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[Intervention Review]

Exercise for hand osteoarthritis

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ABSTRACT

Background

Hand osteoarthritis (OA) is a prevalent joint disease that may lead to pain, stiffness and problems in performing hand-related activities of daily living. Currently, no cure for OA is known, and non-pharmacological modalities are recommended as first-line care. A positive effect of exercise in hip and knee OA has been documented, but the effect of exercise on hand OA remains uncertain.

Objectives

To assess the benefits and harms of exercise compared with other interventions, including placebo or no intervention, in people with hand OA. Main outcomes are hand pain and hand function.

Search methods

We searched six electronic databases up until September 2015.

Selection criteria

All randomised and controlled clinical trials comparing therapeutic exercise versus no exercise or comparing different exercise programmes.

Data collection and analysis

Two review authors independently selected trials, extracted data, assessed risk of bias and assessed the quality of the body of evidence using the GRADE approach. Outcomes consisted of both continuous (hand pain, physical function, finger joint stiffness and quality of life) and dichotomous outcomes (proportions of adverse events and withdrawals).

Main results

We included seven studies in the review. Most studies were free from selection and reporting bias, but one study was available only as a congress abstract. It was not possible to blind participants to treatment allocation, and although most studies reported blinded outcome assessors, some outcomes (pain, function, stiffness and quality of life) were self-reported. The results may be vulnerable to performance and detection bias owing to unblinded participants and self-reported outcomes. Two studies with high drop-out rates may be vulnerable to attrition bias. We downgraded the overall quality of the body of evidence to low owing to potential detection bias (lack of blinding of participants on self-reported outcomes) and imprecision (studies were few, the number of participants was limited and confidence intervals were wide for the outcomes pain, function and joint stiffness). For quality of life, adverse events and withdrawals due to adverse events, we further downgraded the overall quality of the body of evidence to very low because studies were very few and confidence intervals were very wide.

Low-quality evidence from five trials (381 participants) indicated that exercise reduced hand pain (standardised mean difference (SMD) -0.27, 95% confidence interval (CI) -0.47 to -0.07) post intervention. The absolute reduction in pain for the exercise group, compared with the control group, was 5% (1% to 9%) on a 0 to 10 point scale. Pain was estimated to be 3.9 points on this scale (0 = no pain) in the control group, and exercise reduced pain by 0.5 points (95% CI 0.1 to 0.9; number needed to treat for an additional beneficial outcome (NNTB) 9).

Four studies (369 participants) indicated that exercise improved hand function (SMD -0.28, 95% CI -0.58 to 0.02) post intervention. The absolute improvement in function noted in the exercise group, compared with the control group, was 6% (0.4% worsening to 13% improvement). Function was estimated at 14.5 points on a 0 to 36 point scale (0 = no physical disability) in the control group, and exercise improved function by 2.2 points (95% CI -0.2 to 4.6; NNTB 9).

One study (113 participants) evaluated quality of life, and the effect of exercise on quality of life is currently uncertain (mean difference (MD) 0.30, 95% CI -3.72 to 4.32). The absolute improvement in quality of life for the exercise group, compared with the control group, was 0.3% (4% worsening to 4% improvement). Quality of life was 50.4 points on a 0 to 100 point scale (100 = maximum quality of life) in the control group, and the mean score in the exercise group was 0.3 points higher (3.5 points lower to 4.1 points higher).

Four studies (369 participants) indicated that exercise reduced finger joint stiffness (SMD -0.36, 95% CI -0.58 to -0.15) post intervention. The absolute reduction in finger joint stiffness for the exercise group, compared with the control group, was 7% (3% to 10%). Finger joint stiffness was estimated at 4.5 points on a 0 to 10 point scale (0 = no stiffness) in the control group, and exercise improved stiffness by 0.7 points (95% CI 0.3 to 1.0; NNTB 7).

Three studies reported intervention-related adverse events and withdrawals due to adverse events. The few reported adverse events consisted of increased finger joint inflammation and hand pain. Low-quality evidence from the three studies showed an increased likelihood of adverse events (risk ratio (RR) 4.55, 95% CI 0.53 to 39.31) and of withdrawals due to adverse events in the exercise group compared with the control group (RR 2.88, 95% CI 0.30 to 27.18), but the effect is uncertain and further research may change the estimates.

Included studies did not measure radiographic joint structure changes. Two studies provided six-month follow-up data (220 participants), and one (102 participants) provided 12-month follow-up data. The positive effect of exercise on pain, function and joint stiffness was not sustained at medium- and long-term follow-up.

The exercise intervention varied largely in terms of dosage, content and number of supervised sessions. Participants were instructed to exercise two to three times a week in four studies, daily in two studies and three to four times daily in another study. Exercise interventions in all seven studies aimed to improve muscle strength and joint stability or function, but the numbers and types of exercises varied largely across studies. Four studies reported adherence to the exercise programme; in three studies, this was self-reported. Self-reported adherence to the recommended frequency of exercise sessions ranged between 78% and 94%. In the fourth study, 67% fulfilled at least 16 of the 18 scheduled exercise sessions.

Authors' conclusions

When we pooled results from five studies, we found low-quality evidence showing small beneficial effects of exercise on hand pain, function and finger joint stiffness. Estimated effect sizes were small, and whether they represent a clinically important change may be debated. One study reported quality of life, and the effect is uncertain. Three studies reported on adverse events, which were very few and were not severe.

PLAIN LANGUAGE SUMMARY

Exercise for hand osteoarthritis

Background - What is hand osteoarthritis and what is exercise?

Osteoarthritis (OA) is a disease of the joints that causes joint pain, stiffness and swelling. It may hinder people from doing what they want and need to do. Usually, symptoms come on slowly but get worse over time. OA may occur in any joint but is most commonly seen in the hip, knee and small joints of the hand. No cure for OA is known, but available treatment alternatives may reduce pain and stiffness, increase function and improve self-management of the disease.

Exercise is an activity done to improve or maintain your fitness, ability or performance. A period of planned exercise often aims to improve or maintain muscle strength, physical fitness, joint mobility and overall health.

Study characteristics

This Cochrane review presents what we know about the effect of exercise in people with OA in the joints of the hand. After searching for relevant studies up to September 2015, we included seven studies (534 participants). These studies included more women than men. In six studies, half of the people underwent a hand exercise programme and were compared with those who did not exercise. One study compared two groups of people who underwent two different exercise programmes. Evidence from five studies shows the effect of exercise immediately after the exercise programme, and two studies provided results on medium- and long-term sustainability of exercise. We report below only the results reported immediately after the exercise programme was completed.

Key results

On a scale of 0 to 10 points (lower scores mean less pain), people who completed an exercise programme rated their hand pain 0.5 points lower (5% absolute improvement) at the end of treatment compared with people who did not exercise. People who did not exercise rated their pain at 3.9 points.

On a scale of 0 to 36 points (lower scores mean better function), people who completed an exercise programme rated their hand function 2.2 points lower (6% absolute improvement) compared with people who did not exercise. People who did not exercise rated their hand function at 14.5 points.

On a scale of 0 to 100 points (higher scores mean better quality of life), people who completed an exercise programme rated their quality of life 0.3 points higher (0.3% absolute improvement) compared with people who did not exercise. People who did not exercise rated their quality of life at 50.4 points.

On a scale of 0 to 10 points (lower scores mean less finger joint stiffness), people who completed an exercise programme rated their stiffness in the finger joints 0.7 points lower (7% absolute improvement) at the end of treatment compared with people who did not exercise. People who did not exercise rated their finger joint stiffness at 4.5 points.

A small number of people in the exercise group reported adverse events such as increased pain and/or joint swelling. We are uncertain as to whether exercise increases the number of people who experience adverse events.

Quality of the evidence

We graded the quality of the evidence as (very) low. Lack of blinding of participants, the small number of included studies and inclusion of few people in the analyses reduced the robustness and precision of these findings, and further research may change the results. Only half of the included studies reported on adverse effects, and the few adverse events reported occurred in the exercise group.

SUMMARY OF FINDINGS

Summary of findings for the main comparison. Hand exercise compared with no exercise for hand osteoarthritis (immediately post treatment/short term)

Hand exercise compared with no exercise for hand osteoarthritis (immediately post treatment/short term)

Patient or population: patients with hand osteoarthritis

Settings: primary or hospital care

Intervention: exercise

Comparison: no exercise

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	Number of participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	No exercise	Hand exercise				
Hand pain Self-report questionnaires Scale from 0 to 10 (0 represents no pain) Follow-up: median 3 months	Mean hand pain in control groups was 3.9 points^a	Mean hand pain in intervention groups was 0.5 points lower (0.1 to 0.9 points lower)		381 (5 studies)	⊕⊕⊕⊕ Low^{b,c}	SMD -0.27 (-0.47 to -0.07) Absolute reduction in pain 5% (1% to 9%) on a 0-10 scale Relative change 13% (3% to 22%) NNTB: 9 (5 to 32)
Hand function Self-report questionnaires Scale from 0 to 36 (0 represents no physical disability) Follow-up: median 3 months	Mean hand function in control groups was 14.5 points^d	Mean hand function in intervention groups was 2.2 points lower (0.2 points higher to 4.6 points lower)		369 (4 studies)	⊕⊕⊕⊕ Low^{b,c}	SMD -0.28 (-0.58 to 0.02) Absolute improvement in hand function 6% (0.4% worsening to 13% improvement) Relative change 15% (1% worsening to 32% improvement). NNTB: 9 (5 to 52)
Radiographic joint structure changes Not measured	Not measured	Not measured	Not estimable	0 (0)	Not applicable	Radiographic joint changes not measured

Quality of life Self-report questionnaires Scale from 0 to 100 (100 represents maximum quality of life) Follow-up: mean 3 months	Mean quality of life in control groups was 50.4 points^e	Mean quality of life in intervention groups was 0.3 points higher (3.5 points lower to 4.1 points higher)		113 (1 study)	⊕⊕⊕⊕ Very low^{b,f}	MD 0.30 (-3.72 to 4.32) Absolute improvement in quality of life 0.3% (4% worsening to 4% improvement) Relative change 0.6% (7% worsening to 8% improvement)
Finger joint stiffness Self-reported questionnaires Scale from 0 to 10 (0 represents no stiffness). Follow-up: mean 3 months	Mean finger joint stiffness in control groups was 4.5 points^g	Mean finger joint stiffness in intervention groups was 0.7 points lower (0.3 to 1.0 point lower)		368 (4 studies)	⊕⊕⊕⊕ Low^{b,c}	SMD -0.36 (-0.58, -0.15) Absolute reduction in finger joint stiffness 7% (3% to 10%) Relative change 14% (6% to 23%) NNTB: 7 (4 to 15)
Adverse events Follow-up: 3 to 6 months	0 per 1000	32 per 1000^h	RR 4.55 (0.53 to 39.31)	309 (3 studies)	⊕⊕⊕⊕ Very low^{b,f}	Absolute risk difference: 2% more events (2% fewer to 5% more) Relative difference 355% (47% decrease to 3831% increase)
Withdrawal due to adverse events Follow-up: 3 to 6 months	0 per 1000	13 per 1000ⁱ	RR 2.88 (0.30 to 27.18)	309 (3 studies)	⊕⊕⊕⊕ Very low^{b,f}	Absolute risk difference: 1% more events (2% fewer to 3% more) Relative difference 188% (70% decrease to 2618% increase)

*The basis for the **assumed risk** (e.g. 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; MD: mean difference; NNTB: number needed to treat for an additional beneficial outcome; OR: odds ratio; RR: risk ratio; SMD: standardised mean difference.

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.

^aControl group baseline hand pain mean (SD) 3.9 (1.8) from Østerås 2014.

^bDowngraded owing to risk of detection bias on self-reported outcomes (lack of blinding of participants).

^cDowngraded owing to imprecision (few participants, wide confidence interval).

^dControl group baseline hand function mean (SD) 14.5 (8.0) from Dziedzic 2015.

^eControl group baseline quality of life mean (SD) 50.4 (10.3) from Dziedzic 2015.

^fDowngraded two levels for imprecision owing to very few participants and confidence interval crossing 0.

^gControl group baseline finger joint stiffness mean (SD) 4.5 (1.8) from Østerås 2014.

^hThe few adverse events (n = 4) included increased finger joint inflammation and increased hand or shoulder/neck pain.

ⁱAdverse events leading to withdrawal included high and sustained hand pain (n = 1) or shoulder/neck pain (n = 1).

BACKGROUND

Description of the condition

Hand osteoarthritis (OA) is a frequent joint disorder in the adult population. The prevalence of hand OA increases with age, and after the age of 50 years, more women than men are affected (Bijlsma 2011). In previous studies, the reported prevalence of hand OA varied, possibly as the result of differences in sample populations or disease definitions, or both (Pereira 2011; Zhang 2007). In a Norwegian population-based study with persons aged 24 to 76 years, the prevalence of self-reported symptomatic hand OA was 5.8% and 2.5% in women and men, respectively (Grotle 2008). The prevalence of symptomatic hand OA in an American population cohort with mean age 59 years was 15.9% in women and 8.2% in men (Haugen 2011). In a Dutch population cohort including both genders with mean age 66 years, the prevalence was 11% (Kwok 2011). In light of the ageing population trend in most parts of the world, the number of persons with hand OA is expected to increase over the next decades.

Hand OA can manifest as soft tissue swelling, inflammation, bony enlargement and bone erosion. People with hand OA often experience hand pain, finger joint stiffness and reduced grip strength, which may result in activity limitations and participation restrictions (Elliott 2007; Kjekken 2005; Kloppenburg 2007; Stamm 2009; Zhang 2002). Previous research has revealed an association between limited range of motion in finger joints, pain and grip strength (Slatkowsky-Christensen 2010). Kjekken 2005 showed that the average grip strength in women with hand OA was less than 60% that of healthy age- and sex-matched individuals, and that reduced grip strength was related to activity limitations and participation restrictions.

Description of the intervention

Currently, no cure for OA is known, and treatment aims to reduce pain and functional disability. Current pharmacological treatment for hand OA most often is confined to symptomatic treatment, and surgical treatment usually is limited to cases of severe OA in the first carpometacarpal (CMC1) joint. Non-pharmacological modalities are recommended for all people with OA, and information, exercise and weight reduction constitute core treatment recommendations (Fernandes 2013; Hochberg 2012; McAlindon 2014; NICE 2014).

Hand exercise programmes may comprise exercises designed to improve muscle strength, joint mobility and/or joint stability. Guidelines from the European League Against Rheumatism (EULAR) recommend exercise therapy as a strategy for improving hand strength and joint mobility in persons with hand OA (Zhang 2007), whereas more recent guidelines from the American College of Rheumatology (ACR) do not include exercise for hand OA (Hochberg 2012). Guidelines from the National Institute for Health and Care Excellence (NICE) state that exercise should be a core treatment for people with clinical symptomatic OA, irrespective of age, comorbidity, pain severity and disability, but acknowledge that evidence showing effects of exercise in hand OA is limited, and that mechanisms of exercise for the hip and the hand may be different from those for knee OA (NICE 2014). Qualitative analyses performed in a recent review identified five categories of potential pathways for the effects of exercise in knee OA: neuromuscular, peri-articular, intra-articular, psychosocial and general fitness and health (Beck-

wee 2013). A recent systematic review identified increased upper leg strength, decreased extension impairment and improved proprioception as possible mediators in the association between exercise and OA symptoms in knee OA (Runhaar 2015). However, a better understanding of these suggested pathways is warranted - also for hand OA. Increased knowledge may contribute to more targeted treatment strategies and potentially better effects of exercise treatment.

Why it is important to do this review

For knee OA and hip OA, the effect of exercise on pain and function has been well documented (Beumer 2016; Fransen 2014; Fransen 2015; Juhl 2014; Uthman 2013), but for hand OA, the effect remains uncertain. Seven reviews have been published to sum up the evidence on non-pharmacological interventions for hand OA (Bertozzi 2015; Kjekken 2011; Mahendira 2009; Towheed 2005; Valdes 2010; Ye 2011; Zhang 2007). Kjekken 2011 included studies up to May 2010, and review authors conducted a meta-analysis on the effect of hand splints, but not on the effect of exercise. Ye 2011 included studies up to October 2010 and compared outcomes of rehabilitative interventions. Review authors reported inconclusive results and calculated no overall effect of exercise (Ye 2011). Over the past four years, five randomised controlled trials (RCTs) on the effect of hand OA therapy have been published (Davenport 2012; Dziedzic 2015; Hennig 2015; Østerås 2014; Stukstette 2012). In a recent review (Bertozzi 2015), review authors presented results from meta-analyses comparing therapeutic exercise versus control but included only one or two studies in the analyses. Hence, systematic evaluation of current research is needed, and review authors should suggest directions for future research on the effectiveness of exercise therapy in people with hand OA.

OBJECTIVES

To assess the benefits and harms of exercise compared with other interventions, including placebo or no intervention, in people with hand OA. Main outcomes are hand pain and physical function.

METHODS

Criteria for considering studies for this review

Types of studies

We considered for inclusion randomised (parallel-group or cross-over, including cluster-randomised and quasi-randomised) and controlled clinical trials (CCTs) comparing therapeutic exercise versus non-exercise, and trials comparing different exercise programmes.

Types of participants

We included studies of people 18 years of age and older with a physician-confirmed (i.e. radiological or clinical or both) diagnosis of hand OA. We accepted studies including diverse populations only if we could extract data for the hand OA group separately.

Types of interventions

We considered for inclusion interventions assessing the benefits and harms of exercise versus other interventions for hand pain and function in people with hand OA. We defined exercise therapy as interventions targeting muscle strength, joint mobility, joint stability training or a combination of these. We excluded studies investigat-

ing postoperative exercise. However, we considered for inclusion studies that also applied other treatment modalities (e.g. patient education, self-management strategies) if treatment, except for exercise therapy, was similar across intervention and control groups.

Specific comparisons to be made

We searched for trials that included one of the following group comparisons.

- Exercise versus no exercise (e.g. usual care, wait control).
- Exercise versus placebo (sham exercise).
- Exercise versus other interventions.
- Comparison of different exercise programmes.

We considered an attention control intervention provided to minimise the difference in placebo effect between the two groups a comparator intervention (other intervention). Such interventions could include patient education, use of assistive technology, functional activity training, hand cream, orthoses or any combination of two or more of these interventions.

Types of outcome measures

Published recommendations for a core set of outcome measures for phase 3 clinical trials in knee, hip and hand OA include physical function and pain and patient global assessment of disease impact, and for studies of one year or longer, joint imaging (Bellamy 1997; Maheu 2006). Recently, the Outcome Measures in Rheumatology (OMERACT) Hand OA Working Group published preliminary core sets for clinical trials of symptom and structure modification and for observational studies in hand OA (Kloppenborg 2015).

Major outcomes

The main outcomes for benefit were hand pain and hand function, in addition to radiographic joint structure changes, quality of life and finger joint stiffness, according to proposed outcomes for OA intervention reviews recommended by the Cochrane Musculoskeletal Group (CMSG). When available, we included information on the numbers of intervention-related adverse events (i.e. sustained joint inflammation or increased pain) and the numbers of participants withdrawn from studies because of adverse events.

Listed are the seven main outcomes included in the 'Summary of findings' tables.

- Hand pain: When more than one measure of pain was reported in a study, we chose the highest in the hierarchy of outcome measures.
 - * Pain overall (e.g. visual analogue scale (VAS), numerical rating scale (NRS)).
 - * Pain on hand usage.
 - * Australian/Canadian Hand Osteoarthritis Index (AUSCAN) pain subscale.
 - * Other algofunctional scale validated for use in hand OA.
 - * Patient's global assessment.
 - * Physician's global assessment.

- Hand function: When more than one measure of physical function was reported in a study, we chose the highest in the hierarchy of outcome measures.
 - * AUSCAN physical function subscale.
 - * Other algofunctional scale validated for use in hand OA.
 - * Hand function measured by performance-based tests (e.g. grip strength, pinch strength).
 - * Global disability score.
- Radiographic joint structure changes.
- Quality of life.
- Finger joint stiffness.
- Adverse events.
- Withdrawals due to adverse events.

Minor outcomes

Minor outcomes included the following.

- Fulfilment of Osteoarthritis Research Society International/Outcome Measures/Outcome Measures in Rheumatology (OARSI/OMERACT) responder criteria (Pham 2004).
- Joint mobility.
- Psychological well-being.
- Aesthetic damage.
- Need for surgery.

Timing of outcome assessment

The main time point of interest was the first assessment after completion of the exercise programme. When data for longer-term follow-up were available, we extracted such data and categorised them by short-term (< 6 months), medium-term (six to 12 months) and long-term (> 12 months) follow-up.

Search methods for identification of studies

Electronic searches

We carried out a search of seven electronic databases for studies published from inception until the search date (last search September 2015): the Cochrane Central Register of Controlled Trials (CENTRAL; published in the Cochrane Library), MEDLINE, Embase, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), the Allied and Complementary Medicine Database (AMED), the Physiotherapy Evidence Database (PEDro) and Occupational Therapy Systematic Evaluation of Evidence (OTseeker). We provided the search strategies in Appendix 1 (MEDLINE), Appendix 2 (Embase), Appendix 3 (CINAHL), Appendix 4 (AMED), Appendix 5 (PEDro), Appendix 6 (OTseeker) and Appendix 7 (CENTRAL). We developed these search strategies with the help of our local librarian and the CMSG Trials Search Co-ordinator, and we applied no language restrictions.

Searching other resources

We screened the reference lists of all included full-text articles. We performed searches for unpublished complete studies and ongoing studies using the International Clinical Trials Registry Platform of the World Health Organization (WHO) (<http://www.who.int/ictip/en/>) and the following randomised controlled trials registers.

- ClinicalTrials.gov (www.clinicaltrials.gov).

- International Standard Randomised Controlled Trial Number Register (<http://www.controlled-trials.com/iscrtn/>).
- Current Controlled Trials (www.controlled-trials.com).
- Australian New Zealand Clinical Trials Registry (www.anzctr.org.au).
- University hospital Medical Information Network (UMIN) Clinical Trials Registry (www.umin.ac.jp/ctr).

We reviewed unpublished and grey literature using the database OpenSIGLE (System for Information on Grey Literature in Europe). Further, we searched congress proceedings from OARS, EULAR and the ACR from 2008 until September 2015. We present a flow diagram for search results and selection of studies in [Figure 1](#).

Figure 1. Study flow diagram.

Figure 1. (Continued)

Data collection and analysis

Selection of studies

The first review author (NØ) and one of the co-review authors (GS) independently screened the records retrieved and conducted the risk of bias assessment. GS extracted data from all included studies. If agreement was not achieved at any stage, a third review author (IK or KBH) adjudicated.

The process of selecting studies included the following steps.

- Merging search results using reference management software, and removing duplicate records.
- Examining titles and abstracts to remove obviously irrelevant reports.
- Retrieving the full text of potentially relevant reports.
- Linking together multiple reports of the same study and identifying more than one study reported in the same article.
- Examining full-text reports against eligibility criteria.
- Corresponding with investigators, when appropriate, to clarify study eligibility or other missing information.
- Making final decisions on study inclusion.

Data extraction and management

We extracted the following data from all reports directly onto data collection forms.

- **Methods:** study design, total study duration, recruitment method, random sequence generation, allocation sequence concealment, blinding, incomplete outcome data, selective reporting, other concerns about bias.
- **Participants:** total number of participants, setting, diagnostic criteria, age, sex, country, comorbidity, inclusion and exclusion criteria.
- **Interventions:** aims of the intervention, total numbers and types of intervention groups (i.e. placebo, control, comparative intervention), specific intervention, intervention details sufficient for replication, number of therapists providing study treatments, delivery mode (i.e. individual, group-based, home programme), frequency (i.e. sessions per week), treatment content (i.e. muscle strength, joint mobility, joint stability), intensity (i.e. low, moderate, high), duration (i.e. total weeks of treatment), number of directly supervised contact occasions, number of follow-up contacts (i.e. face-to-face; telephone, email or text messages).
- **Outcomes:** outcome measures, time points.
- **Results:** number of participants allocated to each intervention group, sample size, missing data or participants, summary data.
- **Miscellaneous:** funding source, key conclusions, miscellaneous comments from study authors, miscellaneous comments from review authors.

Assessment of risk of bias in included studies

The first review author (NØ) and one of the co-review authors (GS) independently assessed risk of bias, except for one study (Østerås 2014), which was assessed by two other co-review authors (GS, TU). We assessed risk of bias of included studies by using the procedures recommended by Cochrane and described in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We assessed the following methodological domains.

- Random sequence generation (selection bias).
- Allocation concealment (selection bias).
- Blinding of participants and personnel (performance bias).
- Blinding of outcome assessment (detection bias): subjective outcomes.
- Blinding of outcome assessment (detection bias): objective outcomes.
- Incomplete outcome data (attrition bias).
- Selective reporting (reporting bias).
- Other potential threats to validity (e.g. substantial imbalance in participant characteristics at baseline that is strongly related to outcome measures, blocked randomisation in unblinded trials, contamination).

We explicitly judged each of these criteria as presenting 'low risk', 'high risk' or 'unclear risk' of bias.

Measures of treatment effect

Dichotomous data

We calculated the risk ratio (RR) and the 95% confidence interval (CI) for dichotomous outcomes.

Continuous data

We calculated the standardised mean difference (SMD) with 95% CI, as these studies used different scales to evaluate continuous outcomes. The SMD expresses the size of the intervention effect in each study relative to the variability observed in that study. We calculated SMDs by dividing the mean difference (MD) by the standard deviation (SD) of outcomes among participants. We interpreted the SMD as described by Cohen (i.e. SMD of 0.2 was considered to indicate a small beneficial effect, 0.5 a medium effect and 0.8 a large effect of exercise therapy) (Cohen 1988). We analysed longer ordinal scales (i.e. 10 point NRSs) in meta-analyses as continuous data.

Unit of analysis issues

Cross-over studies

We considered cross-over studies for inclusion only when outcome data from the first period were available or could be provided by the study authors upon request.

Studies with multiple treatment groups

When studies had multiple treatment groups, we contacted the investigators by email to ask for data or separate scores for relevant treatment groups to create a single pair-wise comparison.

Dealing with missing data

We contacted investigators by email to request publications, missing outcomes or summary data. If we did not receive a response, we sent one email reminder.

Assessment of heterogeneity

We assessed heterogeneity by using Cochran Q to test the hypothesis that all studies measured the same effects. We assessed the magnitude of heterogeneity using the I^2 statistic. We used the following thresholds for interpretation of I^2 (Higgins 2011).

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

Exercise for hand osteoarthritis (Review)

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

The importance of the observed value of I^2 depended on both magnitude and direction of effects and strength of evidence for heterogeneity (e.g. P value from the χ^2 test, confidence interval for I^2).

Assessment of reporting biases

To reduce the possibility of publication bias, we searched multiple sources for studies that met review eligibility criteria, including 'grey' literature.

Data synthesis

We assumed that results of included studies reflected a distribution of effect sizes rather than a fixed effect size; we therefore employed a random-effects model to pool outcomes from a sufficiently homogeneous set of studies in meta-analyses.

Subgroup analysis and investigation of heterogeneity

We did not perform planned subgroup analyses on age, gender, joint involvement, presence of erosive OA, exercise programme or exercise dosage, as we identified only a small number of studies. We evaluated the influence of using end of treatment scores versus change scores in investigating heterogeneity.

Sensitivity analysis

Owing to the small number of studies, we did not perform originally planned sensitivity analyses on inclusion/exclusion decisions, methodological quality, adequacy of the randomisation process or use of the intention-to-treat principle.

'Summary of findings' table

We used the GRADE approach, as described in Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Schünemann 2011), to assess the quality of the body of evidence. We produced the 'Summary of findings (SoF)' table by using GRADEpro software. This table provides key information concerning the quality of the evidence and the magnitude of intervention effects on main outcomes.

We created an SoF table for the following comparison: exercise versus no exercise/intervention (e.g. usual care, wait control). The low number of included studies precluded completion of the other planned comparisons (exercise vs placebo, exercise vs other interventions, comparisons of different exercise programmes).

Outcomes (in order of importance) reported in the SoF table include the following.

- Hand pain.
- Hand function.
- Radiographic joint structure changes.
- Quality of life.
- Finger joint stiffness.
- Number of participants experiencing any adverse event.
- Number of participants who withdrew because of an adverse event.

In addition to the absolute and relative magnitude of effect presented in the 'Summary of findings' table, we calculated the num-

ber needed to treat for an additional beneficial outcome (NNTB) from the control group event rate (unless the population event rate was known) and the risk ratio using the Visual RxNNT calculator (Cates 2013). For continuous outcomes, we calculated the NNTB by using Wells calculator software, provided by the CMSG editorial office. We determined the minimal important change (MIC) for each outcome for input into the calculator.

RESULTS

Description of studies

Results of the search

The literature search yielded 1055 citations - 802 after duplicates were removed. We identified five additional citations by hand-searching congress proceedings and trial registers (Figure 1). We excluded 792 of 807 citations upon completion of abstract screening. Of 14 full texts and one congress abstract, seven met the inclusion criteria (Davenport 2012; Dziedzic 2015; Hennig 2015; Lefler 2004; Nery 2015; Østerås 2014; Rogers 2009). We excluded eight full-text reports owing to unclear study design (one study), no comparison of exercise versus no exercise (one study), comorbidity/multi-site OA (one study) and multi-modal treatment (no investigation of effects of only exercise) (five studies). A handsearch of reference lists in the full-text reports yielded no additional citations. We requested additional information from five trial authors and received responses from four of them. We performed the last literature search updates in September 2015. We did not examine funnel plots to determine possible publication bias, as the number of studies was insufficient (i.e. fewer than 10).

Included studies

We provide a full description of the seven included studies in the [Characteristics of included studies](#) table. An overview of the studies, a detailed description of the exercise interventions and details on outcomes measured can be found in the Additional tables ([Table 1](#); [Table 2](#); [Table 3](#)).

Design

All of the seven included studies were randomised controlled trials (RCTs), but one was characterised as a "pilot RCT" (Davenport 2012). Five studies used a parallel-group design, one a 2×2 factorial design and one a cross-over design. For the 2×2 study with multiple treatment groups (Dziedzic 2015), we received a data set and extracted data from only two arms - the control group ('leaflet and advice') and the 'exercise only' group - to perform a single pair-wise comparison for this review. All studies were published in English.

Participants

Two studies were conducted in the United Kingdom, two in Norway, two in the USA and one in Brazil. The seven studies included in total 534 participants. The median sample size was 70, but sample size varied from 19 to 130 participants. Most participants were female (median 90% female), and one study included only female participants (Hennig 2015). The mean age of participants was between 60 and 66 years in five studies, but in two studies, the mean age was 75 (Rogers 2009) and 81 (Lefler 2004). The sample recruitment setting varied widely, with some studies recruiting from an elderly living community (Lefler 2004; Rogers 2009); other studies were population based (Dziedzic 2015; Østerås 2014), used an OA cohort (Østerås 2014; Rogers 2009) and recruited from people referred for

specialist care (Davenport 2012; Hennig 2015). Half of these studies reported years with a hand problem (Dziedzic 2015: 5; Hennig 2015: 10) or years with an OA diagnosis (Hennig 2015: 2; Østerås 2014: 12).

Inclusion and exclusion criteria for each study shared some features, whereas others were different between studies. One study focused only on people with carpometacarpal (CMC1) joint OA (Davenport 2012). The other six included participants with a confirmed clinical diagnosis of hand OA, fulfilment of ACR criteria for features of hand OA and/or unilateral/bilateral CMC1 OA. Participants were referred by doctors for specialist care (Davenport 2012; Hennig 2015) and/or were required to report a minimum level of pain or functional impairment. All studies excluded participants with inflammatory rheumatic disease (i.e. rheumatoid arthritis). Some excluded participants who had undergone hand surgery in the previous two to six months (Dziedzic 2015; Hennig 2015; Østerås 2014; Rogers 2009), had received steroid injections (Dziedzic 2015; Hennig 2015; Nery 2015; Østerås 2014; Rogers 2009) or had performed hand exercises (Lefler 2004; Nery 2015; Rogers 2009).

Interventions

We provide an overview of exercise interventions and comparisons in Table 2. One of the seven studies evaluated the effects of two different exercise programmes for CMC1 OA (Davenport 2012), whereas the remaining six studies evaluated hand exercise versus no exercise (control intervention). The aims of the exercise interventions were relatively consistent among studies - to reduce pain, increase grip and pinch strength, increase dexterity, maintain joint stability and increase or maintain range of motion. The number of exercises in each programme varied from three to ten. Davenport 2012 included three exercises: passive extension, active extension and active thumb abduction progressed into turning and twisting activities. Dziedzic 2015 included five stretching exercises (wrist flexion + extension/pronation + supination, tendon gliding, radial finger walking, "O-sign", thumb extension/abduction + opposition to the base of the fifth finger) and five strengthening exercises (elastic band, Play-Doh and external weight for thumb extension and abduction, finger extension, squeezing and pinching, wrist flexion/extension). Hennig 2015 and Østerås 2014 described almost identical exercise programmes ("O-sign", roll into small + large fist, isometric squeeze, thumb abduction/extension against elastic band, finger stretch), but participants in Østerås 2014 squeezed a tube instead of a ball and performed three additional exercises for shoulder girdle/upper arm. The exercise programme in Lefler 2004 included isometric and isotonic resistance training of the hand and forearm muscles (rice grabs, pinch grip lifting, wrist rolls). Rogers 2009 included six flexibility exercises (metacarpophalangeal joint (MCP) flexion, small fist, large fist, Okay-sign, finger spread, thumb opposition) and three strengthening exercises that involved squeezing a Thera-Band Hand Exerciser ball (palm grip, key pinch, fingertip pinch).

Study authors described variation in delivery of the exercise intervention: One study reported supervision of all 18 sessions (Lefler 2004), whereas three studies provided a combination of three to four supervised group sessions (Dziedzic 2015; Østerås 2014) and individual exercise reviews (Davenport 2012), and two studies included no supervised sessions but reported that participants received up to eight regular phone calls from an occupational therapist (Hennig 2015) and monthly phone calls or emails from the principal investigator (Rogers 2009). Østerås 2014 also provided phone calls. Hence, the number of supervised sessions ranged from one to

18. Studies reported large variation in how often participants were instructed to exercise - three to four times daily (Davenport 2012), daily (or on most days) (Dziedzic 2015; Rogers 2009) and two times a week (Nery 2015) to three times a week (Hennig 2015; Østerås 2014). The number of repetitions ranged from three to 15 and the number of series from one to three. Most studies emphasised that the programme should be progressed. Dziedzic 2015 instructed participants to perform exercises within their limit of discomfort, whereas in Lefler 2004, participants started at 40% to 60% of 1 repetition maximum (RM) and progressed to moderate intensity (> 60% of 1 RM), and Østerås 2014 instructed participants to apply moderate to vigorous intensity. For determination of exercise dosage, Hennig 2015 and Østerås 2014 referred to recommendations of the American College of Sports Medicine for developing strength and flexibility (ACSM 1998). In one study, the duration of the exercise intervention was six weeks (Lefler 2004), but in three studies, duration was 12 to 13 weeks (Hennig 2015; Nery 2015; Østerås 2014), in one study 16 weeks (Rogers 2009) and in the last two studies six months and 12 months (Davenport 2012; Dziedzic 2015), respectively. Four studies reported on adherence to the exercise programme. In Lefler 2004, 67% completed 16 or more of 18 sessions, and in Dziedzic 2015, 78% reported that they performed the exercise programme two or more times a week at six months. In Hennig 2015, the median number of recorded sessions in the exercise diary was 37 (of 39), and in Østerås 2014, 94% recorded two or more sessions a week.

Outcomes

The included studies chose somewhat different outcomes as their primary outcome - Australian/Canadian Hand Osteoarthritis Index (AUSCAN) function subscale, Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire, OARSI/OMERACT responder criteria, Patient Specific Functional Scale (PSFS) and Functional Index for Hand Osteoarthritis (FIHOA). All but one study (Rogers 2009) included a global measure of hand pain (VAS or NRS; Lefler 2004: six pain categories). Three studies also used the AUSCAN to measure pain (Dziedzic 2015; Nery 2015; Rogers 2009). Two studies (Dziedzic 2015; Nery 2015) measured hand function and finger joint stiffness using AUSCAN, and two other studies (Hennig 2015; Østerås 2014) used FIHOA and PSFS to measure hand function, and NRS to measure finger joint stiffness. Only one study measured quality of life using Short Form (SF)-12 (Dziedzic 2015). Only three studies (Dziedzic 2015; Hennig 2015; Østerås 2014) reported adverse events. All but one study (Davenport 2012) measured grip strength, and four (Davenport 2012; Dziedzic 2015; Lefler 2004; Nery 2015) measured pinch strength. Three studies (Dziedzic 2015; Hennig 2015; Østerås 2014) reported the numbers of participants fulfilling OARSI/OMERACT responder criteria.

For hand pain, all studies reported an immediate post-treatment/short-term outcome assessment, which was performed at three months (after baseline assessment), except Lefler 2004, which performed the assessment at six weeks. Only four studies (Dziedzic 2015; Hennig 2015; Nery 2015; Østerås 2014) reported on hand function and finger joint stiffness at immediate post-treatment/short-term outcome assessment. One study (Dziedzic 2015) assessed quality of life at three, six and 12 months. Two studies (Dziedzic 2015; Østerås 2014) performed medium-term and long-term sustainability assessments of pain and function at six months, and one (Dziedzic 2015) at 12 months.

Adverse events

Only three studies ([Dziedzic 2015](#); [Hennig 2015](#); [Østerås 2014](#)) specifically reported on adverse events. [Dziedzic 2015](#) reported that no adverse events occurred as a result of the intervention. [Hennig 2015](#) reported that one participant in the intervention group withdrew as the result of high and sustained pain. In [Østerås 2014](#), participants in the exercise group reported four events that were possibly related to the exercise programme. One experienced increased pain and inflammation in one finger, two experienced increased pain and swelling in all fingers and one withdrew owing to sustained increased neck/shoulder pain related to shoulder exercises.

Excluded studies

We excluded eight studies for reasons provided in the study flow diagram ([Figure 1](#)) and in the [Characteristics of excluded studies](#) tables ([Boustedt 2009](#); [Garfinkel 1994](#); [Masterson 2010](#); [Norton 1997](#); [Stamm 2002](#); [Stukstette 2013](#); [Villafane 2013](#); [Wajon 2005](#)).

Risk of bias in included studies

We provided results of the 'Risk of bias' assessment along with comments in the [Characteristics of included studies](#) tables. [Figure 2](#) and [Figure 3](#) present an overview of the assessment per risk of bias item and per study, respectively. The most recent study ([Nery 2015](#)) was published only as a congress abstract and provided insufficient information on the methods applied for assessment of all risk of bias items.

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

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

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias): Self-reported outcomes	Blinding of outcome assessment (detection bias): Objective outcomes	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Davenport 2012	+	+	?	+	+	-	+	?
Dziedzic 2015	+	+	-	-	+	+	+	+
Hennig 2015	+	+	-	-	+	+	+	+
Lefler 2004	?	?	-	-	?	-	-	+
Nery 2015	?	?	?	-	+	?	?	?
Rogers 2009	+	?	+	+	-	-	+	+
Østerås 2014	+	+	-	-	+	+	+	+

Allocation

We considered that four studies ([Davenport 2012](#); [Dziedzic 2015](#); [Hennig 2015](#); [Østerås 2014](#)) described adequate generation of a randomised sequence and adequate allocation concealment procedures. Three studies did not describe their methods adequately, and we were unable to contact trial authors for two of them ([Lefler 2004](#); [Rogers 2009](#)).

Blinding

Authors of two studies reported that participants, but not care personnel, were blinded to treatment allocation, as participants were told that investigators were comparing different exercise regimens for the CMC1 joint ([Davenport 2012](#)) or two different interventions ([Rogers 2009](#)). The other five studies compared exercise versus no exercise, which makes blinding of participants and care personnel impossible. In [Rogers 2009](#), the outcome assessor was not blinded; [Lefler 2004](#) did not report whether the outcome assessor was blinded to group allocation. For all other studies, this was clearly stated. However, as most outcomes evaluated in this review (pain, function, stiffness, quality of life, adverse events) were participant self-reported, vulnerability to detection bias may be present.

Incomplete outcome data

Only half of the studies reported minimal loss to follow-up and use of intention-to-treat (ITT) analyses ([Dziedzic 2015](#); [Hennig 2015](#); [Østerås 2014](#)). Three studies ([Davenport 2012](#); [Lefler 2004](#); [Rogers 2009](#)) had a relatively large drop-out rate before follow-up, and we had insufficient information about one study ([Nery 2015](#)).

Selective reporting

We confirmed study registration with prespecified (primary and secondary) outcomes for six studies, but one of these ([Nery 2015](#)) was registered after the study was initiated. The study with no registration ([Lefler 2004](#)) was published before study registration was required. We judged risk of bias for selective reporting as 'uncertain' for [Nery 2015](#) and 'high' for [Lefler 2004](#).

Other potential sources of bias

[Davenport 2012](#) performed baseline assessments after randomisation, and the congress abstract by [Nery 2015](#) included very limited

information about the study. Therefore, we judged risk of bias as 'uncertain' for these two studies. For the remaining four studies, we judged risk of bias as 'low' because we identified no other potential threats to validity.

Effects of interventions

See: [Summary of findings for the main comparison](#) Hand exercise compared with no exercise for hand osteoarthritis (immediately post treatment/short term)

[Summary of findings for the main comparison](#) presents immediate post-treatment/short-term effects of exercise compared with no exercise in people with hand OA. We attempted to contact six study authors ([Davenport 2012](#); [Dziedzic 2015](#); [Hennig 2015](#); [Lefler 2004](#); [Nery 2015](#); [Rogers 2009](#)) to obtain additional data and details of methods. Four study authors ([Davenport 2012](#); [Dziedzic 2015](#); [Hennig 2015](#); [Nery 2015](#)) responded, and two of them provided original (non-imputed) data for extraction of post-treatment scores ([Hennig 2015](#)) and isolated treatment arm scores ([Dziedzic 2015](#)). We requested but did not receive additional descriptions of methods from the investigators in one study ([Nery 2015](#)) because their study results had not yet been published and were available only as a congress abstract.

Comparison 1. Exercise versus no exercise

Major outcomes

Immediate post-treatment/short-term effects

Hand pain

Five studies assessed pain and provided post-treatment/short-term data on 381 participants ([Figure 4 Analysis 1.1](#)). Pooled results of these five studies showed a beneficial effect of exercise on hand pain (SMD (random-effects model) -0.27, 95% CI -0.47 to -0.07). This effect size would be considered a small beneficial effect ([Cohen 1988](#)). Between-study heterogeneity was negligible ($I^2 = 0\%$). The demonstrated effect size for exercise was equivalent to pain reduction of 0.5 points (95% CI 0.1 to 0.9) on a 0 to 10 scale compared with control, or an absolute reduction in pain of 5% (1% to 9%) and a relative reduction of 13% (3% to 22%).

Figure 4. Forest plot of comparison: 1 Exercise versus no exercise, outcome: 1.1 Hand pain (short term).

Hand function

Four studies evaluated participant-reported hand function and provided post-treatment/short-term data on 369 participants (Figure 5 Analysis 1.2). Pooled results obtained when a random-effects model was applied demonstrated a beneficial effect of exercise on

function (SMD -0.28, 95% CI -0.58 to 0.02). The demonstrated effect size for exercise was equivalent to improvement in function of 2.2 points (95% CI -0.2 to 4.6) on a 0 to 36 scale compared with control, or an absolute reduction in pain of 6% (0.4% to 13%) and a relative reduction of 15% (1% to 32%).

Figure 5. Forest plot of comparison: 1 Exercise versus no exercise, outcome: 1.2 Hand function (short term).

We considered between-study heterogeneity to be moderate to substantial ($I^2 = 51\%$). We explored reasons for this heterogeneity and found that exclusion of data from Østerås 2014 reduced heterogeneity to a negligible level ($I^2 = 0\%$). Close inspection of scores revealed that the mean pain level at baseline was slightly higher for the exercise group than for the control group, and that the mean pain level was slightly reduced in the exercise group and was increased in the control group post treatment. Inclusion of change

scores instead of post-treatment scores from Østerås 2014 resulted in negligible heterogeneity ($I^2 = 5\%$) and demonstrated a beneficial effect of exercise on function (SMD -0.32, 95% CI -0.53 to -0.10).

Quality of life

One study assessed quality of life and provided post-treatment/short-term data on 113 participants (Analysis 1.3) showing that the effect of exercise on quality of life in people with hand OA is

uncertain (MD 0.30, 95% CI -3.72 to 4.32). The effect size for exercise was equivalent to improvement in quality of life of 0.3 points (95% CI -0.2 to 4.1) on a 0 to 100 scale, or an absolute improvement of 0.3% (4% worsening to 4% improvement) and a relative improvement of 0.6% (7% worsening to 8% improvement).

Finger joint stiffness

Four studies assessed participant-reported finger joint stiffness and provided post-treatment/short-term data on 368 participants

(Figure 6 Analysis 1.4). Pooled results of these studies when a random-effects model was applied showed a beneficial effect of exercise on finger joint stiffness (SMD -0.36, 95% CI -0.58 to -0.15). This effect size would be considered a small to moderate beneficial effect (Cohen 1988). Between-study heterogeneity was negligible ($I^2 = 6\%$). The demonstrated effect size for exercise was equivalent to a stiffness reduction of 0.7 points (95% CI 0.3 to 1.0) on a 0 to 10 scale compared with control, or an absolute reduction in stiffness of 7% (3% to 10%) and a relative reduction of 14% (6% to 23%).

Figure 6. Forest plot of comparison: 1 Exercise versus no exercise, outcome: 1.4 Finger joint stiffness (short term).

Adverse events and withdrawals due to adverse events

Three studies reported on adverse events among 309 participants (Analysis 1.5). Dziedzic 2015 reported no adverse events, Hennig 2015 reported one adverse event in the exercise group and Østerås 2014 reported three adverse events in the exercise group. Reported adverse events were increased hand pain, finger joint inflammation or neck/shoulder pain. Pooled data showed that the likelihood of occurrence of adverse events was higher in the exercise group than in the no exercise group, but the effect was uncertain (RR 4.55, 95% CI 0.53 to 39.31). The absolute risk difference showed 2% more events (95% CI -2% to 5%) for the exercise group than for the no exercise group. The relative difference was 355% (95% CI 47% to 3831%) for the exercise group compared with the no exercise group.

Although one study (Dziedzic 2015) reported no adverse events, each of the other studies (Hennig 2015; Østerås 2014) reported one adverse event leading to study withdrawal. Pooled data showed that the likelihood of withdrawal due to adverse events was higher in the exercise group than in the no exercise group, but the effect was uncertain (RR 2.88, 95% CI 0.30 to 27.18; Analysis 1.6). The absolute risk difference showed 1% more events (95% CI -2% to 4%) for the exercise group than for the no exercise group. The relative difference was 188% (95% CI 70% to 2618%) for the exercise group compared with the no exercise group.

Sustainability of results at medium-term and long-term follow-up

Two studies (Dziedzic 2015; Østerås 2014) provided six-month follow-up data (220 participants), and one of these (Dziedzic 2015; 102 participants) also provided 12-month follow-up data. Pooled results of these studies when a random-effects model was applied showed an uncertain effect on hand pain (SMD 0.09, 95% CI -0.18 to 0.35; Analysis 2.1), hand function (SMD -0.05, 95% CI -0.31 to 0.21; Analysis 2.2) and finger joint stiffness (SMD -0.12, 95% CI -0.38 to 0.14; Analysis 2.4). This indicates that at six-month and 12-month follow-up, the effect of the exercise intervention was uncertain.

Minor outcomes: immediate post-treatment/short-term effects

Grip and pinch strength

Five studies evaluated effects on grip strength among 362 participants and provided post-treatment/short-term data (Analysis 1.7). Pooled results when a random-effects model was applied showed a beneficial effect on grip strength (SMD 0.34, 95% CI -0.01 to 0.69) that would be considered small to moderate (Cohen 1988). Between-study heterogeneity was substantial ($I^2 = 59\%$). We explored reasons for this heterogeneity and found that exclusion of data from Østerås 2014 reduced heterogeneity to a moderate level ($I^2 = 42\%$).

Three studies evaluated effects on pinch strength among 179 participants and provided post-treatment/short-term data (Analysis 1.8). Pooled results when a random-effects model was applied showed a small but uncertain beneficial effect (SMD 0.20, 95% CI

-0.10 to 0.49). Between-study heterogeneity was negligible ($I^2 = 0\%$).

OARSI/OMERACT responder criteria

Three studies reported fulfilment of the OARSI/OMERACT responder criteria among 305 participants (Analysis 1.9). Pooled results when a random-effects model was applied showed higher RR among the exercise group than in the no exercise group for fulfilling these criteria (RR 2.80, 95% CI 1.40 to 5.62). Between-study heterogeneity was moderate ($I^2 = 42\%$). Omission of one study (Dziedziec 2015), in which the 95% CI for the RR crossed the value of 1, caused the I^2 to drop to 35% (RR 3.76, 95% CI 1.60 to 8.84).

Comparison 2. Comparison of different exercise programmes

Only one included study compared different exercise programmes (Davenport 2012). Study authors compared specific dynamic stability exercises versus general exercises for CMC1 OA and reported no differences in pain, self-reported function or pinch strength between groups at three-month and six-month follow-up.

DISCUSSION

Summary of main results

We conducted this review to evaluate scientific evidence for the benefits and harms of exercise compared with other interventions, including placebo or no intervention, in people with hand osteoarthritis (OA). Major outcomes evaluated were hand pain, hand function, quality of life, finger joint stiffness, intervention-related adverse events and numbers of participants withdrawn from studies because of adverse events. None of the studies included in this review measured radiographic joint structure changes. Minor outcomes evaluated included grip and pinch strength and fulfilment of the Osteoarthritis Research Society International/Outcome Measures/Outcome Measures in Rheumatology (OARSI/OMERACT) responder criteria. Overall results of meta-analyses suggest that performing exercise is beneficial in terms of reducing hand pain and finger joint stiffness immediately post intervention, but the effect is not sustained at later follow-up. Investigators also found a beneficial effect of exercise on self-reported hand function, but heterogeneity between studies was greater and the confidence interval was slightly larger. Evidence was insufficient to show the effect of exercise on quality of life among people with hand OA. Very few adverse events related to the exercise intervention resulted in very wide confidence intervals for the estimates. Baseline levels of pain, function and stiffness were generally mild to moderate, leaving a limited scope for improvement. Reductions in pain (0 to 10 scale), function (0 to 36 scale) and stiffness (0 to 10 scale) of 0.5, 2.2 and 0.7 points, respectively, probably would not be considered clinically important changes. We identified only a small number of studies and few participants for this review; therefore, future research is very likely to have an important impact on our confidence in the estimates of effect and is likely to change the estimates.

Overall completeness and applicability of evidence

We were able to include five studies in the meta-analyses of this review. Participants were recruited in different settings from elderly living communities to primary or specialist care, and sample sizes varied largely from 19 to 130 participants. Most participants were female (range 66% to 100%), and mean age was mainly between 60 and 65 years, but one study included slightly older people (mean

age 81). Exercise interventions varied largely in terms of content (types of exercises), mode, dose and supervision, but two studies used almost the same exercise programme (Hennig 2015; Østerås 2014). The few studies and participants included in this review did not allow for subgroup analyses. The most recent study (Nery 2015) seemed to show larger beneficial outcomes as compared with the others, but we could extract only limited information from a congress abstract, so several methodological and quality aspects of this study remain to be determined. Results of this review indicate a small to moderate beneficial effect of exercise in people with hand OA, but the absolute effect may not be clinically meaningful. Given that we have limited knowledge of the optimal exercise dosage for persons with hand OA, and that we rely mainly on self-reported data on adherence to the prescribed dosage, the actual dosage followed by participants in the included studies may have been insufficient to produce an optimal effect. As with other exercise interventions, the effect did not seem to be sustained over the long term, which is reasonable if the exercise was discontinued. However, very few harms (adverse events) were reported, meaning that the exercise programme was well tolerated. The external validity of this review is limited by the small number of included studies, and results should be generalised with caution.

Quality of the evidence

Although five of the seven included studies reported blinded outcome assessments, the major outcomes included in this review are self-reported (pain, function, stiffness and quality of life). Five of the seven studies in this review had limitations regarding blinding of participants and personnel (performance bias) as well as blinding of outcome assessment (detection bias) for self-reported outcomes. Although it is difficult, or impossible, to blind participants and personnel to treatment allocation in studies comparing exercise versus no exercise, lack of blinding on self-reported outcomes may have led to inflated effect sizes. Three studies had a high drop-out rate and were considered to have high risk of attrition bias, but for all other risk of bias domains, we considered these studies to present low risk. One included study was available only as a congress abstract, and we could not properly evaluate risk of bias. All included studies showed beneficial results favouring exercise as compared with no exercise for the outcomes of pain, function and stiffness.

We downgraded the overall quality of the body of evidence for hand pain, hand function and finger joint stiffness to low owing to potential detection bias (lack of blinding of participants on self-reported outcome measures) and imprecision (few studies, limited numbers of participants and wide confidence intervals). For quality of life, adverse events and withdrawals due to adverse events, we further downgraded the overall quality of the body of evidence to very low owing to very few studies and very wide confidence intervals.

Potential biases in the review process

We conducted an extensive literature search including handsearching of register databases and congress proceedings, but we may have missed relevant publications or ongoing trials. We expect minimal extracting and reporting bias, as two independent review authors performed these tasks, but we re-analysed data from two studies for the possibility of error. One study was reported only as a congress abstract, and we were unable to contact study authors for two other trials, which had implications for the risk of bias assessment.

Agreements and disagreements with other studies or reviews

Seven systematic reviews (Bertozzi 2015; Kjekken 2011; Mahendira 2009; Towheed 2005; Valdes 2010; Ye 2011; Zhang 2007) and one overview of reviews (Moe 2009) on non-surgical or non-pharmacological treatment of people with hand OA have been published. Five of these reviews were not able to pool exercise data in a meta-analysis. Conclusions from the two most recent reviews were inconsistent, as review authors concluded that exercise has "no overall effect" (Ye 2011) versus "may reduce pain and stiffness and improve function" (Kjekken 2011). However, the conclusions provided by previous reviews were based on a small number of studies with few participants and methodological shortfalls. Except for two studies (Lefler 2004; Rogers 2009), we excluded from this review all studies included in previous reviews for various reasons (Boustedt 2009; Garfinkel 1994; Stamm 2002; Wajon 2005; Characteristics of excluded studies). A recently published systematic review on non-pharmacological interventions (Bertozzi 2015) included four studies, three of which we included in the present review (Dziedzic 2015; Lefler 2004, Rogers 2009) and one that we excluded (Stamm 2002). The authors of this previously published review concluded that they had found (very) low-quality evidence showing no significant improvement in pain intensity, function and stiffness at short-term and long-term follow-up, but they uncovered moderate-quality evidence showing an effect on grip strength at short-term follow-up (Bertozzi 2015).

AUTHORS' CONCLUSIONS

Implications for practice

Currently, low-level evidence suggests that exercise will reduce hand pain and finger joint stiffness and will improve hand function

among people with hand OA. However, inclusion of few studies and participants led to wide confidence intervals; therefore, further research is very likely to have an important impact on our confidence in the estimates of effect and is likely to change the estimates. Estimated effect sizes were small, and whether they represent a clinically important change may be debated.

Implications for research

Research is warranted to determine the optimal exercise programme and the optimal dosage of exercise for hand OA. Thereafter, additional randomised controlled trials are needed to evaluate the effect of an "optimal" exercise programme for hand OA. Such an exercise programme may have to be customised for different phenotypes of hand OA (i.e. CMC1 OA, erosive hand OA, etc.). Monitoring of adherence to the exercise programme and to the prescribed dosage is important, as it will be a prerequisite for determining whether a beneficial effect of exercise has occurred. Supervised exercise sessions are more time-consuming and costly than home-based sessions but may improve participants' compliance with the exercise dosage and instructions.

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CHARACTERISTICS OF STUDIES

Characteristics of included studies [author-defined order]

Davenport 2012

Methods	<p>Study design: pilot parallel RCT</p> <p>Country: UK</p> <p>Method of recruitment: patients referred by doctors to the Pulvertaft Hand Centre</p> <p>Setting: Hand Centre, Derby</p> <p>Length of follow-up: 6 months</p>
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> Clinical diagnosis of first CMC joint OA confirmed radiologically <p>Exclusion criteria</p> <ul style="list-style-type: none"> Suspected or confirmed inflammatory joint disease Coexisting hand conditions Inability to cooperate with the exercise regimens (a decision made by patient and referring doctor together as the result of inability to attend appointments, unwillingness or inability to perform exercises due to home circumstances, health issues, poor memory) <p>Number of people randomised: 39</p> <ul style="list-style-type: none"> Intervention: 17 Control: 21 <p>Number of drop-outs: 16</p> <ul style="list-style-type: none"> Intervention: 9 Control: 7
Interventions	<p>Control group: general exercise regimen</p> <p>Intervention group: specific CMC-joint exercises</p> <p>Specific CMC joint exercise</p> <p><u>Level 1</u></p> <p>Passive extension, 10 sec hold ×3</p> <p>Active extension, 10 sec hold up to ×10</p> <p>Active thumb abduction (abductor pollicis longus) with IP bent, 10 sec hold up to ×10</p> <p><u>Level 2</u></p> <p>Passive extension, 10 sec hold ×3</p> <ul style="list-style-type: none"> Use elastic band for resistance wrapped around base of the thumb and all fingers for exercise 2 + 3. <p>Slow extension, 5 sec hold up to ×10</p> <p>Active thumb abduction; bring tip of the thumb and index finger together without band slackening, up to ×10</p>

Davenport 2012 (Continued)

Level 3

Practice pinching activities (i.e. writing, holding plates, opening clothes pegs, tearing sheets of paper, fastening buttons)

- Keep IP bent and the wrist extended back slightly.

Practice turning/twisting activities (i.e. putting nuts on bolts, using a key in a lock, undoing jar/bottle tops)

- Keep IP bent. Avoid thumb crossing in front of the palm.

Stretch the thumb, especially after strong or long pinching.

General exercise regimen

Level 1

Passive extension, 10 sec hold ×3

Touch thumb to each fingertip and slide thumb down the finger, up to 10×.

Touch thumb to each fingertip and press the thumb against the finger, up to 10×.

Level 2

Passive extension, 10 sec hold ×3

Squeeze a peg between thumb and fingers, up to 10×.

Squeeze a sponge in the hand to strengthen the grip, up to 10×.

Level 3

Practice pinching activities (i.e. writing, holding plates, opening clothes pegs, tearing sheets of paper, fastening buttons).

Practice turning/twisting activities (i.e. putting nuts on bolts, using a key in a lock, undoing jar/bottle tops).

Stretch the thumb, especially after strong or long pinching.

Outcomes	Outcomes assessed at: 3 and 6 months Primary outcome: Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire Secondary outcomes: pinch strength, pain at rest, pain during pinch, abductor pollicis longus (APL) moment	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomly allocated on a 1:1 basis". From the Data Collection Protocol: "A member of the research staff not involved in the project mixed the envelopes randomly and subjects were randomised by selecting the next sealed envelope".
Allocation concealment (selection bias)	Low risk	Sealed envelope method

Davenport 2012 (Continued)

Blinding of participants and personnel (performance bias) Self-reported (pain, function, quality of life, stiffness and more)	Unclear risk	Quote: "It was not possible to blind the treating therapist; however, the investigator and participants were blinded to the allocated exercise group..." Quote in email: "All patients will have an initial appointment where they are given the same standardised written and verbal advice. They will then go on to receive different regimes of exercise depending on the group they have been assigned to".
Blinding of outcome assessment (detection bias) Self-reported outcomes	Low risk	Blinded participants
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Blinded outcome assessor
Incomplete outcome data (attrition bias) All outcomes	High risk	No ITT analysis. Large drop-out. Only 22 (56%) of 39 participants were analysed at last follow-up: 8/17 in intervention, 14/21 in control. Attrition reasons provided. Only complete data for participants retained at assessment points of 3 and 6 months were used.
Selective reporting (reporting bias)	Low risk	Protocol registered: ISRCTN28238521. All outcomes reported
Other bias	Unclear risk	Baseline assessment after randomisation

Dziedzic 2015

Methods	<p>Study design: 2 × 2 factorial RCT</p> <p>Country: UK</p> <p>Method of recruitment: Persons registered with 5 general practices were mailed a population health survey. Responders were invited to telephone the research centre for assessment and eligibility check.</p> <p>Setting: primary care</p> <p>Length of follow-up: 12 months</p>
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> • ≥ 50 years • Reported hand pain over the past 12 months • Reported hand pain, aching or stiffness on 'some days', 'most days' or 'all days' in the past month • AUSCAN pain score ≥ 5 or AUSCAN function score ≥ 9 • Met ACR criteria for features of hand OA or had unilateral or bilateral thumb base OA • Able to understand and capable of giving written informed consent <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Alternative clinical diagnosis, such as inflammatory arthritis • Consultation or treatment for hand problem in previous 6 months <ul style="list-style-type: none"> * Intra-articular joint injection to wrist, fingers or thumb * Fracture or significant injury or surgery to wrist or hand * Consultation for hand problem with an occupational therapist or physiotherapist * Red flags (e.g. history of serious illness or disease such as rheumatoid arthritis, psoriatic arthritis, stroke; progressive neurological signs; acute swollen joint)

Dziedzic 2015 (Continued)

- Other member of the household participating in the trial
- Not able to attend for trial interventions at participating OT departments

Number of people randomised: 130 (2 of the 4 groups in the 2 × 2 factorial RCT)

- **Intervention:** 65
- **Control:** 65

Drop-outs (6-month follow-up): 21

- **Intervention:** 11
- **Control:** 10

Interventions	<p>Control group: no exercises</p> <p>Intervention group: hand exercises</p> <p>Hand exercises</p> <p><u>Stretching exercises</u></p> <p>Wrist flexion and extension, pronation and supination</p> <p>Tendon gliding</p> <p>Radial finger walking</p> <p>Making an "O" with the thumb and index finger</p> <p>Thumb extension/abduction and opposition to the base of the 5th finger</p> <p><u>Strengthening exercises</u></p> <p>Thumb extension/abduction and finger extension using elastic band for resistance</p> <p>Play-Doh rolling and forming into a ring to provide resistance to thumb/finger extension, squeezing into a ball and pinching off pieces between thumb and index finger</p> <p>Holding a 0.5 to 0.75 kg weight while doing wrist flexion and extension exercises in pronation, then in supination</p> <p>Dose: 3 reps initially increasing up to 10 reps, daily (or most days), performed within limit of discomfort</p>	
Outcomes	<p>Outcomes assessed at: 3, 6 and 12 months</p> <p>Primary outcome: OARSI/OMERACT responder criteria</p> <p>Secondary outcomes: hand pain, stiffness and function (AUSCAN), pain severity, grip strength, pinch strength, grip ability test (GAT), health-related QoL</p>	
Notes	<p>We have included data for only 2 of the 4 groups in this 2 × 2 factorial RCT (e.g. control group and exercise only group) because the remaining 2 groups also received a joint protection intervention.</p> <p>The exercise programme was based on a programme for rheumatoid arthritis.</p>	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised via a remote randomisation service....stratified by participants' general practice...random permuted blocks of size 4...computer-generated random number sequence

Dziedzic 2015 (Continued)

Allocation concealment (selection bias)	Low risk	Randomised allocation of the next participant was concealed from administrative and OT staff until the point of randomisation.
Blinding of participants and personnel (performance bias) Self-reported (pain, function, quality of life, stiffness and more)	High risk	Unblinded participants and therapists
Blinding of outcome assessment (detection bias) Self-reported outcomes	High risk	Participants self-reported pain, function and stiffness.
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Blinded outcome assessor
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analyses. Follow-up rates were 90% at 3 months, and 85% at 6 and 12 months. Similar for each intervention arm
Selective reporting (reporting bias)	Low risk	Protocol article published 2011 (Dziedzic 2011) + trial registered: ISRCTN 33870549 + all outcomes reported
Other bias	Low risk	None apparent

Hennig 2015

Methods	Study design: parallel RCT Country: Norway Method of recruitment: hospital outpatient clinic Setting: specialist health care Length of follow-up: 3 months
Participants	Inclusion criteria <ul style="list-style-type: none"> • Female • HOA diagnosed by rheumatologist or orthopaedic surgeon according to ACR criteria • Aged 18 to 80 • Stable medication over past 3 months • Activity limitations: ≥ 3 on PSFS • Ability to communicate in Norwegian Exclusion criteria <ul style="list-style-type: none"> • Hand surgery in the past 3 months • Steroid injection within the past 2 weeks • Impaired hand function due to trauma or disease other than HOA • Cognitive or mental impairment Number of people randomised: 80

Hennig 2015 (Continued)

- **Intervention:** 40
- **Control:** 40

Drop-outs: 8

- **Intervention:** 3
- **Control:** 5

Interventions	Control group: no exercises Intervention group: hand exercises Hand exercises Make "O" sign Roll into a fist, few sec hold Grip strength: squeeze a rubber ball (polyethylene, 7 cm diameter), 5 sec hold Thumb abduction/extension with small elastic band(s) around proximal phalangeals, keep IP/MCP flexed, 5 sec hold Finger stretch, hand laid down on a flat surface, spread all fingers, 5 sec hold Dose: 3 times a week, 10 reps weeks 1-2, 12 reps weeks 3-4, 15 reps weeks 5-13	
Outcomes	Outcomes assessed at: 3 months (13 weeks) Primary outcome: Patient Specific Functional Scale (PSFS) Secondary outcomes: hand pain (NRS), fatigue (NRS), stiffness (NRS), finger range of motion (flexion deficit in mm), patient global assessment of disease activity (NRS), Functional Index Hand Osteoarthritis (FIHOA), grip strength (Jamar), pinch strength, thumb web space (12 cylinders, diameter 1-12 cm), finger dexterity (Moberg Pick-up Test), OARSI/OMERACT responder criteria	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list with a block size of 10
Allocation concealment (selection bias)	Low risk	Concealed, opaque enveloped prepared by a secretary
Blinding of participants and personnel (performance bias) Self-reported (pain, function, quality of life, stiffness and more)	High risk	Unblinded participants and therapists
Blinding of outcome assessment (detection bias) Self-reported outcomes	High risk	Participants self-reported pain, function and stiffness
Blinding of outcome assessment (detection bias)	Low risk	Blinded outcome assessor

Hennig 2015 (Continued)

Objective outcomes

Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analysis. Follow-up 90%, almost balanced between arms (5 vs 3)
Selective reporting (reporting bias)	Low risk	Trial registered: ISRCTN:79019063 + all outcomes reported
Other bias	Low risk	None apparent

Lefler 2004

Methods	<p>Study design: RCT matched on age, gender and extent of hand OA</p> <p>Country: USA</p> <p>Method of recruitment: word of mouth and flyers from residents at an elderly living community</p> <p>Setting: an elderly living community</p> <p>Length of follow-up: 6 weeks</p>
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> • 55 years or older • Hand OA as determined by physician • Some hand/finger impairment from OA pain • Giving informed consent • Apparently healthy and free of contraindications to exercise as determined by a self-reported medical history <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Chronic inflammatory OA of the hands • Strength training during previous 6 months <p>Number of people randomised: 19</p> <ul style="list-style-type: none"> • Intervention: 9 • Control: 10 <p>Drop-outs: 3</p> <ul style="list-style-type: none"> • Intervention: 3 • Control: 0
Interventions	<p>Control group: no exercises</p> <p>Intervention group: hand exercises</p> <p>Exercises: isometric resistance for muscle groups in hand and forearm, rice grabs, pinch grip lifting (bag filled with sand increased in intervals of 250 g) and wrist rolls (PVC pipe with sand bag attached by nylon rope)</p> <p>Dose: 3 times a week. Isometric resistance training 1-10 reps, 6 sec hold at low intensity (40% to 60% of 1 RM). Isotonic resistance training at 40% of 1 RM in 10 to 15 reps, progressed to moderate intensity (more than 60% of 1 RM) in 6 to 8 reps. Performed below a 1.5 point increase in pain on a 6 point scale (no discomfort - extreme discomfort)</p>

Lefler 2004 (Continued)

Outcomes	Outcomes assessed at: 6 weeks Outcomes: pain (6-point scale: no discomfort-extreme discomfort), finger range of motion (goniometer, distance from 5th fingertip to palmar crease), grip strength (Jamar), pinch strength (Jamar pinch gauge)	
Notes	Very small study (only 6 participants completed the exercise programme)	
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	“Randomly assigned” - no more information provided
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) Self-reported (pain, function, quality of life, stiffness and more)	High risk	Unblinded participants and therapists
Blinding of outcome assessment (detection bias) Self-reported outcomes	High risk	Participants self-reported pain, function and stiffness
Blinding of outcome assessment (detection bias) Objective outcomes	Unclear risk	Not reported
Incomplete outcome data (attrition bias) All outcomes	High risk	Not an ITT analysis. 3 of 9 (33% of the exercise group) missed more than 2 of 18 sessions and were dropped from the analyses.
Selective reporting (reporting bias)	High risk	No trial registration found (published before study registration was required)
Other bias	Low risk	None apparent

Nery 2015

Methods	Study design: parallel RCT Country: Brazil Method of recruitment: not reported Setting: not reported Length of follow-up: 12 weeks	
Participants	Inclusion criteria <ul style="list-style-type: none"> Meeting ACR criteria for features of hand OA $\geq$ 1 year 	

Nery 2015 (Continued)

- Age > 55 years
- Both genders
- Pain in interphalangeal joints 3 to 8 cm on 10 cm NRS/VAS

Exclusion criteria

- Other joint disease in hands
- Other rheumatic systemic disease
- Surgery in hands or wrists
- Exercise or joint injection in hands in the previous 3 months
- Disability to perform the exercises

Number of people randomised: 60

- **Intervention:** 30
- **Control:** 30

Drop-outs: not reported

- **Intervention:**
- **Control:**

Interventions	<p>Control group: no exercises</p> <p>Intervention group: hand exercises</p> <p>Exercise programme: progressive resistance strength training programme for intrinsic muscles of the hand</p> <p>Dose: 2 times a week</p>
Outcomes	Pain (NRS/VAS), AUSCAN, Cochin Hand Functional Scale for hand function, grip and pinch strength (hydraulic hand and pinch gauge dynamometer), satisfaction with treatment
Notes	Only congress abstract 2015. ClinicalTrials.gov registered: NCT02528630 after the study was completed

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) Self-reported (pain, function, quality of life, stiffness and more)	Unclear risk	Abstract only - no information provided
Blinding of outcome assessment (detection bias) Self-reported outcomes	High risk	Participants self-reported pain, function and stiffness
Blinding of outcome assessment (detection bias)	Low risk	Blinded outcome assessor

Exercise for hand osteoarthritis (Review)

Nery 2015 (Continued)

Objective outcomes

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Probably not ITT: reported repeated measures ANOVA analyses in abstract
Selective reporting (reporting bias)	Unclear risk	ClinicalTrials.gov registered: NCT02528630, but probably after the study was completed
Other bias	Unclear risk	Abstract only - very little information provided

Rogers 2009

Methods	<p>Study design: cross-over RCT</p> <p>Country: USA</p> <p>Method of recruitment: newspaper announcements, presentations at senior centres, word of mouth, among participants enrolled in a locally based ongoing epidemiological OA study</p> <p>Setting: not reported</p> <p>Length of follow-up: 48 weeks</p>
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> • 50 years or older • Radiographic OA (KL ≥ 2) in at least 1 hand joint • Symptomatic hand OA: minimum 225 mm AUSCAN physical function subscale score <p>Exclusion criteria</p> <ul style="list-style-type: none"> • Participation in hand exercise or hand therapy within prior 6 months • Hand joint injection within prior 3 months • Prior hand surgery requiring joint replacement or other instrumentation in the hands • Planned hand surgery during the time course of the trial • Participation in another interventional trial • Regular use of a cane, walker or assistive crutch • Current use of a therapeutic hand cream • Rheumatic disease other than OA • Presence of other hand or wrist conditions such as tunnel syndrome or tendonitis • History of major hand trauma <p>Number of people randomised: 76</p> <ul style="list-style-type: none"> • Intervention: ? • Control: ? <p>Drop-outs: 30</p> <ul style="list-style-type: none"> • Intervention: ? • Control: ?
Interventions	<p>Control group: sham intervention (non-medicated hand moisturising lotion/hand cream)</p> <p>Intervention group: hand exercises</p> <p>Exercise programme</p>

Exercise for hand osteoarthritis (Review)

Rogers 2009 (Continued)

Flexibility

Tabletop: from neutral position to flexion of 2 to 5. MCP joints, return to neutral

Make small fist: flexion of 2 to 5. PIP and DIP, return to neutral

Make large fist: flexion of all joints to form a fist, return to neutral

Make "Okay signs": form an "O" with the tip of the thumb to the tip of each finger, in turn, returning to neutral after each

Finger spread: hand placed on flat tabletop, from neutral fingers spread apart as wide as possible, return to normal

Thumb reach: tip of thumb touches the 5 MCP, return to neutral

- Strengthening: squeeze Thera-Band Hand Exerciser ball

Gripping: ball in palm

Key pinch: ball between side of the thumb and side of the index finger

Fingertip pinch: ball between tip of the thumb and tip of the index finger

Dose: daily for 10 to 15 minutes, squeeze the Thera-Band ball until 50% depressed. 10 reps weeks 1 to 4, 15 reps weeks 5 to 12, 20 reps (if able) weeks 13 to 16 (except for exercise no. 9) Fingertip pinch: 5-10 reps

Outcomes	<p>Outcomes assessed at: 16, 32 and 48 weeks</p> <p>Primary outcome: AUSCAN function subscale post treatment</p> <p>Secondary outcomes: AUSCAN pain and stiffness, grip and pinch strength (Jamar), finger dexterity (Purdue Pegboard Model 32020)</p>
Notes	No data included in meta-analyses owing to insufficient reporting of outcome data. Received no response on request for additional information

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A clerical assistant not directly involved in the research used a random number table algorithm to assign intervention order for each subject".
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding of participants and personnel (performance bias) Self-reported (pain, function, quality of life, stiffness and more)	Low risk	"Participants were led to believe that the trial involved a comparison of two equally effective treatments".
Blinding of outcome assessment (detection bias) Self-reported outcomes	Low risk	"Participants were led to believe that the trial involved a comparison of two equally effective treatments".
Blinding of outcome assessment (detection bias) Objective outcomes	High risk	Assessor was not blinded. "All testing was conducted by the primary investigator".

Exercise for hand osteoarthritis (Review)

Rogers 2009 (Continued)

Incomplete outcome data (attrition bias) All outcomes	High risk	40% attrition rate
Selective reporting (reporting bias)	Low risk	Study protocol registered: NCT00375947 + all outcomes reported
Other bias	Low risk	16 week wash-out with instructions not to use hand cream or do hand exercises

Østerås 2014

Methods	<p>Study design: parallel RCT</p> <p>Country: Norway</p> <p>Method of recruitment: from 2 OA cohorts: 1 population-based and 1 hospital-based</p> <p>Setting: primary and secondary health care</p> <p>Length of follow-up: 3 and 6 months</p>
Participants	<p>Inclusion criteria</p> <ul style="list-style-type: none"> Meeting ACR criteria for features of hand OA or unilateral/bilateral OA in the first carpometacarpal (CMC1) joint Activity limitations: ≥ 5 on the Functional Index for Hand Osteoarthritis (FIHOA) <p>Exclusion criteria</p> <ul style="list-style-type: none"> Inflammatory rheumatic disease (i.e. rheumatoid arthritis) Steroid injections in the past 2 months Recently experienced severe trauma or recently underwent OA surgery or other major surgery Cognitive dysfunction or language problems. <p>Number of people randomised: 130</p> <ul style="list-style-type: none"> Intervention: 65 Control: 65 <p>Drop-outs (6-month follow-up): 11</p> <ul style="list-style-type: none"> Intervention: 8 Control: 3
Interventions	<p>Control group: no exercises</p> <p>Intervention group: hand exercises</p> <p>Exercise programme</p> <p>Shoulder extension in sitting position using elastic rubber band under the feet and wrapped around the hands; pull the exercise band back with the hands following the thigh from the knee to the iliac crest</p> <p>Biceps curls in standing position, rubber band under the feet and wrapped around the hands</p> <p>Shoulder flexion in standing position, rubber band under the feet and wrapped around the hands, arms hanging down; lift extended arms up towards face level</p> <p>Make "O" sign</p>

Exercise for hand osteoarthritis (Review)

Østerås 2014 (Continued)

Roll into a fist, few sec hold

Grip strength: squeeze a rubber ball (polyethylene, 7 cm diameter), 5 sec hold

Thumb abduction/extension with small elastic band(s) around proximal phalangeals, keep IP/MCP flexed, 5 sec hold

Finger stretch, hand laid down on a flat surface, spread all fingers, 5 sec hold

Dose: 3 times a week, 10 reps weeks 1 to 2, 15 reps weeks 3 to 12, instructed to apply moderate to vigorous intensity

Outcomes	Outcomes assessed at: 3 months (primary endpoint) and 6 months Primary outcome: hand activity performance measured using Functional Index for Hand OsteoArthritis (FIHOA) and Patient Specific Functional Scale (PSFS) Secondary outcomes: hand pain (NRS), fatigue (NRS), stiffness (NRS), patient global assessment of disease activity (NRS), Functional Index Hand Osteoarthritis (FIHOA), grip strength (Jamar), thumb web space (12 cylinders, diameter 1-12 cm), finger dexterity (Moberg Pick-up Test), OARSI/OMERACT responder criteria	
Notes		
Risk of bias		
Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated randomisation list with a block size of 10 prepared by the study biostatistician
Allocation concealment (selection bias)	Low risk	Concealed, opaque envelopes prepared by a secretary
Blinding of participants and personnel (performance bias) Self-reported (pain, function, quality of life, stiffness and more)	High risk	Unblinded participants and therapists
Blinding of outcome assessment (detection bias) Self-reported outcomes	High risk	Participants self-reported pain, function and stiffness
Blinding of outcome assessment (detection bias) Objective outcomes	Low risk	Blinded outcome assessor
Incomplete outcome data (attrition bias) All outcomes	Low risk	ITT analyses. Follow-up 91%, more attrition in intervention group (8 vs 3)
Selective reporting (reporting bias)	Low risk	Protocol article published 2014 (Osteras 2014) + registered trial: ClinicalTrials.gov: NCT01245842 + all outcomes reported
Other bias	Low risk	None apparent

ACR: American College of Rheumatology.

ANOVA: analysis of variance.

Exercise for hand osteoarthritis (Review)

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APL: abductor pollicis longus.
 AUSCAN: Australian/Canadian Hand Osteoarthritis Index.
 CMC: carpometacarpal.
 CMC1: first carpometacarpal joint.
 DASH: Disabilities of the Arm, Shoulder and Hand Questionnaire
 DIP: distal interphalangeal joint.
 FIHOA: Functional Index for Hand OsteoArthritis.
 GAT: Grip Ability Test.
 HOA: hand osteoarthritis.
 IP: interphalangeal.
 ITT: intention-to-treat.
 KL: Kellgren and Lawrence.
 MCP: metacarpophalangeal.
 NRS: numeric rating scale.
 OA: osteoarthritis.
 OARSI/OMERACT: Osteoarthritis Research Society International/Outcome Measures/Outcome Measures in Rheumatology
 OT: occupational therapy.
 PSFS: Patient Specific Functional Scale.
 PVC: polyvinyl chloride.
 QoL: quality of life.
 RCT: randomised controlled trial.
 RM: repetition maximum.
 VAS: visual analogue scale

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

Study	Reason for exclusion
Boustedt 2009	Comparison of 2 different exercise and splint regimens
Garfinkel 1994	Unclear study design/methods. Randomisation procedure "violated", seemed like a cross-over study in part
Masterson 2010	Comparison of joint protection vs no joint protection
Norton 1997	Not possible to isolate results for persons with only hand OA
Stamm 2002	Intervention included exercises and joint protection vs oral/written information on hand OA.
Stukstette 2013	Multi-diciplinary/multi-modal intervention
Villafane 2013	Multi-modal intervention that included hand exercises, joint mobilisation and neurodynamic techniques
Wajon 2005	Comparison of 2 different exercise regimens and 2 different splints

DATA AND ANALYSES

Comparison 1. Exercise versus no exercise (short term)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Hand pain (short term)	5	381	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-0.47, -0.07]
1.1 End of treatment scores/Short-term scores	5	381	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-0.47, -0.07]
2 Self-reported hand function (short term)	4	369	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.58, 0.02]
2.1 End of treatment scores/Short-term scores	4	369	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.58, 0.02]
3 Quality of life (short term)	1	113	Mean Difference (IV, Random, 95% CI)	0.30 [-3.72, 4.32]
3.1 End of treatment scores/Short-term scores	1	113	Mean Difference (IV, Random, 95% CI)	0.30 [-3.72, 4.32]
4 Finger joint stiffness (short term)	4	368	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-0.58, -0.15]
4.1 End of treatment scores/Short-term scores	4	368	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-0.58, -0.15]
5 Adverse events	3	309	Risk Ratio (M-H, Random, 95% CI)	4.55 [0.53, 39.31]
6 Withdrawals due to adverse events	3	309	Risk Ratio (M-H, Random, 95% CI)	2.88 [0.30, 27.18]
7 Grip strength (short term)	5	362	Std. Mean Difference (IV, Random, 95% CI)	0.34 [-0.01, 0.69]
7.1 End of treatment scores/Short-term scores	5	362	Std. Mean Difference (IV, Random, 95% CI)	0.34 [-0.01, 0.69]
8 Pinch strength (short term)	3	179	Std. Mean Difference (IV, Random, 95% CI)	0.20 [-0.10, 0.49]
8.1 End of treatment scores/Short-term scores	3	179	Std. Mean Difference (IV, Random, 95% CI)	0.20 [-0.10, 0.49]
9 OARSI/OMERACT responder criteria	3	305	Risk Ratio (M-H, Random, 95% CI)	2.80 [1.40, 5.62]

Analysis 1.1. Comparison 1 Exercise versus no exercise (short term), Outcome 1 Hand pain (short term).

Analysis 1.2. Comparison 1 Exercise versus no exercise (short term), Outcome 2 Self-reported hand function (short term).

Analysis 1.3. Comparison 1 Exercise versus no exercise (short term), Outcome 3 Quality of life (short term).

Analysis 1.4. Comparison 1 Exercise versus no exercise (short term), Outcome 4 Finger joint stiffness (short term).

Analysis 1.5. Comparison 1 Exercise versus no exercise (short term), Outcome 5 Adverse events.

Analysis 1.6. Comparison 1 Exercise versus no exercise (short term), Outcome 6 Withdrawals due to adverse events.

Analysis 1.7. Comparison 1 Exercise versus no exercise (short term), Outcome 7 Grip strength (short term).

Analysis 1.8. Comparison 1 Exercise versus no exercise (short term), Outcome 8 Pinch strength (short term).

Analysis 1.9. Comparison 1 Exercise versus no exercise (short term), Outcome 9 OARSI/OMERACT responder criteria.

Comparison 2. Exercise versus no exercise (medium term)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Hand pain (6 months)	2	220	Std. Mean Difference (IV, Random, 95% CI)	0.09 [-0.18, 0.35]
2 Self-reported hand function (6 months)	2	228	Std. Mean Difference (IV, Random, 95% CI)	-0.05 [-0.31, 0.21]
3 Quality of life (6 months)	1	100	Mean Difference (IV, Random, 95% CI)	1.90 [-2.27, 6.07]
4 Finger joint stiffness (6 months)	2	225	Std. Mean Difference (IV, Random, 95% CI)	-0.12 [-0.38, 0.14]
5 Grip strength (6 months)	1	106	Std. Mean Difference (IV, Random, 95% CI)	-0.04 [-0.42, 0.35]

Analysis 2.1. Comparison 2 Exercise versus no exercise (medium term), Outcome 1 Hand pain (6 months).

Analysis 2.2. Comparison 2 Exercise versus no exercise (medium term), Outcome 2 Self-reported hand function (6 months).

Analysis 2.3. Comparison 2 Exercise versus no exercise (medium term), Outcome 3 Quality of life (6 months).

Analysis 2.4. Comparison 2 Exercise versus no exercise (medium term), Outcome 4 Finger joint stiffness (6 months).

Analysis 2.5. Comparison 2 Exercise versus no exercise (medium term), Outcome 5 Grip strength (6 months).

Comparison 3. Exercise versus no exercise (long term)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Hand pain (12 months)	1	102	Std. Mean Difference (IV, Random, 95% CI)	-0.22 [-0.61, 0.17]
2 Self-reported hand function (12 months)	1	108	Std. Mean Difference (IV, Random, 95% CI)	-0.09 [-0.47, 0.29]
3 Finger joint stiffness (12 months)	1	108	Std. Mean Difference (IV, Random, 95% CI)	-0.33 [-0.71, 0.05]

Analysis 3.1. Comparison 3 Exercise versus no exercise (long term), Outcome 1 Hand pain (12 months).

Study or subgroup	Exercise		No exercise		Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
	N	Mean(SD)	N	Mean(SD)			
Dziedzic 2015	50	4.2 (2.4)	52	4.7 (2.1)		100%	-0.22[-0.61,0.17]
Total ***	50		52			100%	-0.22[-0.61,0.17]
Heterogeneity: Tau ² =0; Chi ² =0, df=0(P<0.0001); I ² =100%							
Test for overall effect: Z=1.11(P=0.27)							
					Favours exercise -100 -50 0 50 100 Favours no exercise		

Analysis 3.2. Comparison 3 Exercise versus no exercise (long term), Outcome 2 Self-reported hand function (12 months).

Study or subgroup	Exercise		No exercise		Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
	N	Mean(SD)	N	Mean(SD)			
Dziedzic 2015	57	14.9 (8.1)	51	15.6 (7.7)		100%	-0.09[-0.47,0.29]
Total ***	57		51			100%	-0.09[-0.47,0.29]
Heterogeneity: Not applicable							
Test for overall effect: Z=0.46(P=0.65)							
					Favours exercise -100 -50 0 50 100 Favours no exercise		

Analysis 3.3. Comparison 3 Exercise versus no exercise (long term), Outcome 3 Finger joint stiffness (12 months).

Study or subgroup	Exercise		No exercise		Std. Mean Difference Random, 95% CI	Weight	Std. Mean Difference Random, 95% CI
	N	Mean(SD)	N	Mean(SD)			
Dziedzic 2015	57	1.5 (0.9)	51	1.8 (0.9)		100%	-0.33[-0.71,0.05]
Total ***	57		51			100%	-0.33[-0.71,0.05]
Heterogeneity: Not applicable							
					Favours exercise -100 -50 0 50 100 Favours no exercise

Comparison 4. Comparison of different exercise programmes

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Specific CMC exercises vs general CMC exercises			Other data	No numeric data
1.1 Hand pain at rest (short term)			Other data	No numeric data
1.2 Pinch strength (short term)			Other data	No numeric data
1.3 Hand pain at rest (6 months)			Other data	No numeric data
1.4 Pinch strength (6 months)			Other data	No numeric data

Analysis 4.1. Comparison 4 Comparison of different exercise programmes, Outcome 1 Specific CMC exercises vs general CMC exercises.

Study	Specific CMC exercises vs general CMC exercises					
	Median specific exercise	IQR specific exercise group	N specific exercise group	Median general exercise group	IQR general exercise group	N general exercise group
Hand pain at rest (short term)						
Davenport 2012	2.5	1.8-4	13	1.1	0.2-3.1	15
Pinch strength (short term)						
Davenport 2012	2.5	1.9-3.4	13	3.8	3.1-6.5	15
Hand pain at rest (6 months)						
Davenport 2012	2	0.9-2.7	8	0.3	0-3.2	14
Pinch strength (6 months)						
Davenport 2012	2.7	2-3.2	8	3.9	2.8-6.8	14

ADDITIONAL TABLES

Table 1. PROGRESS-Plus

Study	Country	No	Trial type	Setting	Follow-up	Gender	Age	Sympt	Diagn
Davenport 2012	UK	39	Pilot RCT	Hand centre	3, 6 months	82% female	60		
Dziedzic 2015	UK	130	RCT	Primary care/Re-search clinic	3, 6, 12 months	66% female	66	5	
Hennig 2015	Norway	80	RCT	Outpatient sec-ondary care	3 months	100% female	61	10	2
Lefler 2004	US	19	RCT	Elderly living community	6 weeks	90% female	81		
Nery 2015	Brazil	60	RCT		6, 12 weeks	Both genders			
Rogers 2009	US	76	Cross-over	Florida community	16, 32, 48 weeks	85% female	75		
Østerås 2014	Norway	130	RCT	Primary/Se-ondary care	3, 6 months	90% female	66		12

Age: mean age of participants; Diagn: mean number of years since hand OA was diagnosed; No: number of participants randomly assigned; Sympt: mean number of years with hand OA symptoms.

Table 2. Summary of exercise interventions and comparisons

Study, country	Intervention	Comparison	Outcome measures
Davenport 2012 , UK	<p>Mode: home based, but all were seen at weeks 1, 3 and 7 for exercise review</p> <p>Aim: specific CMC joint exercises to reduce pain and to increase grip strength and range of motion</p> <p>Exercises (3): specific CMC joint exercises including passive extension, active extension and active abduction (abductor pollicis longus) against resistance + pinching/turning/twisting activities</p> <p>Dose: 3-4 times a day, 10 seconds hold, 3-10 reps, 3 levels for progression</p> <p>Duration: 6 months</p> <p>Personnel: 1 physiotherapist</p> <p>Number of sessions: > 600</p> <p>Supervised sessions/review: 3</p> <p>Adherence: not reported</p>	<p>Mode: home based, but all were seen at weeks 1, 3 and 7 for exercise review</p> <p>Aim: general exercise regimen for CMC</p> <p>Exercises (3): general exercises including passive extension, thumb to fingertip (slide and press), squeeze a peg between thumb and fingers, squeeze a sponge in the hand + pinching/turning/twisting activities</p> <p>Dose: 3-4 times a day, 10 seconds hold, 3-10 reps, 3 levels for progression</p> <p>Duration: 6 months</p> <p>Personel: 1 physiotherapist</p>	<p>+ Disabilities of the Arm, Shoulder and Hand (DASH) Questionnaire</p> <p>+ pinch strength</p> <p>+ pain at rest and during pinch (VAS)</p> <p>+ abductor pollicis longus (APL) moment</p>
Dziedzic 2015 , UK	<p>Mode: hand exercises in 4 group sessions (1-1.5 hours) first 4 weeks, the rest home based</p> <p>Aim: to improve strength and dexterity. Included stretching and strengthening hand and thumb exercises</p> <p>Exercises (10): stretching (wrist flexion + extension/pronation + supination, tendon gliding, radial finger walking, make "O" sign, thumb-5th finger opposition, thumb extension/abduction) and strengthening exercises (elastic band/Play-Doh providing resistance</p>	<p>No treatment provided, only written information on self-management approaches for hand OA that was given to both groups</p>	<p>+ OARSI/OMERACT responder criteria</p> <p>+ hand pain (NRS)</p> <p>+ pain, stiffness and function (AUSCAN)</p> <p>+ grip strength (Jamar)</p> <p>+ pinch strength (B & L pinch gauge)</p>

Table 2. Summary of exercise interventions and comparisons *(Continued)*

	<p>against thumb/finger abduction/extension, squeeze Play-Doh, pinch off pieces of Play-Doh, external weight during wrist movements)</p> <p>Dose: 3 reps initially, increasing up to 10 reps, daily (or most days); performed within limit of discomfort</p> <p>Duration: 12 months</p> <p>Personnel: 9 occupational therapists</p> <p>Number of sessions: 365</p> <p>Supervised sessions/review: 4</p> <p>Adherence: 78% reported to exercise $\geq 2\times/\text{wk}$ at 6-month follow-up</p>		<p>+ grip ability test (GAT)</p> <p>+ health-related QoL (SF-12)</p>
Hennig 2015, Norway	<p>Mode: home-based hand exercises. Up to 8 telephone calls by an occupational therapist to facilitate adherence and to provide advice on exercise dosage</p> <p>Aim: maximise stable and pain-free functional finger joint ROM, increase grip strength, maintain joint stability, prevent/delay development of fixed deformities</p> <p>Exercises (5): make "O" sign, roll into small + large fist, rubber ball squeeze, thumb abduction/extension against elastic band, finger stretch</p> <p>Dose: 3 times a week, 10 reps weeks 1-2, 12 reps weeks 3-4, 15 reps weeks 5-13</p> <p>Duration: 3 months (13 weeks)</p> <p>Personnel: 2 occupational therapists.</p> <p>Number of sessions: 39</p> <p>Supervised sessions/review: 1 (but up to 8 phone calls from an occupational therapist)</p> <p>Adherence: median (min-max) number of recorded sessions was 37 (26-43)</p>	No treatment provided, only leaflet with information about hand OA, ergonomic principles and advice	<p>+ Patient Specific Functional Scale (PSFS)</p> <p>+ Functional Index for Hand OsteoArthritis (FIHOA)</p> <p>+ hand pain, stiffness, function, fatigue, and patient global assessment of disease activity (NRS)</p> <p>+ number of painful joints</p> <p>+ grip strength (Jamar)</p> <p>+ flexion deficit and thumb opposition</p> <p>+ thumb web space (12 cylinders, diameter 1-12 cm)</p> <p>+ finger dexterity (Moberg Pick-up Test)</p> <p>+ OARSI/OMERACT responder criteria</p>
Lefler 2004, US	<p>Mode: supervised</p> <p>Aim: to improve grip strength, pinch strength, joint stability, finger range of motion and joint pain</p> <p>Exercises: isometric resistance for muscle groups in hand and forearm, rice grabs, pinch grip lifting and wrist rolls</p> <p>Dose: 3 times a week. Isometric resistance training 1-10 reps, 6 seconds hold at low intensity (40%-60% of 1 RM) 3 times a week. Isotonic resistance training at 40% of 1 RM in 10-15 reps, progressed to moderate intensity (more than 60% of 1 RM) in 6-8 reps. Performed below a 1.5 point increase in pain on a 6 point scale (no discomfort-extreme discomfort)</p> <p>Duration: 6 weeks</p> <p>Personnel: not reported</p> <p>Number of sessions: 18</p>	No treatment provided	<p>+ pain (6 point scale)</p> <p>+ finger range of motion (goniometer)</p> <p>+ grip strength (Jamar)</p> <p>+ pinch strength (Jamar pinch gauge)</p>

Table 2. Summary of exercise interventions and comparisons (Continued)

Supervised sessions/review: 18

Adherence: 67% completed 16-18 sessions (3 participants missing > 2 sessions were excluded in analyses)

Nery 2015, Brazil	<p>A session on joint protection and energy conservation for hands was provided before randomisation.</p> <p>Mode: not reported</p> <p>Aim: to target pain, function and strength in hand OA</p> <p>Exercises: not reported</p> <p>Dose: 2 times a week, no more information</p> <p>Duration: 12 weeks</p> <p>Personnel: not reported</p> <p>Number of sessions: 24</p> <p>Supervised sessions/review: not reported</p> <p>Adherence: not reported</p>	<p>A session on joint protection and energy conservation for hands was provided before randomisation.</p> <p>No treatment provided</p>	<p>+ pain (NRS/VAS)</p> <p>+ pain, stiffness, function (AUSCAN)</p> <p>+ hand function (Cochin Hand Functional Scale)</p> <p>+ grip and pinch strength (hydraulic hand and pinch gauge dynamometer)</p> <p>+ satisfaction with treatment</p>
Rogers 2009, US	<p>Aim: to improve joint flexibility + grip and pinch strength</p> <p>Exercises (9): flexibility (6): flexion of 2-5 MCP joints, small fist, large fist, Okay signs, finger spread, thumb reach. Strength (3): squeeze Thera-Band Hand Exerciser ball until 50% depressed: in palm, key pinch and thumb-index fingertip pinch</p> <p>Dose: daily</p> <p>Duration: 16 weeks</p> <p>Personnel: principal investigator</p> <p>Number of sessions: 112</p> <p>Supervised sessions/review: 1</p> <p>Adherence: not reported</p>	<p>Instructed to apply hand cream once per day using a gentle, non-vigorous technique</p>	<p>+ pain, stiffness, function (AUSCAN)</p> <p>+ grip strength (Jamar)</p> <p>+ key pinch strength (Jamar pinch dynamometer)</p> <p>+ hand dexterity (Purdue Pegboard Model 32020)</p>
Østerås 2014, Norway	<p>Mode: 4 group sessions + 32 home-based sessions of hand and upper arm exercises. Weekly telephone call by a project group member in weeks with no group session to facilitate adherence and provide advice on exercise dosage</p> <p>Aim: to improve grip strength and thumb stability, to maintain finger range of motion</p> <p>Exercises (8): shoulder extension and biceps curl in sitting position with elastic band, shoulder flexion in standing with elastic band, make "O" sign, roll into small + large fist, rubber tube squeeze (10 sec hold), thumb abduction/extension against elastic band, finger stretch</p> <p>Dose: 3 times a week, 10 reps weeks 1-2, 15 reps weeks 3-12, instructed to apply moderate to vigorous intensity</p> <p>Duration: 3 months (12 weeks)</p> <p>Personnel: 2 occupational therapists.</p>	<p>No treatment provided</p>	<p>+ Functional Index for Hand OsteoArthritis (FIHOA)</p> <p>+ Patient Specific Functional Scale (PSFS)</p> <p>+ hand pain, stiffness, function, fatigue, and patient global assessment of disease activity (NRS)</p> <p>+ grip strength (Jamar)</p> <p>+ thumb web space (12 cylinders, diameter 1-12 cm)</p> <p>+ finger dexterity (Moberg Pick-up Test)</p>

Table 2. Summary of exercise interventions and comparisons *(Continued)*
Number of sessions: 36

+ OARSI/OMERACT responder criteria

Supervised sessions/review: 4

Adherence: 47% recorded 35-36 sessions and 94% recorded ≥ 22 sessions.

APL: abductor pollicis longus.

AUSCAN: Australian/Canadian Hand Osteoarthritis Index.

CMC: carpometacarpal.

DASH: Disabilities of the Arm, Shoulder and Hand Questionnaire

FIHOA: Functional Index for Hand OsteoArthritis.

GAT: Grip Ability Test.

NRS: numeric rating scale.

OA: osteoarthritis.

OARSI/OMERACT: Osteoarthritis Research Society International/Outcome Measures/Outcome Measures in Rheumatology

PSFS: Patient Specific Functional Scale.

RM: repetition maximum.

SF-12: The 12-Item Short Form Health Survey

VAS: visual analogue scale

Table 3. Outcome measures

Study	Primary outcome measure	NRS/VAS pain	AUSCAN pain/function/stiffness	FIHOA function	NRS function	SF-12 NRS stiffness	Reported on adverse events	Grip strength	Pinch strength	OARSI/OMERACT responder criteria
Davenport 2012	DASH	√							√	
Dziedzic 2015	OMERACT/OARSI responder criteria	√	√			√	√	√	√	√
Hennig 2015	PSFS	√		√	√	√	√	√		√
Lefler 2004	?	√ (6 categories)						√	√	
Nery 2015	?	√	√					√	√	
Rogers 2009	AUSCAN Function		√				√	√	√	
Østerås 2014	PSFS + FIHOA	√		√	√	√	√	√		√

AUSCAN: Australian/Canadian Hand Osteoarthritis Index.

DASH: Disabilities of the Arm, Shoulder and Hand Questionnaire

FIHOA: Functional Index for Hand OsteoArthritis.

NRS: numeric rating scale.

OARSI/OMERACT: Osteoarthritis Research Society International/Outcome Measures/Outcome Measures in Rheumatology

PSFS: Patient Specific Functional Scale.

SF-12: The 12-Item Short Form Health Survey

VAS: visual analogue scale

APPENDICES

Appendix 1. MEDLINE search strategy

1. Osteoarthritis/
2. osteoarthritis\$.tw.
3. osteoarthros\$.tw.
4. (degenerative adj (joint or arthritis\$)).tw.
5. (arthritis adj1 noninflammatory).tw.
6. (arthrosis or arthroses).tw.
7. or/1-6
8. exp Hand/
9. exp Hand Joints/
10. trapeziometacarpal.tw.
11. metacarpophalangeal joint\$.tw.
12. carpometacarpal joint\$.tw.
13. cmc\$.tw.
14. basal joint\$.tw.
15. carpal joint\$.tw.
16. hand\$.tw.
17. thumb\$.tw.
18. finger\$.tw.
19. phalangeal.tw.
20. (dip or pip).tw.
21. palmar fascia.tw.
22. thenar.tw.
23. volar plate.tw.
24. wrist joint\$.tw.
25. or/8-24
26. 7 and 25
27. exp Exercise/
28. exp Exercise Movement Techniques/
29. exp Exercise Therapy/
30. exercise\$.tw.
31. training.tw.
32. strengthening.tw.

33. yoga.tw.
34. tai ji.tw.
35. tai chi.tw.
36. stretching.tw.
37. (kinesiotherapy or kinesitherapy).tw.
38. or/27-37
39. 26 and 38
40. limit 39 to yr="2000 -Current"

Appendix 2. Embase search strategy

1. exp osteoarthritis/
2. osteoarthriti\$.tw.
3. osteoarthros\$.tw.
4. (degenerative adj (joint or arthriti\$)).tw.
5. (arthritis adj1 noninflammatory).tw.
6. (arthrosis or arthroses).tw.
7. or/1-6
8. exp hand/
9. hand joint/
10. hand\$.tw.
11. trapeziometacarpal.tw.
12. metacarpophalangeal joint\$.tw.
13. carpometacarpal joint\$.tw.
14. cmc\$.tw.
15. basal joint\$.tw.
16. carpal joint\$.tw.
17. thumb\$.tw.
18. finger\$.tw.
19. phalangeal.tw.
20. (dip or pip).tw.
21. palmar fascia.tw.
22. thenar.tw.
23. volar plate.tw.
24. wrist joint\$.tw.
25. or/8-24
26. 7 and 25

27. exp exercise/
28. exp kinesiotherapy/
29. (kinesiotherapy or kinesitherapy).tw.
30. exercise\$.tw.
31. training.tw.
32. strenghtening.tw.
33. yoga.tw.
34. (tai ji or tai chi).tw.
35. stretching.tw.
36. yoga/
37. or/27-36
38. 26 and 37
39. limit 38 to yr="2000 -Current"

Appendix 3. CINAHL search strategy

#	Query	Limiters/Ex- panders
S44	S43	Limiters - Pub- lished Date from: 20000101-20111231
S43	S26 and S42	
S42	OR/S27-S41	
S41	TX yoga	
S40	(MH "Yoga")	
S39	TX stretch*	
S38	TX kinesiotherapy or kinesitherapy	
S37	(MH "Tai Chi")	
S36	TX tai chi	
S35	TX tai ji	
S34	TX strenghtening	
S33	TX training	
S32	TX exercise*	
S31	(MH "Isometric Exercises")	

(Continued)

S30	(MH "Therapeutic Exercise")
S29	(MH "Upper Extremity Exercises")
S28	(MH "Muscle Strengthening+")
S27	(MH "Exercise")
S26	S8 and S25
S25	OR/S9-S24
S24	TX wrist joint*
S23	TX carpometacarpal
S22	TX volar plate
S21	TX thenar
S20	TX palmar fascia
S19	TX (dip or pip)
S18	TX phalangeal
S17	TX finger*
S16	TX thumb*
S15	TX hand*
S14	TX "carpal joint**"
S13	TX "basal joint**"
S12	TX cmc*
S11	TX trapeziometacarpal or metacarpophalangeal
S10	(MH "Hand Joints+")
S9	(MH "Hand+")
S8	OR/S1-S7
S7	TX arthrosis or arthroses
S6	TX arthritis N1 noninflammatory
S5	TX "degenerative arthriti**"
S4	TX "degenerative joint"
S3	TX osteoarthros*

(Continued)

S2	TX osteoarthritis*
S1	(MH "Osteoarthritis")

Appendix 4. AMED search strategy

1. Osteoarthritis/
2. osteoarthritis\$.tw.
3. osteoarthros\$.tw.
4. (degenerative adj (joint or arthritis\$)).tw.
5. (arthritis adj1 noninflammatory).tw.
6. (arthrosis or arthroses).tw.
7. or/1-6
8. exp Hand/
9. exp hand joints/
10. trapeziometacarpal.tw.
11. metacarpophalangeal joint\$.tw.
12. carpometacarpal joint\$.tw.
13. cmc\$.tw.
14. basal joint\$.tw.
15. carpal joint\$.tw.
16. hand\$.tw.
17. thumb\$.tw.
18. finger\$.tw.
19. phalangeal.tw.
20. (dip or pip).tw.
21. palmar fascia.tw.
22. thenar.tw.
23. volar plate.tw.
24. wrist joint\$.tw.
25. or/8-24
26. 7 and 25
27. exp Exercise/
28. exp Exercise Therapy/
29. exercise\$.tw.
30. training.tw.

Exercise for hand osteoarthritis (Review)

31. strengthening.tw.
32. yoga.tw.
33. tai ji.tw.
34. tai chi.tw.
35. stretching.tw.
36. yoga/
37. (kinesiotherapy or kinesitherapy).tw.
38. or/27-37
39. 26 and 38
40. limit 39 to yr="2000 -Current"

Appendix 5. PEDro search strategy

Abstract & Title: Osteoarthritis or osteoarthrosis or arthrosis or arthroses or OA

Body Part: Hand or wrist

Appendix 6. OTseeker search strategy

Key words: osteoarthritis* OR osteoarthros* OR arthrosis OR arthroses

AND

Intervention: Exercise/Strength training

OR
Hand Therapy
Movement training

Diagnoses/Subdisciplines Hand or upper Limb Condition

Key words: arthros* AND hand* AND exercise*

arthros* AND hand* AND training
arthros* AND hand* AND strengthening
arthros* AND hand* AND stretch*

osteoarthr* AND hand* AND training
osteoarthr* AND hand* AND strength*

osteoarthr* AND hand* AND yoga

osteoarthr* AND hand* AND tai chi

osteoarthr* AND hand* AND exercise*

Appendix 7. CENTRAL search strategy

#1	MeSH descriptor Osteoarthritis, this term only	1413
#2	(osteoarthritis*):ti,ab,kw or (osteoarthros*):ti,ab,kw or (degenerative NEXT (joint or arthritis)):ti,ab,kw or (arthritis NEXT noninflammatory):ti,ab,kw or (arthrosis or arthroses):ti,ab,kw	4582

Exercise for hand osteoarthritis (Review)

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(Continued)

#3	(#1 OR #2)	4582
#4	MeSH descriptor Hand explode all trees	1785
#5	MeSH descriptor Hand Joints explode all trees	313
#6	(trapeziometacarpal):ti,ab,kw or (metacarpophalangeal NEXT joint*):ti,ab,kw or (carpometacarpal NEXT joint*):ti,ab,kw or (cmc* or hand* of thumb* or finger* or phalangeal):ti,ab,kw or (basal or carpal) NEXT joint*:ti,ab,kw	2865
#7	(dip or pip):ti,ab,kw or (palmar NEXT fascia):ti,ab,kw or (thenar):ti,ab,kw or (volar plate):ti,ab,kw or (wrist NEXT joint*):ti,ab,kw	826
#8	(#4 OR #5 OR #6 OR #7)	4689
#9	(#3 AND #8)	106
#10	MeSH descriptor Exercise explode all trees	8373
#11	MeSH descriptor Exercise Movement Techniques explode all trees	830
#12	MeSH descriptor Exercise Therapy explode all trees	4923
#13	(exercise* or training):ti,ab,kw or (strengthening or stretching):ti,ab,kw or (yoga):ti,ab,kw or (tai NEXT (ji or chi)):ti,ab,kw or (kinesiotherapy or kinesitherapy):ti,ab,kw	48891
#14	(#10 OR #11 OR #12 OR #13)	48967
#15	(#9 AND #14)	10

CONTRIBUTIONS OF AUTHORS

KBH and IK conceived the idea for the review. All review authors contributed to writing the protocol. NØ and GS screened records for eligibility, considered studies for inclusion, extracted (not NØ) and recorded study data and performed risk of bias assessment and methodological quality assessment. NØ drafted the review. All review authors discussed inclusion versus exclusion of studies, provided comments, made suggestions on draft versions of the review and approved the current version.

DECLARATIONS OF INTEREST

Three of the review authors have been involved in two of the included randomised controlled trials conducted to assess the effect of hand exercises in hand OA (NØ, IK and KBH). None of these three were involved in data extraction.

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Internal sources

- No sources of support supplied

External sources

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We did not include the Osteoarthritis Research Society International/Outcome Measures/Outcome Measures in Rheumatology (OARSI/OMERACT) responder criteria as a minor outcome in the protocol, but half of the included studies reported fulfilment of these criteria, so we decided to include this as a minor outcome in the review.

INDEX TERMS

Medical Subject Headings (MeSH)

*Exercise Therapy [adverse effects]; *Hand Joints; Arthralgia [etiology] [*therapy]; Finger Joint; Hand Strength [physiology]; Osteoarthritis [*therapy]; Pain Measurement; Patient Dropouts; Quality of Life; Randomized Controlled Trials as Topic; Self Report

MeSH check words

Aged; Female; Humans; Male