (SMD -0.37, 95% CI -0.57 to -0.16). Physical function was estimated to be 24 points on a 0- to 100-point scale (0 was no loss of physical function) in the control group, the improvement translated to a mean of 7 points (95% CI 4 to 13) compared with the control group.

Only five of the 10 RCTs exclusively recruited people with symptomatic hip OA (419 participants). There was no significant difference in pain or physical function outcomes compared with five studies recruiting participants with hip or knee OA (130 participants).

Authors' conclusions

Pooling the results of these 10 RCTs demonstrated that land-based therapeutic exercise programmes can reduce pain and improve physical function among people with symptomatic hip OA.

PLAIN LANGUAGE SUMMARY

Exercise for osteoarthritis of the hip

Background - what is OA of the hip and what is exercise?

OA is a disease of the joints, such as your hip. When the joint loses cartilage, the bone grows to try to repair the damage. However, instead of making things better, the bone grows abnormally and makes things worse. For example, the bone can become misshapen and make the joint painful and unstable. Doctors used to think that osteoarthritis (OA) simply resulted in thinning of the cartilage. However, it is now known that OA is a disease of the whole joint.

OA is one of the most common forms of arthritis and affects men and women equally. OA is one of the main causes of disability as people grow older.

Exercise can be any activity that enhances or maintains muscle strength, physical fitness and overall health. People exercise for many different reasons including weight loss, strengthening muscles and to relieve the symptoms of OA.

Study characteristics

This summary of an update of a Cochrane review presents what we know from research about the effect of exercise for people with OA of the hip. After searching for all relevant studies up to February 2013, we included five new studies since the last version of the review, giving 10 studies (549 participants) with mostly mild-to-moderate symptomatic hip OA, alone or with knee OA. Except for one study where participants enrolled in a tai chi programme, all other participants underwent land-based exercise programmes consisting of traditional muscle strengthening, functional training and aerobic fitness programmes, either individually supervised or as part of a group, compared with people who did not exercise.

Key results

Pain on a scale of 0 to 100 points (lower scores mean reduced pain):

- People who completed an exercise programme rated their pain to be 8 points lower (4 to 11 points lower) at end of treatment (8% absolute improvement) compared with people who did not exercise.

- People who completed an exercise programme rated their pain as 21 points.

- People who did not exercise rated their pain as 29 points.

Physical function on a scale of 0 to 100 points (lower score means better physical function):

- People who completed an exercise programme rated their physical function to be 7 points lower (1 to 12 points lower) at end of treatment (7% absolute improvement) compared with people who did not exercise.

- People who completed an exercise programme rated their physical function as 22 points.

- People who did not exercise rated their physical function as 29 points.

Quality of life (higher score means better quality of life):

- Overall, people with hip OA participating in the studies had a similar quality of life compared with the general population (normative scores of average 50 points), and quality of life was not further improved by participation in an exercise programme: 0 points higher.

- People who completed an exercise programme rated their quality of life as 50 points on a population norm-based scale.

- People who did not exercise rated their quality of life as 50 points on a population norm-based scale.

Withdrawals

- three more people out of 100 dropped out of the exercise programme (1% absolute increase).

- Six out of 100 people in exercise programmes dropped out.

- Three out of 100 people who did not exercise dropped out.

Quality of the evidence

This review showed that there is high-quality evidence that in people with hip OA, exercise reduced pain slightly and improved physical function slightly. Further research is unlikely to change the estimate of these results.

Low-quality evidence indicated that exercise may not improve quality of life. Further research is likely to change the estimate of these results.

Moderate-quality evidence showed that exercise probably does not increase study drop-outs. Further research may change the estimate.

We do not have precise information about side effects such as injuries or falls during exercise, but we would expect these to be rare, and no injuries were reported in the studies.

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

Immediate post-treatment effect of exercise for osteoarthritis of the hip

Patient or population: people with osteoarthritis of the hip
Settings:
Intervention: land-based exercise

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Land-based exercise				
Pain Self report	The mean pain ranged across control groups from **29 points on a 0-100 scale** (lower score is better)	The mean pain in the intervention groups was **8 points lower** (4 to 11 points lower) compared with control group using a 0-100 scale[1]	-	549 (9 studies)	⊕⊕⊕⊕ **high**	SMD -0.38 (-0.55 to -0.2) Absolute change: 8 points (4 to 11) on a 0-100 scale Relative change 28% (14% to 38%)[1] NNTB: 6 (4 to 11)
Physical function	The mean physical function ranged across control groups from **29 points on a 0-100 scale to 36 points on a 0-68 scale** (lower score is better)	The mean physical function in the intervention groups was **7 points lower** (1 to 12 points lower) compared with control group using a 0 to100 scale[2]	-	521 (9 studies)	⊕⊕⊕⊕ **high**	SMD -0.33 (-0.54 to -0.05) Absolute change: 7 points (1 to 12) on a 0-100 scale Relative change: 24% (3% to 42%) [2] NNTB: 6 (4 to 41)
Quality of life	Mean quality of life in the control group was estimated as **50 points**, based on a population norm-based scale	Quality of life improved by **0 points**	-	183 (3 studies)	⊕⊕◯◯ **low**[3,4]	SMD 0.07 (-0.23, 0.36)

Withdrawals or dropouts	**34 per 1000**	**59 per 1000** (30 to 114)	**OR 1.77** (0.86 to 3.65)	715 (7 studies)	⊕⊕⊕○ **moderate**[5]	Absolute risk difference: 1% more events (1% fewer to 4% more) Relative difference: 68% increase (13% decrease to 224% increase)
Adverse events not reported	See comment	See comment	Not estimable	-	See comment	No adverse events such as injuries were reported

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **NNTB:** number needed to treat for an additional beneficial outcome

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

1. Control group baseline mean (standard deviation) was 29.1 (20.2) points on 0- to 100-point scale (Juhakoski 2011).
2. Control group baseline mean (standard deviation) was 28.9 (22.4) points on 0- to 100-point scale (Juhakoski 2011).
3. Potential imprecision, as outcome only reported in three studies.
4. Indirectness: quality of life does not appear to be influenced by mild-to-moderate symptomatic hip OA as the quality of life assessment reported in the two studies using the SF-MCS was in line with published population-based normative values.
5. Imprecison as the number of events were small, and the outcome was poorly reported; many studies reported the number of participants attending outcomes assessments, but did not provide quantitative data regarding the number of participants withdrawing from study treatment.

BACKGROUND

Description of the condition

The prevalence of symptomatic radiographic hip osteoarthritis (OA) increases with age and is estimated to be around 5% to 15% for among white people aged 55 years and over (Lawrence 1998; Odding 1998; Moskowitz 2007; Busija 2010). Symptomatic hip OA is associated with joint pain, physical disability and poor health status (Croft 2002; Dawson 2004), and is the most common reason for total hip replacement surgery. While progression between onset of hip pain to severe symptoms and end-stage disease is variable, disease progression generally appears to be much more rapid than that observed in knee OA (Arden 2006).

How the intervention might work

Risk factors for incident hip OA include a wide range of local and systemic factors (Arden 2006; Lane 2007; Moskowitz 2007). While age, genetic disposition and many musculoskeletal comorbidity causing hip OA (Paget's disease, developmental deformities of the hip joint, rheumatoid arthritis, etc.) are arguably not modifiable risk factors, improving the mechanical environment of the hip joint and reducing joint loading in this weight-bearing joint have some face validity as useful therapeutic interventions (Zhang 2008). In support, it has been shown that hip OA is associated with markedly reduced lower limb muscle strength (Arokoski 2002; Suetta 2007), and occupations involving a heavy physical load (Fransen 2011).

Why it is important to do this review

There is no cure for hip OA or treatments proven to slow disease progression. The main treatment goal for people with hip OA, therefore, is to reduce joint pain and physical disability. Current international guidelines for the treatment of hip OA recommend strengthening exercises based on the evidence provided by one meta-analysis (Hernandez-Molina 2008) of benefit in terms of pain reduction (Zhang 2010). However, the 95% confidence intervals (CI) around the reported small treatment effect (0.38) were wide (0.08 to 0.68) and there is currently no evidence of treatment benefit in terms of physical function.

OBJECTIVES

To determine whether land-based therapeutic exercise is beneficial for people with hip OA in terms of reduced joint pain, improved physical function and improved quality of life.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCTs) or controlled clinical (quasi-randomised) trials comparing some form of land-based therapeutic exercise with a non-exercise group.

Types of participants

Adults, men or women, with either an established diagnosis of hip OA according to accepted criteria or self reporting hip OA on the basis of chronic anterior joint pain (without radiographic confirmation).

Types of interventions

Any land-based therapeutic exercise regimens aiming to relieve the symptoms of hip OA, regardless of content, duration, frequency or intensity. This included any exercise designed improve muscle strength, range of joint movement or aerobic capacity (or combinations of the three). Programmes could be designed and supervised by physiotherapists or other professionals, or provided as a home programme with minimal monitoring. We included pre-surgery (total hip replacement) programmes. The comparator (control) group could be active (any non-exercise intervention) or placebo (no treatment or waiting list) group. We excluded studies that compared one type of exercise programme versus another exercise programme, provided an exercise programme to all treatment allocations (and evaluated the added benefit of an electrophysical agent or hydrotherapy), compared exercise with manual therapy and compared programmes of varying intensities.

Types of outcome measures

In accordance with international consensus regarding the core set of outcome measures for phase III clinical trials in OA (Bellamy 1997), the RCT needed to include assessment of at least one of:

- hip pain;
- self reported physical function;
- quality of life.

We assessed these outcomes at two time points: immediately at the end of treatment (post-treatment) and long-term follow-up (sustainability).

In addition, we noted the number of participants withdrawing from the study prior to the post-treatment assessment and the number of participants experiencing adverse events, if provided.

Search methods for identification of studies

We searched five databases were searched from inception to February 2013, with no restriction on language: MEDLINE (Appendix 1), EMBASE (Ovid) (Appendix 2), PEDro (Physiotherapy Evidence Database) (Appendix 3), CINAHL (EBSCOhost) (Appendix 4) and *The Cochrane Library* (Wiley Interscience) (Appendix 5).

We also included a search of ClinicalTrials.gov (www.ClinicalTrials.gov) and the WHO trials portal (www.who.int/ictrp/en/).

Data collection and analysis

Selection of studies

Three review authors (MF, SM, GH) independently screened retrieved clinical studies for inclusion. If we did not reach an agreement at any stage, a fourth review author (SR) adjudicated.

Data extraction and management

Three review authors (MF, SM, GH) extracted data from all included studies and conducted the risk of bias assessment. If we did not reach an agreement at any stage, a fourth review author (SR) adjudicated.

If data on more than one pain scale were provided for a trial, we extracted data from the pain scale that was highest on this list according to a previously described hierarchy of pain-related outcomes (Juni 2006; Reichenbach 2007):

1. Global pain;
2. Pain on walking;
3. Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) pain subscore;
4. Composite pain scores other than WOMAC;
5. Pain on activities other than walking;
6. Rest pain or pain during the night;
7. WOMAC global algofunctional score;
8. Lequesne Osteoarthritis Index global score;
9. Other algofunctional scale.

If data on more than one physical function scale were reported in a trial, data were extracted according to the hierarchy presented below:

1. Global disability score;
2. Walking disability;
3. WOMAC disability subscore;
4. Composite disability scores other than WOMAC;
5. Disability other than walking;
6. WOMAC global scale;
7. Lequesne Osteoarthritis Index global score;
8. other algofunctional scale.

If data on more than one quality of life scale were reported in a trial, data were extracted according to the hierarchy presented below:

1. 36-item Short Form (SF-36), Mental Component Summary (MCS);
2. 12-item Short Form (SF-12) MCS;
3. EuroQol;
4. Sickness Impact Profile (SIP);
5. Nottingham Health Profile (NHP);
6. other quality of life scales.

Assessment of risk of bias in included studies

We assessed the risk of bias of included studies in accordance with The Cochrane Collaboration's recommended methods (Risk of bias in included studies).

We assessed the risk of bias according to the following domains.

1. Random sequence generation.
2. Allocation concealment.
3. Blinding of participants and personnel.
4. Blinding of outcome assessment.
5. Incomplete outcome data.
6. Selective outcome reporting.
7. Other bias (baseline imbalances between allocation groups in participant characteristics, occurrence of 'null bias' due to exercise intervention being mostly unmonitored or lengthy period between end of monitored treatment and assessment of outcomes).

We assessed each potential source of bias as high, low or unclear and provided a quote from the study report together with a justification for our judgement in the 'Risk of bias' table. We summarised the risk of bias judgements across different studies for each of the domains listed.

Where information on risk of bias related to unpublished data or correspondence with a trialist, we noted this in the 'Risk of bias' table.

We presented the figures generated by the 'Risk of bias' tool to provide summary assessments of the risk of bias.

If the random sequence generation, allocation concealment and incomplete outcome data domain were adequately met in a study, we judged the overall risk of bias as low for that study.

Measures of treatment effect

As the studies used a variety of continuous scales to evaluate pain, physical function and quality of life outcomes, a unitless measure of treatment effect size was needed to allow the results of the various RCTs to be combined. We used standardised mean differences (SMD) to calculate treatment effect sizes from the end of treatment scores and related standard deviation (SD) scores, where possible. Therefore, the treatment effect size is a unitless measure providing an indication of the size of the change in terms of its variability. Outcomes pooled using SMD were re-expressed as absolute mean

difference using a representative control group (high weighting in pooled analyses) baseline SD. We pooled Mantel-Haenszel odds ratios (OR) to calculate the effect of treatment allocation on study withdrawal prior to the first outcomes assessment.

Unit of analysis issues

The unit of analysis was the participant, and thus there were no unit of analysis issues.

Dealing with missing data

There were no missing data. We contacted study authors if the data could not be extrapolated in the desired form from the published manuscript.

Assessment of heterogeneity

In a random-effects model, the overall effects are adjusted to include an estimate of the degree of variation between studies, or heterogeneity, in intervention effect (Tau^2) (Deeks 2011). The Chi ^{2} test assesses whether the differences in results are beyond those that can be attributed to sampling error (chance). The impact of heterogeneity on the meta-analysis results is quantified by the I^2 statistic. This statistic describes the percentage of variability in the effect estimates that is due to heterogeneity rather than chance (Deeks 2011); 30% to 60% probably represents moderate heterogeneity while greater than 50% is usually considered as representing substantial heterogeneity.

Assessment of reporting biases

For studies published after 1 July 2005, we screened the Clinical Trial Register at the International Clinical Trials Registry Platform of the World Health Organization (apps.who.int/trialssearch) for the a priori trial protocol. We evaluated whether selective reporting of outcomes is present (outcome reporting bias).

To assess for potential small-study effects in meta-analyses (i.e. the intervention effect is more beneficial in smaller studies), we compared effect estimates derived from a random-effects model and a fixed-effect model of meta-analysis. In the presence of small-study effects, the random-effects model will give a more beneficial estimate of the intervention than the fixed-effect estimate (Sterne 2011).

Data synthesis

We used the random-effects model to combine outcomes.

'Summary of findings' table

We created a 'Summary of findings' table using the following outcomes: pain, self reported physical function and adverse events, and also quality of life and withdrawals for the immediate post treatment time point. We assessed the quality of the evidence using the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness and publication bias) to assess the quality of a body of evidence for the outcomes using GRADEpro software (Schünemann 2011a; Schünemann 2011b).

Outcomes pooled using SMD were re-expressed as absolute mean difference using a representative control group baseline SD from a trial using a familiar instrument and dividing by the points of the measurement scale and expressed as a percentage.

In the comments column of the 'Summary of findings' table, we have presented the absolute per cent difference, the relative per cent change from baseline and the number needed to treat for an additional beneficial outcome (NNTB), or an additional harmful outcome (NNTH) (the number needed to treat (NNT) is only provided for outcomes with statistically significant differences between the intervention and control groups).

For dichotomous outcomes, the absolute risk difference was calculated using the risk difference statistic in Review Manager 5 (RevMan 2012) and the result expressed as a percentage; the relative percentage change was calculated as the risk ratio -1 and was expressed as a percentage; and the NNT from the control group event rate and the risk ratio were determined using the Visual Rx NNT calculator (Cates 2008).

For continuous outcomes, the absolute risk difference was calculated as the mean difference between intervention and control groups in the original measurement units (divided by the scale), expressed as a percentage; the relative difference was calculated as the absolute change (or mean difference) divided by the baseline mean of the control group from a representative trial. We used the Wells calculator to obtain the NNTB for continuous measures (available at the Cochrane Musculoskeletal Group (CMSG) Editorial office; musculoskeletal.cochrane.org/). The minimal clinically important difference (MCID) for each outcome was determined for input into the calculator. We assumed an MCID of 15 points on a 0- to 100-point pain scale; and 10 points on a 0- to 100-point function scale.

Subgroup analysis and investigation of heterogeneity

We evaluated the influence of using end of treatment or change scores for the investigation of heterogeneity.

Sensitivity analysis

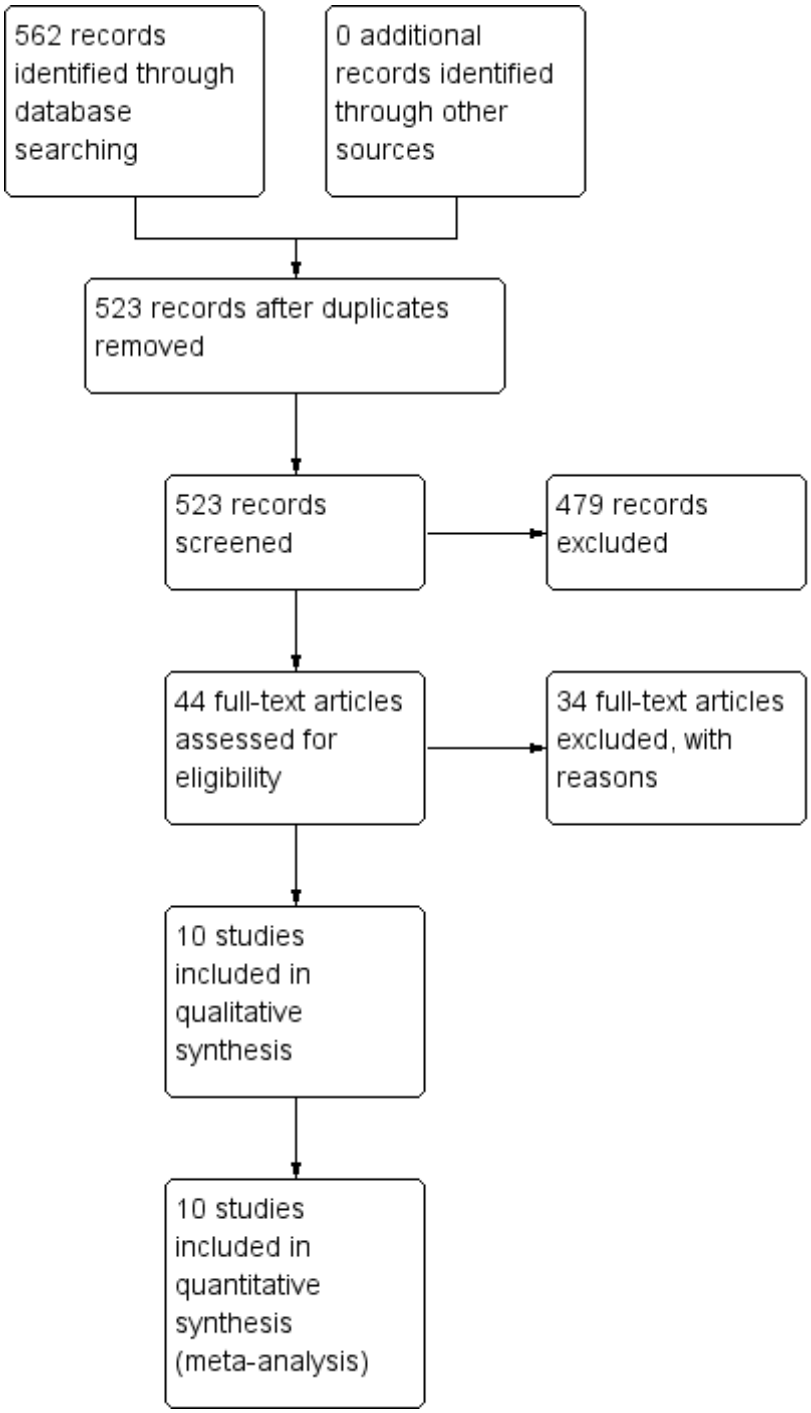
To evaluate potential exercise programme targeting, we conducted a sensitivity analysis to assess the impact of recruiting solely participants with hip OA compared with recruiting participants with hip or knee OA.

RESULTS

Description of studies

Of the 44 retrieved RCTs identified from the literature search (Figure 1), 10 met the inclusion criteria (van Baar 1998; Hopman-Rock 2000; Foley 2003; Tak 2005; Fransen 2007; Fernandes 2010; Carlson 2011; Juhakoski 2011; Abbott 2013; French 2013) and are detailed in the Characteristics of included studies table. Of the 10 studies, only five recruited solely participants with symptomatic hip OA (Tak 2005; Fernandes 2010; Carlson 2011; Juhakoski 2011; French 2013). The other five studies recruited participants with either hip OA or knee OA, or both. These five RCTs provided data specific for the participants indicating the hip joint as either the only symptomatic joint or the most symptomatic (signal) joint for pain reporting. Two studies included three allocations, each having a land-based exercise allocation (gym-based classes (Foley 2003) or Tai Chi classes (Fransen 2007), a hydrotherapy allocation and a waiting list control group. For the current meta-analysis, the land-based exercise allocation was compared with the waiting list control group. Two further studies had an exercise allocation (individual treatments) in addition to an allocation to exercise plus manual therapy (Abbott 2013; French 2013). For these two studies, the exercise (alone) allocation was compared with the waiting list or usual care control group.

Figure 1. Study flow diagram.



We excluded 34 studies for reasons provided in the Characteristics of excluded studies table (Figure 1).

Only two RCTs had more than 50 participants in each allocation group (Fernandes 2010; Juhakoski 2011).

There was large variability in treatment dosage. Four studies provided fewer than 10 supervised sessions (Hopman-Rock 2000; Tak 2005; Abbott 2013; French 2013). Five studies provided access to at least 16 sessions. Six of the 10 RCTs evaluated class-based programmes, while the other four studies provided treatments as individual sessions with a physiotherapist (van Baar 1998; Fernandes 2010; Abbott 2013; French 2013). While one RCT evaluated a specific 'Tai Chi for Arthritis' programme (Fransen 2007), the other studies evaluated more traditional muscle strengthening, functional training and aerobic fitness programmes.

Sample recruitment varied widely. Four RCTs recruited community volunteers (Hopman-Rock 2000; Tak 2005; Fransen 2007; Juhakoski 2011), one RCT recruited participants through general practice (van Baar 1998), and four recruited mostly through specialist clinics (Foley 2003; Carlson 2011; Abbott 2013; French 2013). The variability in recruitment strategies resulted in marked differences in study participant samples. Approximately 50% of participants in one RCT reported a symptom duration of less than one year (van Baar 1998), while another RCT included a large proportion (40%) of participants who were already on the orthopaedic surgery waiting list (Foley 2003).

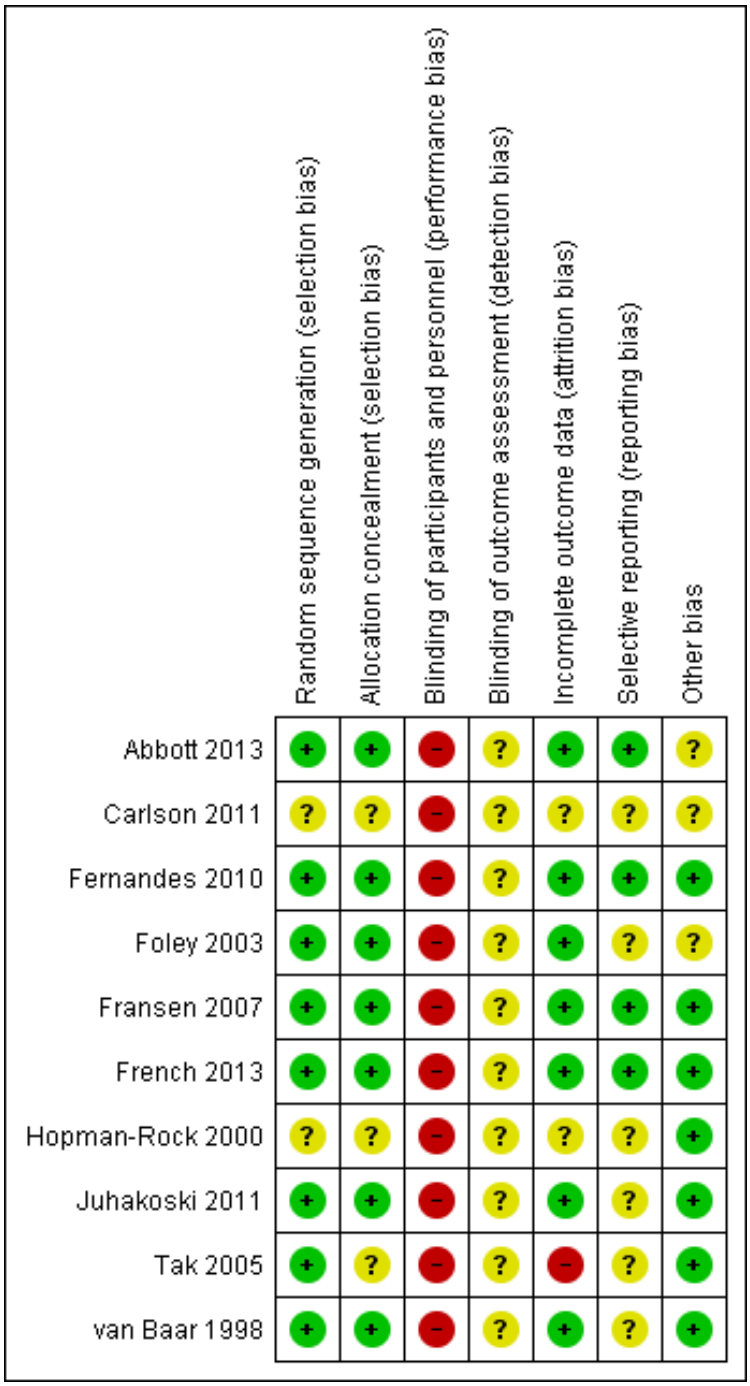
Seven included RCTs used the WOMAC to evaluate pain or physical function, or both (Foley 2003; Fransen 2007; Fernandes 2010; Carlson 2011; Juhakoski 2011; Abbott 2013; French 2013). One study used a numerical rating scale to evaluate pain (with activity), while using the WOMAC subscale to evaluate physical function (French 2013). The other three studies, all conducted in The Netherlands, used a 10-cm visual analogue scale (VAS) to evaluate hip pain and either the Influence of Rheumatic Diseases on General Health and Lifestyle (IRGL) questionnaire (van Baar 1998; Hopman-Rock 2000) or the Groningen Activity Restriction Scale (GARS) (Tak 2005) to evaluate physical function. The GARS measures level of disability performing 18 daily activities with a score ranging from 18 (no problems) to 72 (only with help from others).

For pain and physical function, nine RCTs provided immediate post-treatment outcomes assessments, while five RCTs evaluated treatment sustainability three to six months after completion of the supervised exercise programme. Only five RCTs provided quality of life assessments (Hopman-Rock 2000; Foley 2003; Tak 2005; Fransen 2007; French 2013). Data specific for participants with hip OA could only be provided by three studies (Tak 2005; Fransen 2007; French 2013). Two of these studies provided the population-based SF-12 MCS scores as an indicator of quality of life (Fransen 2007; French 2013), while one study used a generic 0 to 10 VAS scale (Tak 2005). Quality of life data, specific for hip OA participants, were not available from two older studies reported in the original review (Hopman-Rock 2000; Foley 2003).

Risk of bias in included studies

One RCT was only reported as a conference abstract with insufficient information to evaluate risk of bias criteria (Carlson 2011) (Figure 2).

Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.



Allocation

We considered seven of the 10 included RCTs as 'low risk of bias' for allocation concealment (van Baar 1998; Foley 2003; Fransen 2007; Fernandes 2010; Juhakoski 2011; Abbott 2013; French 2013), while three had 'uncertain risk' (Hopman-Rock 2000; Tak 2005; Carlson 2011), as no specific information was provided (Figure 2).

Blinding

None of the included RCTs was able to blind participants or personnel (therapists providing the interventions) to treatment allocation (Figure 2).

While all of the included RCTs reported blinding of outcomes assessor, the outcomes (pain, physical function, quality of life) were participant reported and results may, therefore, be vulnerable to detection bias.

Incomplete outcome data

Eight of the 10 included RCTs had only minimal loss to follow-up or used intention-to-treat analysis.

Selective reporting

Only four of the 10 included RCTs indicated evidence of study registration.

Other potential sources of bias

There were three studies with unclear risk of other biases: lengthy period (eight months) between end of supervised treatment programme and outcomes assessment (Abbott 2013); abstract only so minimal information on study methodology (Carlson 2011); 40% of participants on the orthopaedic surgery waiting list (Foley 2003).

Effects of interventions

See: **Summary of findings for the main comparison** Immediate post-treatment effect of exercise for osteoarthritis of the hip; **Summary of findings 2** Sustainability (three to six months) for osteoarthritis of the hip

We contacted four study authors to provide data specific for OA hip for pain and physical function outcomes (van Baar 1998; Hopman-Rock 2000; Foley 2003; Abbott 2013). All four responded with the requested data. We were unable to contact the authors of one included pilot study that had been published as an abstract (Carlson 2011).

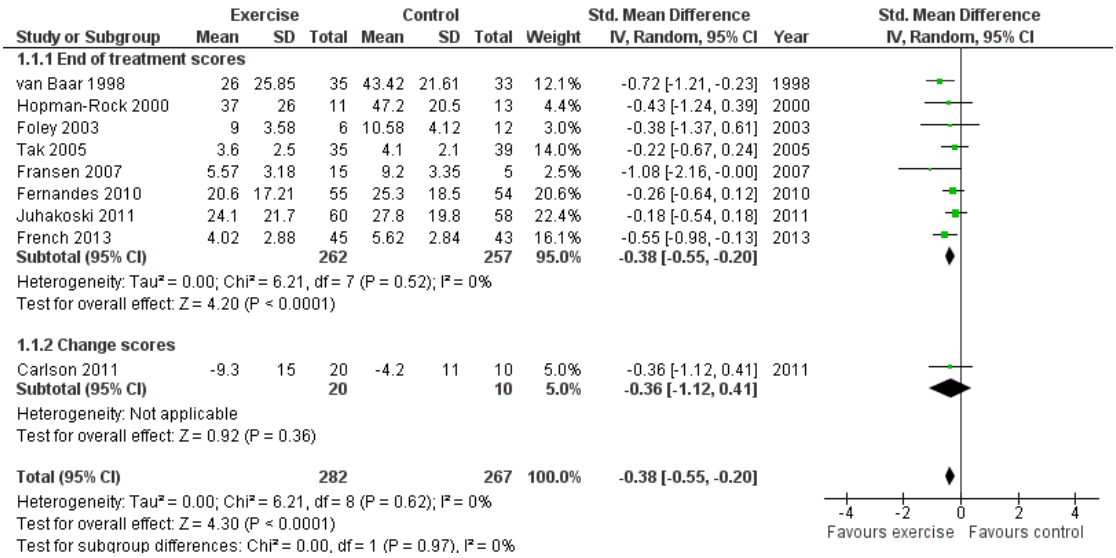
Immediate post treatment

Pain

Nine of the 10 included RCTs provided immediate post-treatment effects on 549 participants.

Combining the results demonstrated a significant benefit (SMD (random-effects model) -0.38, 95% CI -0.55 to -0.20; Figure 3). This effect size would be considered small to moderate (Cohen 1977). Between-study heterogeneity was negligible (I^2 = 0%). The demonstrated effect size for exercise was equivalent to a pain reduction of 8 points (95% CI 4 to 11) on a 0 to 100 scale compared with a control group.

Figure 3. Forest plot of comparison: 1.1 Pain.

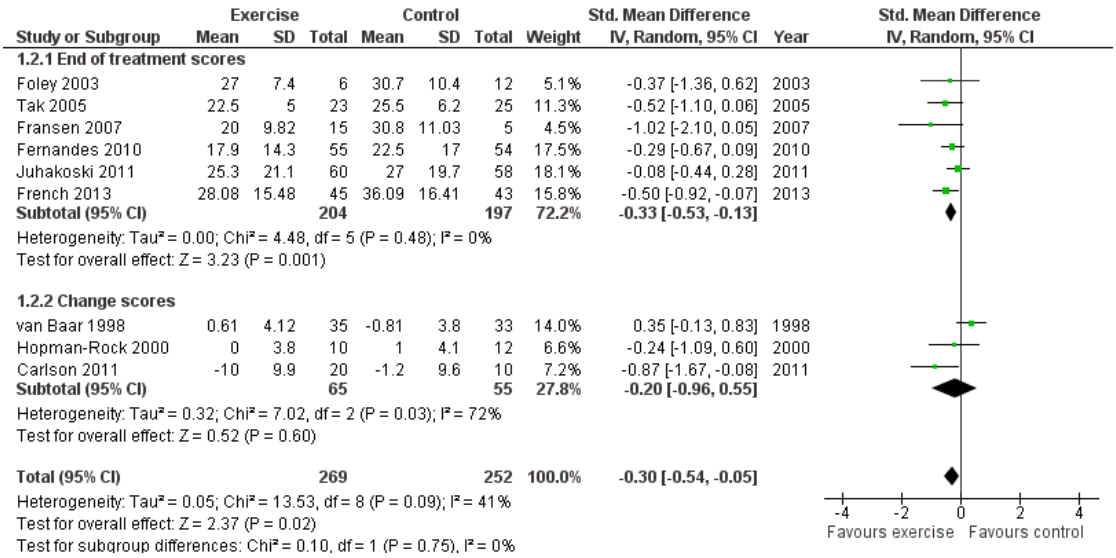


Physical function

Nine of the 10 included RCTs provided immediate post-treatment effects on 521 participants.

Combining the results demonstrated a significant benefit (SMD -0.30, 95% CI -0.54 to -0.05; Figure 4). Between-study heterogeneity was moderate (I^2 = 41%). Limiting pooling to the six RCTs providing post-treatment scores, rather than change scores, resulted in a similar benefit (SMD -0.33, 95% CI -0.53 to -0.13) and reduced between-study heterogeneity to 0%. This effect size would be considered small to moderate (Cohen 1977). The demonstrated effect size for exercise was equivalent to an improvement of physical function of 7 points (95% CI 1 to 12) on a 0 to 100 scale compared with a control group.

Figure 4. Forest plot of comparison: 1.2 Physical function.



Quality of life

Only three of the 10 included RCTs could provide immediate post-treatment effects on 183 participants with hip OA. A higher score is a better score. Two studies used population norm-based scores with a mean of 50 (SD 10). No significant difference was detected (SMD 0.10, 95% CI -0.23 to 0.36). Between-study heterogeneity was negligible (I^2 = 0%).

Study withdrawals

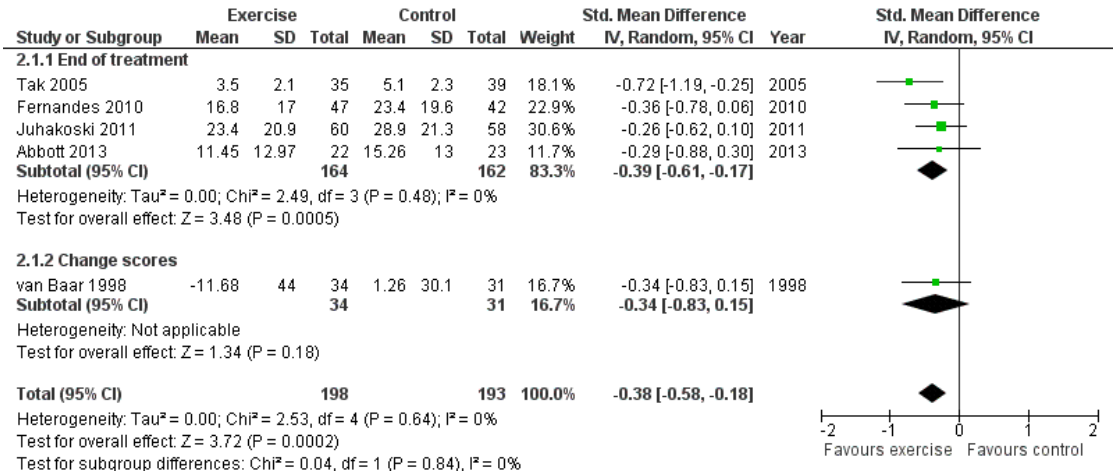
Only seven studies provided data on study withdrawals at the time of the first post-treatment assessment. Of these seven studies, only whole sample estimates (knee and hip OA) were available for two studies (van Baar 1998; Foley 2003). There was no significantly increased risk of study withdrawal from the exercise allocation (6.3%) compared with the control group (3.4%) (Risk difference 0.01, 95% CI -0.01 to 0.04); Analysis 1.4).

Treatment sustainability (three to six months)

Pain

Five of the 10 included RCTs provided treatment sustainability pain outcomes on 391 participants. Combining the results demonstrated a significant benefit (SMD -0.38, 95% CI -0.58 to -0.18; Figure 5). Between-study heterogeneity was negligible (I^2 = 0%). This effect size would be considered small to moderate (Cohen 1977).

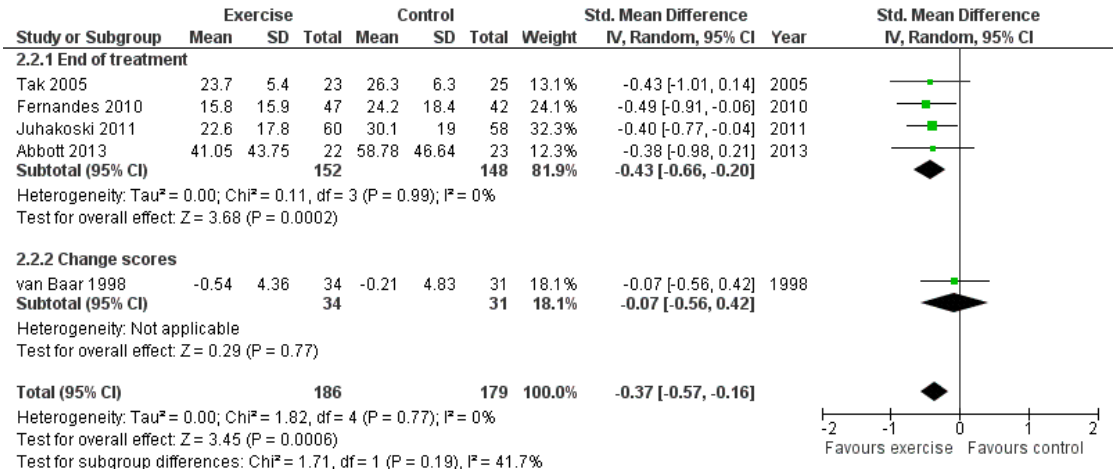
Figure 5. Sustainability (three to six months), outcome: 2.1 Pain.



Physical function

Five of the 10 included RCTs provided treatment sustainability physical function outcomes on 365 participants. Combining the results demonstrated a significant benefit (SMD -0.37, -0.57 to -0.16; Figure 6). Between-study heterogeneity was negligible (I^2 = 0%). This effect size would be considered small to moderate (Cohen 1977).

Figure 6. 2 Sustainability (three to six months), outcome: 2.2 Physical function.



Studies recruiting only participants with hip osteoarthritis compared with studies recruiting

participants with hip and knee osteoarthritis

Pain

Combining the results of the five studies (419 participants) recruiting solely people with hip OA demonstrated a significant benefit (SMD -0.30, 95% CI -0.49 to -0.10). Combining the results of the four studies (130 participants) recruiting people with either hip or knee OA demonstrated a larger mean benefit (SMD -0.66, 95% CI -1.02 to -0.29). There was no significant difference between the two groups of studies (P value = 0.09).

Physical function

Combining the results of the five studies (393 participants) recruiting solely people with hip OA demonstrated a significant benefit (SMD -0.35, 95% CI -0.57 to -0.13). Combining the results of the four studies (128 participants) recruiting people with either hip or knee OA did not detect a significant benefit (SMD -0.20, 95% CI -0.79 to 0.40). There was no significant difference between the two groups of studies (P value = 0.64). Between-study heterogeneity was substantial for the studies recruiting participants with either hip or knee OA (I^2 = 54%).

Adverse events

Only five RCTs specifically reported adverse events (van Baar 1998; Foley 2003; Tak 2005; Fransen 2007; Abbott 2013). Abbott 2013 "detected no trial related adverse events", van Baar 1998 stated one patient receiving exercise reported adverse effects; Tak 2005 reported two participants in the exercise group withdrew due to increased back pain; Foley 2003 reported four withdrawals in the exercise group due to increased pain (two people), increased blood pressure (one person) and doctor's advice (one person) compared with one withdrawal due to illness in the control group; and Fransen 2007 reported only withdrawals in the Tai Chi allocation among participants with knee OA.

ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

Sustainability (3-6 months) for osteoarthritis of the hip

Patient or population: people with osteoarthritis of the hip
Settings:
Intervention: sustainability (3-6 months)

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	Sustainability (3-6 months)				
Pain Follow-up: 3-6 months	The mean pain ranged across control groups from **5 points on a 0-10 scale to 29 points on a 0-100 scale**	The mean pain in the intervention groups was **0.38 standard deviations lower** (0.58 to 0.18 lower) This translates to an absolute mean reduction 8 (4 to 12) points compared with control group using a 0-100 scale	-	391 (6 studies)	⊕⊕⊕⊕ **high**	SMD -0.38 (-0.58 to -0.18) Absolute change 8 (4 to 12) points on a 0-100 scale
Physical Function Follow-up: 3-6 months	The mean physical function ranged across control groups from **24 points on a 0-100 scale to 59 points on a 0-170 scale**	The mean physical function in the intervention groups was **0.37 standard deviations lower** (0.57 to 0.16 lower) This translates to an absolute mean reduction 7 (4 to 13) points compared with control group using a 0-100 scale	-	365 (6 studies)	⊕⊕⊕⊕ **high**	SMD -0.37 (-0.57 to -0.16) Absolute change 7 (4 to 13) points on a 0-100 scale

Adverse events not reported	See comment	See comment	Not estimable	-	See comment	No adverse events such as injuries were reported

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: confidence interval; **NNTB:** number needed to treat for an additional beneficial outcome

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

DISCUSSION

Summary of main results

The objective of this systematic review was to evaluate the current scientific evidence for the benefit of land-based exercise for people with symptomatic hip OA in terms of joint pain, self reported physical function and quality of life. The overall results of the meta-analysis suggest that land-based exercise is beneficial in terms of reduced pain and improved physical function at the completion of a supervised exercise programme and these benefits are sustained for at least a further three to six months. There was insufficient evidence available to determine the effect of exercise on quality of life among people with hip OA. The level of pain was generally mild to moderate at baseline and thus although the reduction in pain in favour of exercise was potentially small (a mean absolute change of 8%), a mean relative change of 28% (38% for the upper limit) could be considered clinically important for a low-risk intervention such as exercise. Similarly for physical function, a relative change of 42% could not be ruled out.

Overall completeness and applicability of evidence

The meta-analysis could include 10 small RCTs. There were marked differences between these RCTs in the content and duration of the exercise programmes provided and in the participant samples recruited. Only one of the larger RCTs demonstrated significant benefits in both pain and physical function at the end of the treatment programme (French 2013). This study provided only eight weekly sessions of individually supervised exercise sessions but also prescribed a daily home programme of 30 minutes of walking, cycling or swimming. One other study demonstrated significant benefit in terms of pain only (van Baar 1998). The participants in this study were referrals from general practice with mostly very early symptomatic disease (less than one year). The two largest RCTs were the only studies to demonstrate significant sustainable benefit at three to six months for physical function (Fernandes 2010; Juhakoski 2011). The first provided 24 individual sessions with a physiotherapist over 12 weeks (Fernandes 2010). The exercise programme had a mixed content of muscle strengthening and functional exercise. The second provided 16 sessions of high-intensity muscle strengthening (Juhakoski 2011). It is notable that these three RCTs demonstrating significant benefits were among the five RCTs that restricted recruitment to people with hip OA. Of the other two RCTs restricting recruitment to only participants with hip OA, one had a much smaller sample size (Tak 2005), and the other did not evaluate long-term outcomes (Carlson 2011). It is likely that their exercise programmes were, therefore, more specific to this condition compared to RCTs that recruited both people with knee, hip or both knee and hip OA. This concern would be particular for hip OA as the proportion of participants with hip OA in these combined programmes is always much smaller than the proportion with knee OA. The proportion of RCTs restricting recruitment to people with hip OA was much higher for this update (5/10 studies), compared with the previous review (1/5 studies), and may explain the shift to finding significant improvement for physical function in the current update.

It would be worthwhile if future studies explore the effect of more intensive lower limb muscle strengthening programmes further and provide more information regarding exercise adherence or the effect of strategies to improve exercise adherence in this population. We have still only been able to include five studies specifically targeting people with hip OA. Exercise covers a very broad area, so the potential for development of more beneficial and sustainable exercise protocols is evident. A larger number of studies would allow for meaningful subgroup analyses on basis of exercise content and dosage.

Quality of the evidence

Most of the RCTs included in this systematic review were considered by our criteria to have a 'low risk of bias'. While all the RCTs reported having blinded outcome assessment, participants were aware of their allocation status. Given that the main outcomes of this review were participant self reported pain and physical function, there is a possibility that the treatment effect sizes may be inflated. Given the difficulty blinding participants to exercise treatment allocation (versus no exercise) and the high quality of the evidence for pain and physical function benefit, we expect that new studies would not change our confidence in the effect estimates.

The quality of the body of evidence was high for pain and function. Although there may be a potential study limitation for the evidence for pain and function (a potential for bias that may overestimate the effect sizes), we did not consider that it was substantial enough to downgrade the evidence. The evidence underpinning quality of life was low overall due to the limited number (three) of small studies evaluating this outcome. Further, quality of life does not appear to be influenced by mild-to-moderate symptomatic hip OA as the quality of life assessment reported in the two studies using the SF-MCS was in line with published population-based normative values. The evidence for withdrawals was moderate due to unspecific reporting. Many studies simply reported the number of participants attending outcomes assessments, and did not provide quantitative data regarding the number of participants withdrawing from study treatment.

Potential biases in the review process

We expect minimal biases in extracting and reporting of data (four review authors selected studies for inclusion, two review authors independently extracted data). We conducted an extensive liter-

ature search. However, the possibility of publication bias could not be ruled out, as we did not attempt to retrieve unpublished studies.

Agreements and disagreements with other studies or reviews

The mean effect size for immediate post-treatment hip pain reported in this meta-analysis were similar to those reported in a previous meta-analysis (SMD -0.38) (Hernandez-Molina 2008). The previous meta-analysis included five RCTs from 1998 to 2007 included in this review, but also included three further RCTs evaluating hydrotherapy, as well as the hydrotherapy results of two included RCTs (Foley 2003; Fransen 2007). While the mean effect size was identical, the CIs around the estimate were much wider (95% CI 0.08 to 0.68) than those demonstrated in the current review (95% CI 0.20 to 0.55). The original Cochrane review, "Exercise for osteoarthritis of the hip" (Fransen 2009), could only pool the findings of five RCTs with 204 participants. This previous review did not demonstrate a significant benefit in terms of pain and physical function. Marked heterogeneity was evident and only one of the five RCTs restricted recruitment to people with hip OA (Tak 2005). In the current review, about 75% of study participants were enrolled in RCTs restricting recruitment to people with hip OA.

AUTHORS' CONCLUSIONS

Implications for practice

There is currently high-level evidence that land-based exercise will reduce hip pain (van Baar 1998; French 2013), and improve physical function (Fernandes 2010; Juhakoski 2011; French 2013), among people with symptomatic hip osteoarthritis.

Implications for research

Identify possible predictors of treatment responsiveness and exercise adherence in this population.

Develop multi-armed randomised controlled trials to help provide evidence of optimal exercise content and dosage. Initiate research to assess the long-term effectiveness of exercise for people with hip osteoarthritis in terms of disease progression and time to joint replacement surgery.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

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

Abbott 2013

Methods	Low bias risk Blinded assessor ITT analysis Usual GP care control group
Participants	People with hip and knee OA 4-arm RCT: manual therapy, exercise therapy, manual therapy plus exercise therapy, usual GP care alone 45 people with hip OA allocated to exercise or usual GP care alone groups Mean age: 66 years ACR clinical criteria
Interventions	Individually provided by physiotherapy, 50 minutes (7 weeks, 1 x per week plus 2 booster sessions week 16) Control: usual GP care alone
Outcomes	At 1 year: WOMAC pain (0-50) WOMAC physical function (0-170)
Notes	Long interval between end of monitored treatment (4 months) and outcomes assessment (1 year)

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation centre used
Allocation concealment (selection bias)	Low risk	Randomisation centre used
Blinding of participants and personnel (performance bias) All outcomes	High risk	Physiotherapists and participants aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT and minimal loss to follow-up (maximum: 2/51 exercise; 4/51 usual care)
Selective reporting (reporting bias)	Low risk	Registered trial protocol

Abbott 2013 (*Continued*)

Other bias	Unclear risk	8-month interval between end of monitored treatment and outcomes assessment

Carlson 2011

Methods	Unclear risk of bias
Participants	Hip only Recruited from specialist clinics and the community Pain at least once per week in 1 or both hips, difficulty with ADL secondary to hip pain, radiographic evidence of femoral or acetabular osteophytes (or both) or axial joint space narrowing and active hip flexion < 115 degrees
Interventions	20 people allocated to 3 month aerobic activity and resistance training programme (45 minutes) 2-3 times per week, 10 people to usual care
Outcomes	Post treatment only Pain on 0-100 VAS WOMAC physical function (0-100)
Notes	No response to email request for further information

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Abstract only - no information provided
Allocation concealment (selection bias)	Unclear risk	Abstract only - no information provided
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Abstract only - no information provided
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Abstract only - no information provided
Selective reporting (reporting bias)	Unclear risk	Abstract only - no information provided
Other bias	Unclear risk	None apparent

Fernandes 2010

Methods	Low bias risk Blinded assessor No loss to follow-up at 4 months Patient education only control ('Hip School')
Participants	*Hip OA only 109 people with hip pain > 3 months and HHS 60-95 Mean age 58 years Radiographic criteria: joint space width < 4 mm
Interventions	Individually based, clinic 12 weeks (2 x per week) Treatment: mixed - strengthening, functional, flexibility
Outcomes	At 4 months: WOMAC Pain (0-100) WOMAC Physical Function (0-100)
Notes	About 20% loss to follow-up at 10 months

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer generated, blocks of 10
Allocation concealment (selection bias)	Low risk	Independent researcher, sealed numbered envelopes
Blinding of participants and personnel (performance bias) All outcomes	High risk	Physiotherapists and participants aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	Only 1 person lost to follow-up at 4 months (20 people lost at 10 months)
Selective reporting (reporting bias)	Low risk	Main outcomes specified a priori - WOMAC pain
Other bias	Low risk	None apparent

Foley 2003

Methods	Low bias risk Blinded assessor ITT analysis Waiting list
Participants	People with hip and knee OA recruited 29 mostly clinic patients with hip OA Mean age: 70 years Radiographic criteria
Interventions	Class-based (6 weeks) Treatment: 18 x strengthening, ROM, 30-minute classes Control: telephone call every 2 weeks
Outcomes	At 6 weeks: WOMAC pain (0-20) WOMAC function (0-68) Unable to obtain SF-12 MCS data specific for people with hip OA for the updated review
Notes	Separate analysis per hip OA, gym-based group vs. controls

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer generated
Allocation concealment (selection bias)	Low risk	Central allocation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	Small numbers lost to follow-up, balanced between allocation groups
Selective reporting (reporting bias)	Unclear risk	Unable to ascertain
Other bias	Unclear risk	About 40% on orthopaedic waiting list

Fransen 2007

Methods	Low bias risk Blinded assessor ITT analysis Waiting list
Participants	People with hip and knee OA recruited 20 community volunteers hip OA 75% female Mean age: 70 years ACR criteria
Interventions	Class-based (12 weeks) Treatment: 24 x tai chi classes, 60-minute classes Control: waiting list
Outcomes	At 12 weeks: WOMAC pain (0-100) WOMAC function (0-100) SF-MCS
Notes	Disaggregated analysis (hip or knee OA) according to identified signal (most painful) joint

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Random numbers table
Allocation concealment (selection bias)	Low risk	Central allocation by administrator
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analysis
Selective reporting (reporting bias)	Low risk	Trial registered NCT00123994
Other bias	Low risk	None apparent

French 2013

Methods	Low risk bias Blind assessor ITT analysis Waiting list control
Participants	*Hip OA only recruited (ACR clinical and radiographic criteria) 88 people (exercise or control) referred for physiotherapy by GPs or hospital consultants Mean age: 65 years
Interventions	Individually provided 'standardised' exercise programme (8 x 30-minute sessions over 8 weeks) plus daily home exercise programme (aerobic walking/cycling/swimming 30 minutes) Treatment: strengthening, flexibility, aerobic
Outcomes	At 9 weeks: Pain on activity (0-10 NRS) WOMAC Physical Function (0-68) SF-12 MCS
Notes	Low-intensity programme - 8 x 30 minutes monitored only. Unclear why WOMAC pain not used as primary outcome

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated sequence
Allocation concealment (selection bias)	Low risk	Off-site randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	Multiple imputations, only 3 people lost to follow-up at 9 weeks
Selective reporting (reporting bias)	Low risk	Protocol published
Other bias	Low risk	None apparent

Hopman-Rock 2000

Methods	Moderate bias risk Blind assessor Efficacy analysis Waiting list
Participants	Hip and knee OA recruited (ACR criteria) 28 volunteers hip OA, 80% female Mean age: 65 years
Interventions	Class-based (6 weeks) Treatment: 6 x education + exercise, 60-minute classes
Outcomes	At 6 weeks: VAS pain (2) IRGL mobility (7-28) Unable to obtain quality of life data specific for people with hip OA for the updated review
Notes	Short programme. Only 6 supervised treatment occasions

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Efficacy analysis
Selective reporting (reporting bias)	Unclear risk	Insufficient information
Other bias	Low risk	None apparent

Juhakoski 2011

Methods	Low bias risk Blinded assessor ITT analysis GP care control group
Participants	*Hip OA only Community volunteers Mean age: 66 years About 80% overweight or obese ACR clinical criteria K&L 1-2 (85%)
Interventions	Exercise and GP care Class-based (12 weeks) 45 minutes x 12 weekly sessions + 4 booster sessions 1 year later Strengthening (with maximal effort)
Outcomes	3 months/6 months WOMAC Pain (0-100) WOMAC Physical Function (0-100)
Notes	Both groups access to physiotherapy (as part of GP care); however, only mean sum of visits over 24 months of 1.3 (active group) vs. 2.0 (control group). WOMAC scores 'adjusted' for baseline differences in outcome measures, age, gender, radiological score, comorbidities, existence of knee OA or knee pain (or both) and duration of hip symptoms

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer generated
Allocation concealment (selection bias)	Low risk	Sealed envelopes, offsite randomisation
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT, last observation carried forward, minimal loss to follow-up (2 people at 3 months)
Selective reporting (reporting bias)	Unclear risk	Not registered

Juhakoski 2011 (*Continued*)

Other bias	Low risk	None apparent

Tak 2005

Methods	Moderate bias risk Blinded assessor Efficacy analysis Waiting list
Participants	*Hip OA only 109 community volunteers Mean age: 68 years Clinical ACR criteria Clinical criteria OA hip
Interventions	Class-based (8 weeks) Treatment: 8 x strengthening + home programme, 60-minute classes
Outcomes	At 8 weeks: VAS pain (0-10) GARS function (18-72) Generic quality of life (0-10)
Notes	Short programme. Only 8 supervised treatment sessions

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated table
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	High risk	Efficacy analysis, 36% and 28% missing data for pain outcome
Selective reporting (reporting bias)	Unclear risk	Not registered

Tak 2005 (*Continued*)

Other bias	Low risk	None apparent

van Baar 1998

Methods	Low bias risk Blinded assessor ITT analysis Control: GP education
Participants	Hip and knee OA recruited 81 people from GP clinic with hip OA 79% female Mean age: 68 years ACR criteria
Interventions	Individual programme (12 weeks) Treatment: 17 x physiotherapy (30-minute sessions) + GP education
Outcomes	At 12 weeks: Pain (VAS x 1) (0-100) Function IRGL (7-28)
Notes	Separate results provided for hip OA. Mostly early disease as approximately 50% sample had symptom duration < 1 year

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Random numbers table
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes, sequential numbering for audit trail
Blinding of participants and personnel (performance bias) All outcomes	High risk	Participants and personnel aware of treatment allocation
Blinding of outcome assessment (detection bias) Self-reported outcomes	Unclear risk	Blinded outcomes assessor, but participant self reported pain and function
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analysis
Selective reporting (reporting bias)	Unclear risk	Not registered

van Baar 1998 (*Continued*)

Other bias	Low risk	None apparent

ACR: American College of Rheumatology; ADL: activities of daily living; GARS: Groningen Activity Restriction Scale; GP: general practitioner; HHS: Harris Hip Score; IRGL: Influence of Rheumatic Diseases on General Health and Lifestyle; ITT: intention to treat; K&L: Kellgren and Lawrence; MCS: Mental Component Summary; NRS: Numerical Rating Scale; OA: osteoarthritis; RCT: randomised controlled trial; ROM: range of motion; SF: Short Form; SF-12: 12-item Short Form; WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index; VAS: visual analogue scale.

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

Study	Reason for exclusion
Abbott 2012	Health economic evaluation only, abstract
Angst 2001	No control group
Boeer 2010	No non-exercise group, all participated in 'Hip School'
Brantingham 2012	No non-exercise group. RCT comparing 2 different manual and manipulative therapy techniques in addition to exercise
Cochrane 2005	No land-based exercise group
Coupe 2007	Supplementary analysis Veenhof 2006
de Jong 2004	No non-exercise control group
Eitzen 2011	Supplementary analysis Fernandes 2010. Predictive study using gait characteristics
Green 1993	No appropriate control. Assessed added benefit of hydrotherapy to home exercises
Halbert 2001	Physical activity advice/recommendation only
Haslam 2001	Advice and exercise was the control group The evaluated treatment was acupuncture
Heuts 2005	Arthritis self management education programme with no supervised exercise sessions
Hinman 2007	No land-based exercise group
Hoeksma 2004	No non-exercise control. Manual therapy vs. exercise
Hoeksma 2005	Supplementary analysis of Hoeksma 2004

(*Continued*)

Hoeksma 2006	Supplementary analysis of Hoeksma 2004
Klasbo 2003	Education sessions with on therapeutic exercise advice
Koybashi 2010	No non-exercise control
Lin 2004	No land-based exercise group
Pisters 2010a	No non-exercise group. Both treatment allocation were supervised by physiotherapists and involved exercise-focused programmes
Pisters 2010b	No non-exercise group. Both treatment allocation were supervised by physiotherapists and involved exercise-focused programmes
Ravaud 2004	Cluster randomised trial, unsupervised exercise and all participants prescribed daily Vioxx
Rooks 2006	Peri-operative exercise programme
Song 2010	Suspect focus on people with knee osteoarthritis; however, site of symptomatic osteoarthritis not specified
Steenstrup 2012	Limited exercise involved (only 10 x a single hip abduction exercise). The physiotherapy involved mostly manual therapy plus electrotherapy
Steinhilber 2012	Included people with total hip replacement
Stener-Victoria 2004	No land-based exercise group
Svege 2010	Supplementary analysis of Fernandes 2010
Svege 2011	Supplementary analysis of Fernandes 2010
Sylvester 1989	No appropriate control. Hydrotherapy compared with exercises plus shortwave diathermy (14 people)
Uesugi 2012	Evaluating 2 delivery modes (DVD or written materials) of same exercise programme
van Baar 2001	Secondary analysis van Baar 1998 (follow-up study)
Veenhof 2006	No non-exercise control. Both treatment allocations (behavioural graded activity or usual physiotherapy care) were supervised by physiotherapists and involved exercise-focused programmes
Wang 2007	No land-based exercise group

DATA AND ANALYSES

Comparison 1. Immediate post treatment

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	9	549	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.55, -0.20]
1.1 End of treatment scores	8	519	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.55, -0.20]
1.2 Change scores	1	30	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-1.12, 0.41]
2 Physical function	9	521	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-0.54, -0.05]
2.1 End of treatment scores	6	401	Std. Mean Difference (IV, Random, 95% CI)	-0.33 [-0.53, -0.13]
2.2 Change scores	3	120	Std. Mean Difference (IV, Random, 95% CI)	-0.20 [-0.96, 0.55]
3 Quality of life	3		Std. Mean Difference (IV, Random, 95% CI)	Subtotals only
3.1 End of treatment scores	3	183	Std. Mean Difference (IV, Random, 95% CI)	0.07 [-0.23, 0.36]
4 Study withdrawals	7	715	Risk Difference (M-H, Random, 95% CI)	0.01 [-0.01, 0.04]

Comparison 2. Sustainability (three to six months)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	5	391	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.58, -0.18]
1.1 End of treatment	4	326	Std. Mean Difference (IV, Random, 95% CI)	-0.39 [-0.61, -0.17]
1.2 Change scores	1	65	Std. Mean Difference (IV, Random, 95% CI)	-0.34 [-0.83, 0.15]
2 Physical function	5	365	Std. Mean Difference (IV, Random, 95% CI)	-0.37 [-0.57, -0.16]
2.1 End of treatment	4	300	Std. Mean Difference (IV, Random, 95% CI)	-0.43 [-0.66, -0.20]
2.2 Change scores	1	65	Std. Mean Difference (IV, Random, 95% CI)	-0.07 [-0.56, 0.42]

Comparison 3. Hip osteoarthritis (OA) versus hip/knee OA studies

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain post treatment	9	549	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.55, -0.20]
1.1 Hip OA only	5	419	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-0.49, -0.10]
1.2 Hip/knee OA	4	130	Std. Mean Difference (IV, Random, 95% CI)	-0.66 [-1.02, -0.29]
2 Physical function post treatment	9	521	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-0.54, -0.05]
2.1 Hip OA only	5	393	Std. Mean Difference (IV, Random, 95% CI)	-0.35 [-0.57, -0.13]
2.2 Hip/knee OA	4	128	Std. Mean Difference (IV, Random, 95% CI)	-0.20 [-0.79, 0.40]

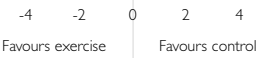
Analysis 1.1. Comparison 1 Immediate post treatment, Outcome 1 Pain.

Review: Exercise for osteoarthritis of the hip

Comparison: 1 Immediate post treatment

Outcome: 1 Pain

Study or subgroup	Exercise N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 End of treatment scores							
van Baar 1998	35	26 (25.85)	33	43.42 (21.61)		12.1 %	-0.72 [-1.21, -0.23]
Hopman-Rock 2000	11	37 (26)	13	47.2 (20.5)		4.4 %	-0.43 [-1.24, 0.39]
Foley 2003	6	9 (3.58)	12	10.58 (4.12)		3.0 %	-0.38 [-1.37, 0.61]
Tak 2005	35	3.6 (2.5)	39	4.1 (2.1)		14.0 %	-0.22 [-0.67, 0.24]
Fransen 2007	15	5.57 (3.18)	5	9.2 (3.35)		2.5 %	-1.08 [-2.16, 0.00]
Fernandes 2010	55	20.6 (17.21)	54	25.3 (18.5)		20.6 %	-0.26 [-0.64, 0.12]
Juhakoski 2011	60	24.1 (21.7)	58	27.8 (19.8)		22.4 %	-0.18 [-0.54, 0.18]
French 2013	45	4.02 (2.88)	43	5.62 (2.84)		16.1 %	-0.55 [-0.98, -0.13]
Subtotal (95% CI)	**262**		**257**			**95.0 %**	**-0.38 [-0.55, -0.20]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 6.21$, df = 7 (P = 0.52); $I^2 = 0.0\%$							
Test for overall effect: Z = 4.20 (P = 0.000027)							
2 Change scores							
Carlson 2011	20	-9.3 (15)	10	-4.2 (11)		5.0 %	-0.36 [-1.12, 0.41]
Subtotal (95% CI)	**20**		**10**			**5.0 %**	**-0.36 [-1.12, 0.41]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.92 (P = 0.36)							
Total (95% CI)	**282**		**267**			**100.0 %**	**-0.38 [-0.55, -0.20]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 6.21$, df = 8 (P = 0.62); $I^2 = 0.0\%$							
Test for overall effect: Z = 4.30 (P = 0.000017)							
Test for subgroup differences: $Chi^2 = 0.00$, df = 1 (P = 0.97), $I^2 = 0.0\%$							

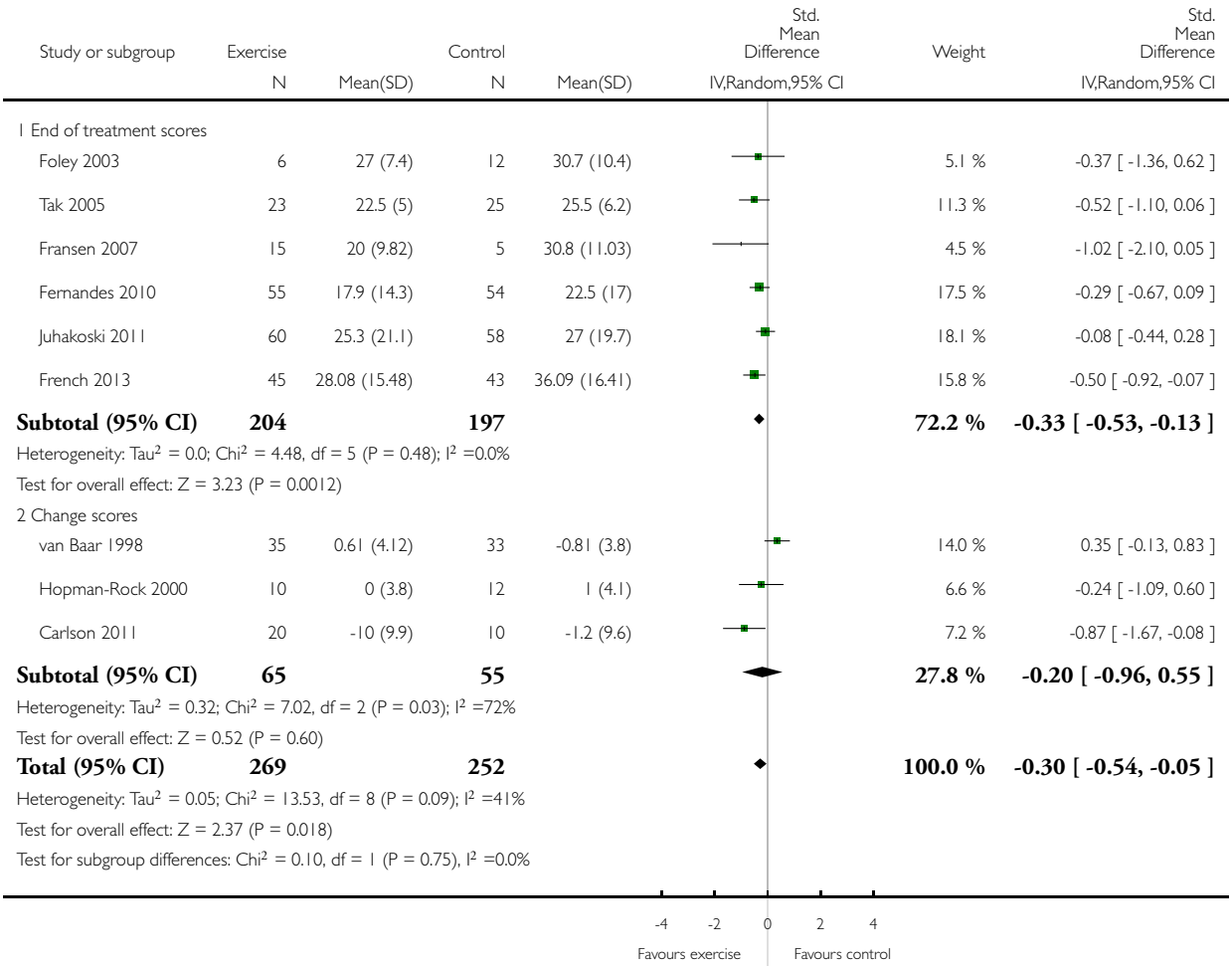


Analysis 1.2. Comparison 1 Immediate post treatment, Outcome 2 Physical function.

Review: Exercise for osteoarthritis of the hip

Comparison: 1 Immediate post treatment

Outcome: 2 Physical function

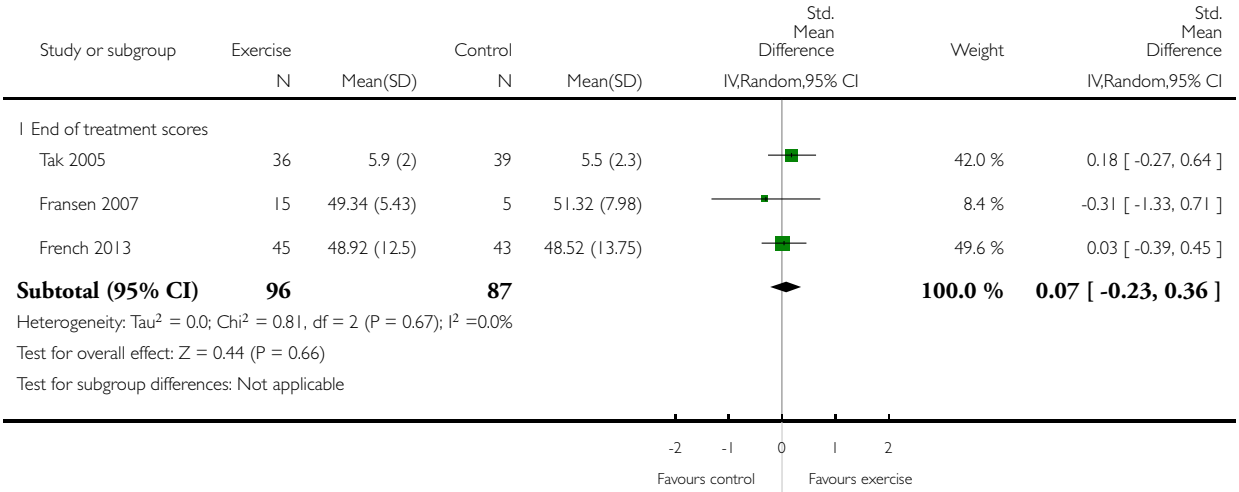


Analysis 1.3. Comparison 1 Immediate post treatment, Outcome 3 Quality of life.

Review: Exercise for osteoarthritis of the hip

Comparison: 1 Immediate post treatment

Outcome: 3 Quality of life



Analysis 1.4. Comparison 1 Immediate post treatment, Outcome 4 Study withdrawals.

Review: Exercise for osteoarthritis of the hip

Comparison: 1 Immediate post treatment

Outcome: 4 Study withdrawals

Study or subgroup	Exercise n/N	Control n/N	Risk Difference M-H,Random,95% CI	Weight	Risk Difference M-H,Random,95% CI
van Baar 1998	6/99	4/102		15.7 %	0.02 [-0.04, 0.08]
Foley 2003	3/35	3/35		4.1 %	0.0 [-0.13, 0.13]
Tak 2005	10/55	5/54		4.3 %	0.09 [-0.04, 0.22]
Fransen 2007	1/15	0/5		1.1 %	0.07 [-0.20, 0.33]
Fernandes 2010	0/55	0/54		31.5 %	0.0 [-0.04, 0.04]
Juhakoski 2011	0/60	0/58		34.1 %	0.0 [-0.03, 0.03]
French 2013	3/45	0/43		9.3 %	0.07 [-0.02, 0.15]
Total (95% CI)	**364**	**351**		**100.0 %**	**0.01 [-0.01, 0.04]**

Total events: 23 (Exercise), 12 (Control)

Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 7.79$, df = 6 (P = 0.25); $I^2 = 23\%$

Test for overall effect: Z = 1.01 (P = 0.31)

Test for subgroup differences: Not applicable

Analysis 2.1. Comparison 2 Sustainability (three to six months), Outcome 1 Pain.

Review: Exercise for osteoarthritis of the hip

Comparison: 2 Sustainability (three to six months)

Outcome: 1 Pain

Study or subgroup	Exercise N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 End of treatment							
Tak 2005	35	3.5 (2.1)	39	5.1 (2.3)		18.1 %	-0.72 [-1.19, -0.25]
Fernandes 2010	47	16.8 (17)	42	23.4 (19.6)		22.9 %	-0.36 [-0.78, 0.06]
Juhakoski 2011	60	23.4 (20.9)	58	28.9 (21.3)		30.6 %	-0.26 [-0.62, 0.10]
Abbott 2013	22	11.45 (12.97)	23	15.26 (13)		11.7 %	-0.29 [-0.88, 0.30]
Subtotal (95% CI)	**164**		**162**			**83.3 %**	**-0.39 [-0.61, -0.17]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 2.49$, df = 3 (P = 0.48); $I^2 = 0.0\%$							
Test for overall effect: Z = 3.48 (P = 0.00051)							
2 Change scores							
van Baar 1998	34	-11.68 (44)	31	1.26 (30.1)		16.7 %	-0.34 [-0.83, 0.15]
Subtotal (95% CI)	**34**		**31**			**16.7 %**	**-0.34 [-0.83, 0.15]**
Heterogeneity: not applicable							
Test for overall effect: Z = 1.34 (P = 0.18)							
Total (95% CI)	**198**		**193**			**100.0 %**	**-0.38 [-0.58, -0.18]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 2.53$, df = 4 (P = 0.64); $I^2 = 0.0\%$							
Test for overall effect: Z = 3.72 (P = 0.00020)							
Test for subgroup differences: $Chi^2 = 0.04$, df = 1 (P = 0.84), $I^2 = 0.0\%$							

Analysis 2.2. Comparison 2 Sustainability (three to six months), Outcome 2 Physical function.

Review: Exercise for osteoarthritis of the hip

Comparison: 2 Sustainability (three to six months)

Outcome: 2 Physical function

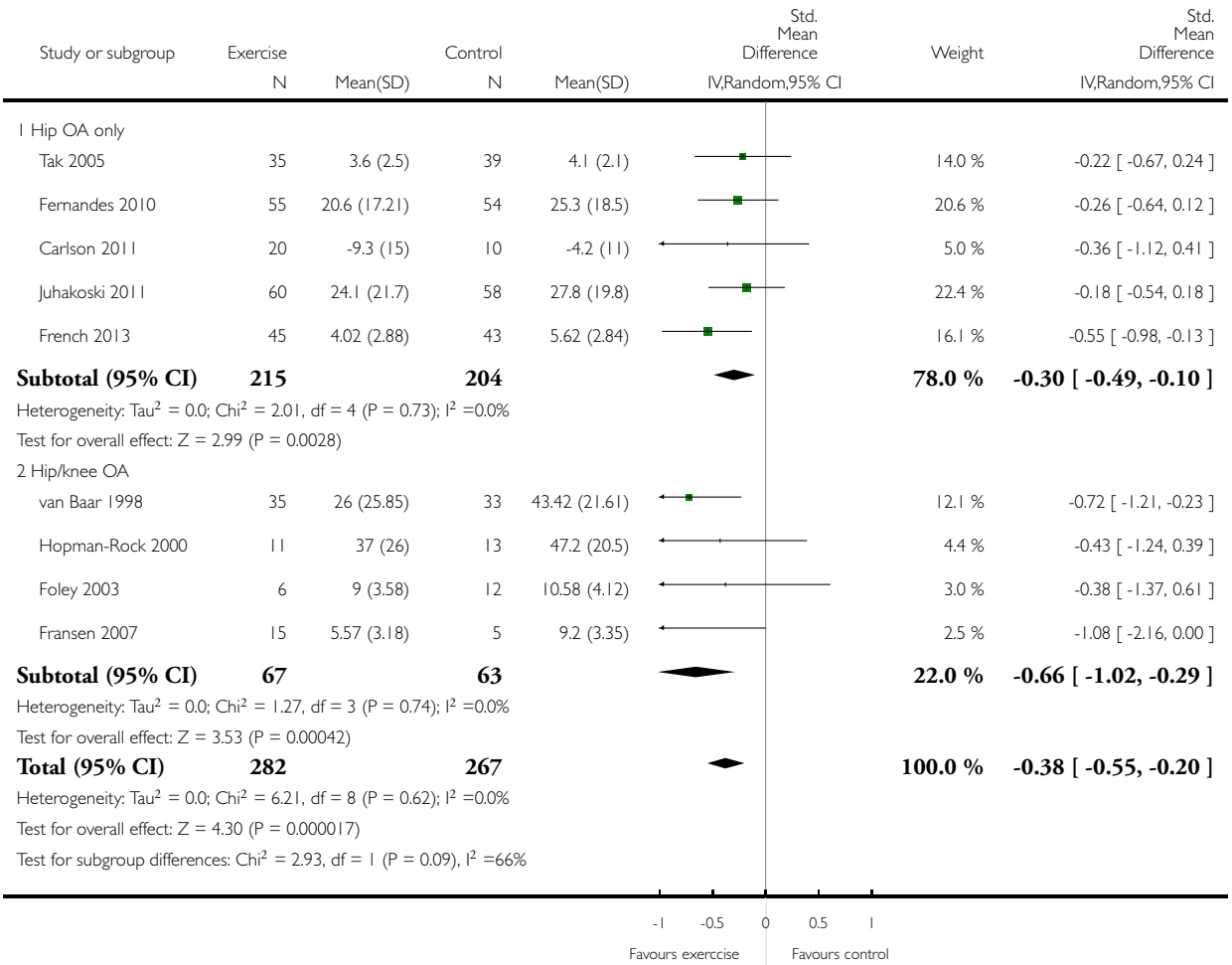
Study or subgroup	Exercise N	Mean(SD)	Control N	Mean(SD)	Std. Mean Difference IV,Random,95% CI	Weight	Std. Mean Difference IV,Random,95% CI
1 End of treatment							
Tak 2005	23	23.7 (5.4)	25	26.3 (6.3)		13.1 %	-0.43 [-1.01, 0.14]
Fernandes 2010	47	15.8 (15.9)	42	24.2 (18.4)		24.1 %	-0.49 [-0.91, -0.06]
Juhakoski 2011	60	22.6 (17.8)	58	30.1 (19)		32.3 %	-0.40 [-0.77, -0.04]
Abbott 2013	22	41.05 (43.75)	23	58.78 (46.64)		12.3 %	-0.38 [-0.98, 0.21]
Subtotal (95% CI)	**152**		**148**			**81.9 %**	**-0.43 [-0.66, -0.20]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.11$, df = 3 (P = 0.99); $I^2 = 0.0\%$							
Test for overall effect: Z = 3.68 (P = 0.00023)							
2 Change scores							
van Baar 1998	34	-0.54 (4.36)	31	-0.21 (4.83)		18.1 %	-0.07 [-0.56, 0.42]
Subtotal (95% CI)	**34**		**31**			**18.1 %**	**-0.07 [-0.56, 0.42]**
Heterogeneity: not applicable							
Test for overall effect: Z = 0.29 (P = 0.77)							
Total (95% CI)	**186**		**179**			**100.0 %**	**-0.37 [-0.57, -0.16]**
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.82$, df = 4 (P = 0.77); $I^2 = 0.0\%$							
Test for overall effect: Z = 3.45 (P = 0.00056)							
Test for subgroup differences: $Chi^2 = 1.71$, df = 1 (P = 0.19), $I^2 = 42\%$							

Analysis 3.1. Comparison 3 Hip osteoarthritis (OA) versus hip/knee OA studies, Outcome 1 Pain post treatment.

Review: Exercise for osteoarthritis of the hip

Comparison: 3 Hip osteoarthritis (OA) versus hip/knee OA studies

Outcome: 1 Pain post treatment

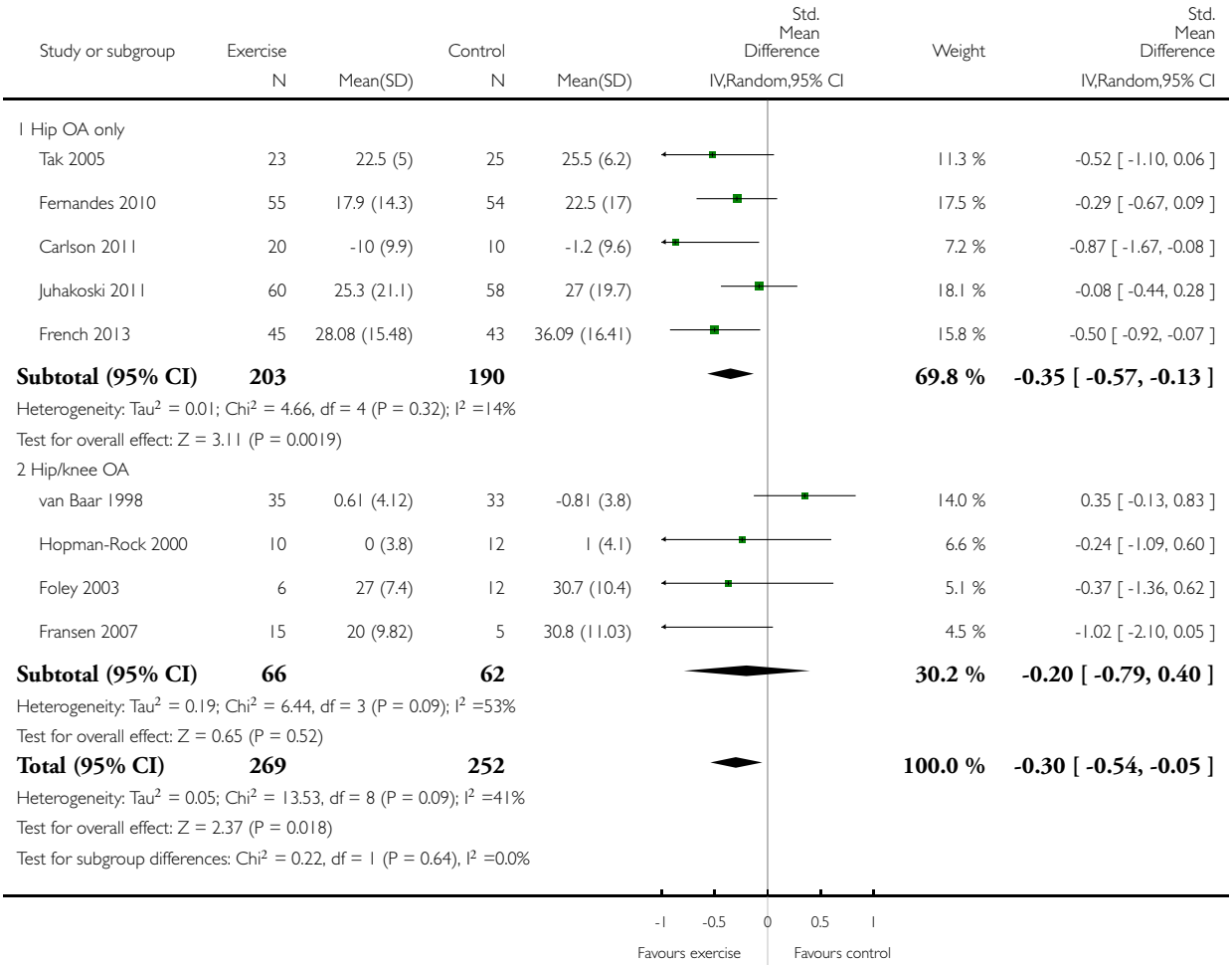


Analysis 3.2. Comparison 3 Hip osteoarthritis (OA) versus hip/knee OA studies, Outcome 2 Physical function post treatment.

Review: Exercise for osteoarthritis of the hip

Comparison: 3 Hip osteoarthritis (OA) versus hip/knee OA studies

Outcome: 2 Physical function post treatment



APPENDICES

Appendix 1. MEDLINE search strategy

1. exp osteoarthritis/
2. osteoarthr$.tw.
3. (degenerative adj2 arthritis).tw.
4. arthrosis.tw.
5. or/1-4
6. Hip/
7. exp Hip Joint/
8. hip$.tw.
9. or/6-8
10. exp EXERCISE/
11. exp exertion/
12. exp Physical Fitness/
13. exp Exercise Test/
14. exp Exercise Tolerance/
15. exp Sports/
16. exp PLIABILITY/
17. exp Physical Endurance/
18. exertion$.tw.
19. exercis$.tw.
20. sport$.tw.
21. ((physical or motion) adj5 (fitness or therap$)).tw.
22. (physical$ adj2 endur$).tw.
23. ((strength$ or isometric$ or isotonic$ or isokinetic$ or aerobic$ or endurance or weight$) adj5 (exercis$ or train$)).tw.
24. exp physical therapy modalities/
25. physiotherap$.tw.
26. manipulat$.tw.
27. kinesiotherap$.tw.
28. exp Rehabilitation/
29. rehab$.tw.
30. (skate$ or skating).tw.
31. run$.tw.
32. jog$.tw.
33. treadmill$.tw.
34. swim$.tw.
35. bicycl$.tw.
36. (cycle$ or cycling).tw.
37. walk$.tw.
38. (row or rows or rowing).tw.
39. muscle strength$.tw.
40. or/10-39
41. randomized controlled trial.pt.
42. controlled clinical trial.pt.
43. randomized.ab.
44. placebo.ab.
45. drug therapy.fs.
46. randomly.ab.
47. trial.ab.
48. groups.ab.
49. 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48

50. humans.sh.
51. 49 and 50
52. and/5,9,40,51

Appendix 2. EMBASE search strategy

1. exp osteoarthritis/
2. osteoarthr$.tw.
3. (degenerative adj2 arthritis).tw.
4. arthrosis.tw.
5. or/1-4
6. Hip/
7. hip$.tw.
8. 6 or 7
9. exp EXERCISE/
10. fitness/
11. exercise test/
12. exercise tolerance/
13. exp Sport/
14. pliability/
15. exp "physical activity, capacity and performance"/
16. exertion$.tw.
17. exercis$.tw.
18. sport$.tw.
19. ((physical or motion) adj5 (fitness or therap$)).tw.
20. (physical$ adj2 endur$).tw.
21. ((strength$ or isometric$ or isotonic$ or isokinetic$ or aerobic$ or endurance or weight$) adj5 (exercis$ or train$)).tw.
22. exp physiotherapy/
23. physiotherap$.tw.
24. manipulat$.tw.
25. kinesiotherap$.tw.
26. exp REHABILITATION/
27. rehab$.tw.
28. (skate$ or skating).tw.
29. run$.tw.
30. jog$.tw.
31. treadmill$.tw.
32. swim$.tw.
33. bicycl$.tw.
34. (cycle$ or cycling).tw.
35. walk$.tw.
36. (row or rows or rowing).tw.
37. muscle strength$.tw.
38. or/9-37
39. and/5,8,38
40. random$.ti,ab.
41. factorial$.ti,ab.
42. (crossover$ or cross over$ or cross-over$).ti,ab.
43. placebo$.ti,ab.
44. (doubl$ adj blind$).ti,ab.
45. (singl$ adj blind$).ti,ab.

46. assign$.ti,ab.
47. allocat$.ti,ab.
48. volunteer$.ti,ab.
49. crossover procedure.sh.
50. double blind procedure.sh.
51. randomized controlled trial.sh.
52. single blind procedure.sh.
53. or/40-52
54. exp animal/ or nonhuman/ or exp animal experiment/
55. exp human/
56. 54 and 55
57. 54 not 56
58. 53 not 57
59. 39 and 58

Appendix 3. PEDRO search strategy

Advanced search
Therapy: Fitness training OR Strength training
Body Part: Thigh or hip

Appendix 4. CINAHL search strategy

S56 S55 and S42
S55 S54 or S53 or S52 or S51 or S50 or S49 or S48 or S47 or S46 or S45 or S44 or S43 S54 TI Allocat* random* or AB Allocat* random*
S53 (MH "Quantitative Studies")
S52 (MH "Placebos")
S51 TI Placebo* or AB Placebo*
S50 TI Random* allocat* or AB Random* allocat*
S49 (MH "Random Assignment")
S48 TI Randomi?ed control* trial* or AB Randomi?ed control* trial*
S47 TI singl* mask* or TI doubl* mask* or TI treb* mask* or TI tripl* mask* or AB singl* mask* or AB doubl* mask* or AB treb* mask* or AB tripl* mask*
S46 TI singl* blind* or TI doubl* blind* or TI treb* blind* or TI tripl* blind* or AB singl* blind* or AB doubl* blind* or AB treb* blind* or AB tripl* blind*
S45 TI "clinic* trial*" or AB "clinic* trial*"
S44 PT Clinical Trial
S43 (MH "Clinical Trials+")
S42 S41 and S40 and S5
S41 S39 or S38 or S37 or S36 or S35 or S34 or S33 or S32 or S31 or S30 or S29 or S28 or S27 or S26 or S25 or S24 or S23 or S22 or S21 or S20 or S19 or S18 or S17 or S16 or S15 or S14 or S13 or S12 or S11 or S10 or S9 or S8 or S7 or S6
S40 S8 or S7 or S6
S39 (ti "muscle strength*") or (ab "muscle strength*")
S38 (ti row or rows or rowing) or (ab row or rows or rowing)
S37 (ti walk*) or (ab walk*)
S36 (ti cycle* or cycling) or (ab cycle* or cycling)
S35 (ti bicycl*) or (ab bicycl*)
S34 (ti swim*) or (ab swim*)
S33 (ti swim*) or (ab swim*)
S32 (ti treadmill*) or (ab treadmill*)

S31 (ti jog*) or (ab jog*)
S30 (ti run*) or (ab run*)
S29 (ti skate* or skating) or (ab skate* or skating)
S28 (ti rehab*) or (ab rehab*)
S27 (MH “Rehabilitation+”)
S26 (ti kinesiotherap*) or (ab kinesiotherap*)
S25 (ti manipulat*) or (ab manipulat*)
S24 (ti physiotherap*) or (ab physiotherap*)
S23 (MH “Physical Therapy+”)
S22 TI (strength* or isometric* or isotonic* or isokinetic*or aerobic* or endurance or weight*) or AB (strength* or isometric* or isotonic* or isokinetic*or aerobic* or endurance or weight*)
S21 TI physical* n2 endur* or AB physical* n2 endur*
S20 TI physical N5 fitness or TI physical N5 therap* or AB physical N5 fitness or AB physical N5 therap* or TI motion n5 therap* or AB motion n5 therap*
S19 (ti sport*) or (ab sport*)
S18 (ti exercis*) or (ab exercis*)
S17 (ti exertion*) or (ab exertion*)
S16 (MH “Physical Endurance+”)
S15 (MH “Pliability
S14 (MH ”Sports+“)
S13 (MH ”Exercise Tolerance+“)
S12 (MH ”Exercise Test+“)
S11 (MH ”Physical Fitness“)
S10 (MH ”Exertion+“)
S9 (MH ”Exercise+“)
S8 (ti hip*) or (ab hip*)
S7 (MH ”Hip Joint
S6 (MH “Hip”)
S5 S4 or S3 or S2 or S1
S4 (ti arthrosis) or (ab arthrosis)
S3 (ti degenerative N2 arthritis) or (ab degenerative N2 arthritis)
S2 (ti osteoarthr*) or (ab osteoarthr*)
S1 (MH “Osteoarthritis+”)

Appendix 5. *The Cochrane Library* search strategy

MeSH descriptor Osteoarthritis explode all treesosteoarthr*:ti,ab(degenerative next arthritis):ti,abarthrosis:ti,ab(#1 OR #2 OR #3 OR #4)MeSH descriptor Knee explode all treesMeSH descriptor Knee Joint explode all treesknee*:ti,ab(#6 OR #7 OR #8)MeSH descriptor Exercise explode all treesMeSH descriptor Exertion explode all treesMeSH descriptor Physical Fitness explode all treesMeSH descriptor Exercise Test explode all treesMeSH descriptor Exercise Tolerance explode all treesMeSH descriptor Sports explode all treesMeSH descriptor Pliability explode all treesMeSH descriptor Physical Endurance explode all treesexertion*:ti,abexercis*:ti,absport*:ti,ab((physical or motion) near/5 (fitness or therap*)):ti,ab(physical* near/2 endur*):ti,ab((strength* or isometric* or isotonic* or isokinetic* or aerobic* or endurance or weight*) near/5 (exercis* or train*)):ti,abMeSH descriptor Physical Therapy Modalities explode all trees(physical next therap*):ti,abphysiotherap*:ti,abmanipulat*:ti,abkinesiotherap*:ti,abMeSH descriptor Rehabilitation explode all treesrehab*:ti,ab(skate* or skating):ti,abrun*:ti,abjog*:ti,abtreadmill*:ti,abswim*:ti,abbicycl*:ti,ab(cycle* or cycling):ti,abwalk*:ti,ab(row or rows or rowing):ti,abmuscle next strength:ti,ab(#10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40)(#5 AND #9 AND #41)

WHAT'S NEW

Last assessed as up-to-date: 9 May 2013.

Date	Event	Description
24 March 2014	New citation required and conclusions have changed	Change in conclusions on update: significant benefit in terms of physical function now demonstrated Methods were updated in accordance with current Cochrane Collaboration recommendations: risk of bias assessment and Summary of Findings Tables added Quality of life assessment and study withdrawal rates were added in the update Pain and physical function outcomes were further disaggregated into immediate post treatment effects and sustainability (3-6 months post treatment)
9 May 2013	New search has been performed	Five new studies added to this update: Fernandes 2010; Juhakoski 2011; Carlson 2011; French 2013; Abbott 2013

HISTORY

Review first published: Issue 3, 2009

Date	Event	Description
19 April 2009	New citation required but conclusions have not changed	Substantive amendment
14 January 2009	New search has been performed	This updated review is one of two Cochrane reviews replacing an earlier review, 'Exercise for osteoarthritis of the hip or knee'. Since the original review, the editors decided to subdivide the review into separate conditions. The Background section has been revised to provide information on the specific disorder only, and the search strategy has been revised accordingly. The Methods section has been updated to reflect current Cochrane Musculoskeletal Group methods. 3 new studies were added in this updated review: Foley 2003; Fransen 2007; Tak 2005
14 January 2009	Amended	Converted to new review format. CMSG ID added A040-R

CONTRIBUTIONS OF AUTHORS

Three review authors (SM, MF, GH) independently screened retrieved clinical studies for inclusion, extracted data from all included studies and conducted the methodological quality assessment. If we did not reach an agreement at any stage, a fourth review author (SR) adjudicated. All four review authors reviewed the final manuscript prior to submission.

DECLARATIONS OF INTEREST

None.

SOURCES OF SUPPORT

Internal sources

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External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We have updated the methods in the review since the original protocol, in accordance with the current recommended methods of the Cochrane Musculoskeletal Group, and The Cochrane Collaboration. The original protocol was for a review entitled "Exercise for osteoarthritis of the hip or knee". Since the original review, the editors decided to subdivide the review into two reviews of separate conditions. For this update of the specific review for hip OA, we have added two more outcomes: quality of life and study withdrawal rates. We have also now conducted a sensitivity analysis according to recruitment criteria, comparing studies recruiting only participants with hip OA with those recruiting participants with hip or knee OA.

INDEX TERMS

Medical Subject Headings (MeSH)

*Exercise Therapy; *Hip Joint; Arthralgia [*therapy]; Osteoarthritis, Hip [*therapy]; Randomized Controlled Trials as Topic

MeSH check words

Humans