Behavioural physical activity interventions in participants with lower-limb osteoarthritis: a systematic review with meta-analysis

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ABSTRACT
Objective: To assess effectiveness of osteoarthritis interventions to promote long-term physical activity behaviour change.

Design: A systematic review and meta-analysis. Protocol registration PROSPERO CRD4201300444 5 (http://www.crd.york.ac.uk/prospero/).

Study selection: Randomised controlled trials (RCTs) comparing physical activity interventions with placebo, no/minimal intervention in community-dwelling adults with symptomatic knee or hip osteoarthritis. Primary outcomes were change in physical activity or cardiopulmonary fitness after a minimum follow-up of 6 months.

Data extraction: Outcomes were measures of physical activity (self-reported and objectively measured) and cardiovascular fitness. Standard mean differences between postintervention values were used to describe the effect sizes.

Results: 27 984 titles were screened and 180 papers reviewed in full. Eleven RCTs satisfied inclusion criteria, total study population of 2741 participants, mean age 62.2. The commonest reasons for study exclusion were follow-up less than 6 months and no physical activity measures. The majority of included interventions implement an arthritis self-management programme targeting coping skills and self-efficacy. Seven studies used self-report measures, the pooled effect of these studies was small with significant heterogeneity between studies (SMD 0.22 with 95% CI –0.11 to 0.56, z=1.30 (p=0.19) I² statistic of 85%). Subgroup analysis of 6–12 month outcome reduced heterogeneity and increased intervention effect compared to control (SMD 0.53, 95% CI 0.41 to 0.65, z=8.84 (p<0.00001) I² of 66%).

Conclusions: Arthritis self-management programmes achieve a small but significant improvement in physical activity in the short term. Effectiveness of intervention declines with extended follow-up beyond 12 months with no significant benefit compared to control. The small number of studies (11 RCTs) limited ability to define effective delivery methods. Investigation of behavioural lifestyle interventions for lower limb osteoarthritis populations would benefit from consensus on methodology and outcome reporting.

Strengths and limitations of this study

- To the best of our knowledge, this is the first systematic review of the longitudinal effectiveness of interventions to increase and maintain physical activity in lower limb osteoarthritis (OA) populations. A comprehensive search of several databases and sources was undertaken to identify eligible trials.
- We reduced potential bias in the conduct of this review by having authors independently screening titles and abstracts to identify a shortlist of full papers that was agreed for critical appraisal.
- Inclusion criteria for this study were rigorous, with emphasis on duration of follow-up and measurement of sustained behaviour change.
- The primary objective focused on assessing physical activity outcomes in defined OA populations. This improves homogeneity across the included studies but may create limitations for clinical translation.
- The meta-analysis should be interpreted with caution secondary to the identified heterogeneity and inherent risk of Simpson’s paradox and associated ecological fallacy. This review did not evaluate cost-effectiveness of the interventions.

This includes use of validated physical activity reporting tools and planning for long-term follow-up.

BACKGROUND

The lifetime risk of symptomatic lower limb osteoarthritis (OA) approaches 45% and generates a significant population health burden. 1–3 OA is associated with increased prevalence of cardiovascular risk factors and excess mortality. 4, 5 Morbidity in the obese OA population is equivalent to over a twofold increased risk of cardiovascular disease compared to non-obese OA free populations. 6–7 The risk of OA is also

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associated with impaired glucose, hypertension and elevated cholesterol. Adipose tissue inflammation is a common link between OA and cardiovascular risk supporting a common aetiology between metabolic syndrome and symptomatic lower limb OA. One in two people with symptomatic OA are obese and the majority are inactive with less than 15% achieving recommended physical activity guidelines. Physical activity participation is independent of pain or radiological severity of OA. A criticism of current OA management is that it may be too reductionist, focusing on short-term musculoskeletal goals and neglects long-term behavioural outcomes. Targeting modifiable behavioural risk factors such as physical activity may improve long-term morbidity and mortality.

**RATIONALE**

Exercise intervention is an effective strategy for managing OA symptoms and immobility. The most recent systematic reviews identify a bias towards evaluating short-term pain, functional and well-being outcomes. Recommendations include: validating measures of physical activity behaviour including questionnaires and activity monitors; targeting established guidelines for activity; using established behavioural theory as a framework for the interventions; measuring determinants of behaviour change; and, reporting outcomes beyond the termination of the behavioural intervention.

The objectives for this review are:

1. Evaluate effectiveness of OA behavioural interventions on sustained physical activity or cardiovascular fitness, over a minimum of 6 months, in lower limb OA populations.
2. To critically evaluate physical activity research methodology applied in randomised control trials of behavioural interventions for lower limb OA.
3. Summarise physical activity behavioural change strategies incorporated in OA exercise interventions for lower limb OA.

**METHODS**

**Protocol registration**

PROSPERO (http://www.crd.york.ac.uk/PROSPERO/) No CRD42013004445.

**Search methods for identification of studies**

An information specialist developed the search strategy based on an established design used in Cochrane reviews of interventions to promote physical activity. The search terms spanned the breadth of exercise, lifestyle and physical activity descriptors and included trial and intervention specific terms. The updated search included osteoarthritis and musculoskeletal specific terms. The objective of the search was to be inclusive of populations with potential osteoarthritis burden in the general adult population exposed to exercise intervention. The search strategy is detailed in the supplementary online file. We searched the following databases: CENTRAL (Inception to June 2014), MEDLINE (1946 to June 2014), EMBASE (1974 to June 2014), CINAHL (1982 to June 2014), AMED (1985 to June 2014), PsycINFO (1967 to June 2014), SPORTdiscus (1980 to June 2014), OpenGrey (October 2012 and June 2014), SCIeSearch (1945 to June 2014), ACM Digital Library (October 2012 and June 2014) and IEEE Xplore Digital Library (October 2012 and June 2014). The Cochrane highly sensitive search was used to identify randomised controlled trials. No language restrictions were applied. The bibliographies of relevant review articles and selected articles were examined for additional potentially relevant trials. Literature searches were completed October 2012 and updated June 2014 with publications dates screened up to the 17 June 2014.

**Study inclusion criteria and selection**

Two authors (WW and SK) independently manually screened the titles identified during the search to exclude those that were obviously outside the scope of the review. The authors were conservative at this stage and where disagreement occurred the citation was included for abstract review. Two authors (WW and SK) independently reviewed the abstracts of all citations that passed the initial title screen. Literature searches and where disagreement occurred the citation was for abstract review. Two authors (WW and SK) independently reviewed the abstracts of all citations that passed the initial title screen. The following inclusion criteria were applied to determine if the full paper needed further scrutiny.

Did the study:

1. Aim to examine the effectiveness of an exercise/physical activity/cardiovascular fitness promotion strategy?
2. Include a participant population where the majority had symptomatic, physician diagnosed and radiological confirmed diagnosis of OA?
3. Allocate participants in to the intervention or control group using a method of randomisation?
4. Have a control group that is exposed to placebo, no and/or minimal intervention?
5. Include adults of 16 years and older?
6. Recruit community dwelling adults?
7. Have a follow-up period of at least 6 months between start of the intervention and measuring the outcomes?
8. Analyse the results by intention-to-treat or, failing that, ensuring that there is less than a 20% loss to follow-up?

The authors were conservative and where disagreement occurred the citation was included for full text review. Two authors (WW and SK) reviewed the full text of all studies that passed the abstract screening using the
inclusion criteria described above to identify the final set of eligible studies. When there was disagreement at this stage it was resolved after discussion with other authors (CF and JN). We linked publications and reports that utilised the same data to avoid replication in the analysis.

**Data collection and management**

The data extraction form was independently piloted by two authors (CF and JR) and subsequently adjusted to ensure it captured the relevant data. Two authors (WW and SK) independently extracted the data from all the selected studies using the standard form. When there was disagreement a third author reviewed the study and a consensus was reached. We separately extracted data from multiple publications of the same study and then combined them to avoid replication. Any missing or ambiguous data was clarified with the study corresponding author.

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

The risk of bias was only assessed and reported for studies that met the inclusion criteria. The Cochrane Risk of Bias assessment instrument was expanded to include risk of bias assessment specific for physical activity interventions. Two authors (WW and SK) assessed the risk of bias. Where there was disagreement between review authors in the risk of bias assessment, a third author (CF or JN) was asked to independently appraise the study and discrepancies were resolved by consensus between all three authors.

We assessed the studies for the five general domains of bias: selection, performance, attrition, detection and reporting. Risk of bias scores were allocated for:

1. Allocation sequence generation;
2. Allocation concealment;
3. Incomplete outcome data;
4. Selective outcome reporting;
5. Comparable groups at baseline;
6. Contamination between groups;
7. Validated outcome measures;
8. Outcome measure applied appropriately;
9. Final analysis adjusted for baseline PA levels;
10. Outcome assessment that was independent and blinded;
11. Intention-to-treat analysis

When sufficient information was available, each domain was identified as ‘high’ or ‘low’ risk of bias. When there was a lack of information or uncertainty over the potential for bias, we described the domain as ‘unclear’. We judged the studies overall as having a ‘low’, ‘medium’, or ‘high’ risk of bias given consideration of the study design and size, and the potential impact of any identified weakness noted in the table for each study. The assessment of risk of bias and quality of included RCTs was then summarised using the GRADE approach.

**Summary measures of treatment effect and unit of analysis**

Studies were analysed using the mean and SD of outcomes expressed in the original papers. We expressed the effect size using the standard mean difference between the postintervention values of the randomised groups. We used the outcomes reported after the longest duration of follow-up. When studies investigated multiple interventions, intervention arms inclusive of exercise where combined, including interventions separating aerobic and resistance exercise. Means and SD were calculated for the combined intervention arms according to the overall numbers within each arm using established approaches.

If domains of activity were reported separately within a single study, when possible mean effects were pooled to provide a summary effect for the intervention, otherwise, self-reported leisure time activity was used as the outcome measure. To allow comparison with reported intervention effects from previous reviews, including interventions in the general adult population, effect sizes were described according to Cohen’s classification of effect size small (0.2 to <0.3), medium (0.3 to <0.8) and large (>0.8). Effect sizes for the individual studies were plotted with associated error bars using forest plots. Statistically significant results were identified as CIs excluding a null effect and an α value for z<0.05.

**Dealing with missing data**

We excluded studies that had a high degree of incomplete data (defined as having more than 40% incomplete data) during the risk of bias assessment or when it appeared that the missing data were likely to be associated with the reported intervention effect. We contacted the authors of potentially included studies if missing data were unclear or data had not been fully reported. Missing data were captured in the data extraction form and reported in the risk of bias table. In the current review meta-analysis did not require imputation of missing mean values or SDs.

**Assessment of heterogeneity**

Heterogeneity was quantified and evaluated to determine whether the observed variation in the study results was compatible with the variation expected by chance alone. Heterogeneity was assessed through examination of the forest plots and quantified using the I² statistic according to the type of outcome utilised. I² statistic was graded according to Cochrane interpretation (>75% considerable/large heterogeneity). The meta-analysis was repeated for each of the following outcome measures: cardiopulmonary function (Peak VO₂), accelerometer and self-report outcomes.

**Assessment of reporting biases**

Given the small number of studies and number of trials reporting different outcomes measures formal assessment of reporting bias, plotting on funnel plot, was not
performed. This decision was made in accordance with Cochrane guidance for assessing reporting bias as plotting less than 10 studies may not distinguish between chance findings and real asymmetry.37

Data synthesis
Meta-analysis was restricted to the seven studies with self-reported physical activity outcomes. Studies only reporting cardiovascular fitness and objective measures were limited in number and were excluded from meta-analysis. Analysis was completed using established methods.36 Analysis was performed using Excel Microsoft software incorporating MetaEasy statistical software and RevMan V.5.2 statistical software.38 39 The DerSimonian and Laird random-effects model was the default to incorporate heterogeneity between studies, the inverse variance method used to calculate the overall effect and SE.40 Meta-regression analysis was completed using the Wilson (2010) SPSS macro using IBM SPSS Statistics for Windows, V.22.0. Meta-regression was completed using a random effects model.41

RESULTS
The literature search yielded 27 984 articles from across the physical activity and exercise literature. The majority of studies were excluded following review of titles and abstracts as not meeting the major inclusion criteria outlined in the study protocol. Of the 180 articles selected for critical reading (figure 1), 169 were excluded with explanation (see online supplementary file appendix 1). The majority of excluded randomised comparison trials report no or insufficient measures of physical activity (n=77).

Eleven studies (2741 participants, mean age 62.2) were included for review.42-52 Two studies were gender balanced while eight studies had over 70% female participation. One study which delivered an online intervention, relied on self-reported diagnosis of OA, physician diagnosis was confirmed in 68% of the population.45 The majority of interventions were completed in North America (n=8). The studies reporting ethnic demographic data (n=7) had study populations 70% White Caucasian. Full descriptions of the included studies and associated interventions and behavioural strategies are available in the online supplement (see online supplementary file appendix 2). Included trials were published between 1997 and 2013. The maximum length of follow-up was 29 months, the majority report between 6 and 12 months follow-up (8 trials). Six trials recruited participants with knee OA, four trials included hip and knee OA and one trial exclusively recruited participants with hip OA. Nine trials incorporate an arthritis self-management programme, targeting self-efficacy and coping skills. Five trials recorded a measure of self-efficacy as a potential determinant of behaviour change. Four (36%) trials discussed intervention design with context to Bandura’s Social Cognitive Theory.53 54

Two trials reported cardiopulmonary fitness, two reported accelerometer data, six trials used self-report measures of physical activity while one trial reported both accelerometer and self-report data. The majority of studies delivered the intervention within 6 months (n=8), utilising face-to-face interaction and supervised exercise, three interventions continued for between 9 and 18 months.

Risk of bias and quality assessment
Risk of bias and additional quality markers were assessed across all included trials (see online supplementary file appendix 3). The participant allocation methods were rated as low risk across all included trials. The majority of trials described randomisation at the individual level, one trial used cluster randomisation at the primary care practice level. Allocation concealment was adequate in 45% of the trials and not described in the remainder. Validated measures of physical activity or cardiopulmonary fitness were used in 9 of the 11 included studies. There was variability in the application of the outcome measures and methods applied with potential bias in accelerometer data collection. Bias primarily relate to the wear time and a deficiency in described strategies to improve participant compliance with wear time. All studies adjusted for baseline physical activity. In the majority of studies (7 of 11 studies) it was unclear whether outcome assessment was blinded. The greatest risk of bias related to incomplete data with increasing attrition across studies with duration of follow-up, 36% suffered attrition greater than 20% beyond 12 months, all of these studies included an intention-to-treat analysis. When available risk of selective reporting was assessed by comparing protocols or primary analysis plans with reported outcomes. In the majority of included studies selective reporting bias was low (90%). The overall assessment of the included RCTs using the GRADE approach suggests moderate quality data with majority of studies downgraded secondary to limitations in design.36

Effects of interventions
Self-report measures of physical activity
Seven studies reported physical activity outcomes using self-report measures, each study using a different measure. Five of the studies reported a positive effect, however only two studies reported a significant difference comparing intervention with control. The pooled effect for the seven interventions was not significant and there was considerable heterogeneity between the interventions (SMD 0.22 with 95% CI −0.11 to 0.56, z=1.3 (p=0.19) I² statistic of 85%; figure 2).

All seven studies implemented an arthritis self-management strategy targeted to improve self-efficacy and four trials based interventions on Bandura’s Social Cognitive Theory.54 Five of the studies combined arthritis self-management with supervised exercise. The
intensity and duration of interventions varied across the studies (table 1).

Planned interaction between participants and the interventions ranged from less than 7–138 h. Compliance with the interventions calculated using mean participant attendance and presented as a percentage of all available intervention sessions/activity, was above 70% for all studies within the first 12 weeks of the intervention. Five of the studies completed 12 month follow-up, attrition was high for two for these studies above 40% at 12 months. Both studies applied an intention-to-treat analysis.

Post hoc meta-regression was completed to explore the influence of (1) Age of participants at baseline, (2) Estimated hours of contact with the intervention, (3) Duration of follow-up in months and (4) Rates of attrition, on effectiveness of intervention. In bivariate analysis estimated hours of contact time with the intervention and duration of follow-up had significant influence on intervention effectiveness. In multivariate regression only duration of follow-up remained significant ($\beta$ coefficient for regression $-0.04$ (95% CI $-0.08$ to $-0.004$) $p=0.03$) with diminished effect of intervention at extended follow-up. To explore time effects a sub-group analysis was completed restricting meta-analysis to interventions reporting 6–12 months outcomes. This included five studies, total population of 1249 participants. The pooled standard mean difference between

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**Figure 1** PRISMA flow diagram; randomised controlled trial study selection.

**Figure 2** Forest plot for meta-analysis of self-reported physical activity outcomes following exercise intervention.

**Table 1**

<table>
<thead>
<tr>
<th>Study or Subgroup</th>
<th>Experimental</th>
<th>Control</th>
<th>Std. Mean Difference IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>894</td>
<td>566</td>
<td>0.22 [-0.11, 0.56]</td>
</tr>
</tbody>
</table>

Heterogeneity: $Tau^2 = 0.16$; $Chi^2 = 40.60$, df = 6 ($P < 0.00001$); $I^2 = 85$

Test for overall effect: $Z = 1.30$ ($P = 0.19$)


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intervention and control was 0.53 (95% CI 0.41 to 0.65), z score=8.84 (p<0.00001) with I² statistic of 66%. Included in this subgroup was the study by Lorig et al\textsuperscript{45} which delivered an online intervention. Recruitment for this trial relied on self-reported diagnosis of OA and only 68% of this cohort had a physician confirmed diagnosis. Excluding this study on the grounds of diagnosis improved the heterogeneity across the four remaining studies (n=957, SMD 0.64 (95% CI 0.51 to 0.78) z score=9.17 (p<0.00001), I² statistic=0). The subgroup analysis supports a significant improvement in short-term physical activity up to 12 months following arthritis self-management programmes.

### Objective measures of physical activity

Three of the 11 studies reported physical activity outcomes using accelerometers as objective measures of physical activity, all three studies implemented arthritis self-management interventions.\textsuperscript{46 49 51} Talbot et al\textsuperscript{49} investigated nurse prescribed individual walking plans supported by activity self-monitoring. The intervention was completed over 12 weeks with weekly contact during a structured education programme. The study reported a negative effect comparing intervention and control (SMD $−0.64$, 95% CI $−1.33$ to $0.05$). Farr et al\textsuperscript{51} implemented a high-intensity 9 month intervention with the option of three exercise sessions per week (SMD 0.29 95% CI $−0.03$ to 0.61). The intervention was inclusive of 12 weeks of structured education targeting coping skills and self-efficacy. Murphy\textsuperscript{46} reported data for both objective and subjective physical activity measures. The effect margin using objective measurement showed no real difference over using the questionnaire (SMD 0.07 95% CI $−0.48$ to 0.62 versus SMD 0.28 CI $−0.27$ to 0.84).

### Cardiorespiratory fitness

Two studies examined the effect of their intervention on cardiorespiratory fitness.\textsuperscript{43 50} Ettinger et al\textsuperscript{43} examined the effectiveness of supervised weekly resistance and aerobic exercise, the comparison group received health education. The exercise interventions covered 18 months in duration. The first 3 months were high contact with three sessions per week, followed by prescription of a personal exercise plan that was supported with home visits and telephone calls. The standardised mean difference for the intervention was 2.35 (95% CI 2.07 to 2.62), representing a positive large effect. Thorstensson\textsuperscript{50} evaluated a 6-week intervention consisting of 2×60 min supervised weekly sessions, plus daily home resistance exercise and 30 minutes walking per day. The comparison group received usual care consisting of three sessions with a physical therapist during the 6-month intervention. The mean effect of intervention over control was negative (SMD $−0.19$, 95% CI $−0.76$ to 0.37). There are significant differences between these two studies, both in intensity of contact, duration of intervention, control group and follow-up time. Heterogeneity assessment reflects this with an I² statistic

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**Table 1** Intervention duration, participant-provider contact time, subsequent intervention compliance, attrition and self-report outcome over respective study duration

<table>
<thead>
<tr>
<th>Study</th>
<th>Number of participants at baseline</th>
<th>Intervention duration</th>
<th>Estimated hours of contact</th>
<th>Follow-up duration months</th>
<th>Compliance at 12 months</th>
<th>Attrition</th>
<th>Effect of intervention compared to control on physical activity outcome at follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brosseau</td>
<td>222</td>
<td>12 months</td>
<td>≥70%</td>
<td>7% at 6 months 60%</td>
<td>0</td>
<td>0</td>
<td>0.00.0.</td>
</tr>
<tr>
<td>Hughes</td>
<td>215</td>
<td>8 weeks</td>
<td>70%</td>
<td>0</td>
<td>12</td>
<td>60%</td>
<td>0.0.0.</td>
</tr>
<tr>
<td>Lorig</td>
<td>292</td>
<td>6 weeks</td>
<td>45%</td>
<td>0</td>
<td>12</td>
<td>58%</td>
<td>0.0.0.</td>
</tr>
<tr>
<td>Murphy</td>
<td>121</td>
<td>6 months</td>
<td>23%</td>
<td>0</td>
<td>12</td>
<td>0%</td>
<td>0.0.0.</td>
</tr>
<tr>
<td>Rosemann</td>
<td>1021</td>
<td>Over 90%</td>
<td>22%</td>
<td>0</td>
<td>12</td>
<td>0%</td>
<td>0.0.0.</td>
</tr>
<tr>
<td>Schlenk</td>
<td>26</td>
<td>Less than 7</td>
<td>19%</td>
<td>0</td>
<td>0</td>
<td>19%</td>
<td>0.0.0.</td>
</tr>
<tr>
<td>Svege</td>
<td>109</td>
<td>12 weeks</td>
<td>75%</td>
<td>0</td>
<td>0</td>
<td>75%</td>
<td>0.0.0.</td>
</tr>
</tbody>
</table>

(0) No significance difference in self-reported physical activity between intervention group and control, (+) significance difference in self-reported physical activity between intervention group and control, (.) no data.
of 98%. Neither Ettinger nor Thorstensson defined a theoretical or behavioural framework for their interventions.

DISCUSSION
Physical activity measurement and research methodology in exercise and osteoarthritis interventions
This is the first systematic review to evaluate sustained physical activity change following behavioural OA intervention. The current review identifies significant deficiencies in the use of validated physical activity measurement tools in OA interventions. A total of 180 papers were considered in full for this review. Of the 169 papers that did not meet inclusion criteria, short duration of follow-up (n=46) and lack of parameterisation of physical activity (n=77) are the most common explanation for study exclusion. This is despite availability of a number of validated self-report physical activity tools.\(^ {55,56}\) Explanation for under-reporting of physical activity behaviours in the excluded studies is unclear. A minority of the excluded trials published trial protocols which has prevented review of selective outcome reporting.

To date exercise and OA reviews have included trials with as little as 4–6 weeks follow-up. The average follow-up in the current review was 12 months. Epidemiological modelling studies suggest that outcome evaluation should continue beyond 5 years to accurately measure cost-effectiveness and health outcomes.\(^ {57}\) In practice extended follow-up may be limited by funding restrictions or compromised by study attrition.

This review highlights limited consensus in research methodology, especially in relation to measurement of physical activity. A weakness in many of the studies is the use of self-reported minutes of exercise, which may only capture activity in one physical activity domain (recreation and leisure).\(^ {55}\) Using validated questionnaires as opposed to recall of active minutes per week or exercise diaries may facilitate more comprehensive data capture across activity domains.\(^ {56}\)

Objective measurement of physical activity with wrist worn accelerometers provide a feasible method to monitor daily activity and provide an opportunity for participants to self-monitor behaviour change.\(^ {58–61}\) Incorporating wearable devices and self-monitoring may additionally improve assessment of intervention compliance and fidelity allowing evaluation of remote and low contact interventions. Studies in the current review use early examples of accelerometers and the technology and methodology since this timeframe has progressed significantly. Physical activity protocol design has evolved to support the wearing of wrist worn accelerometers to provide seven full days of activity measurement. However, this duration of wear time and associated number of data points need a suitable infrastructure to collate and analyse the data.\(^ {52}\)

This review suggests that consensus is required for the use of physical activity measures in behavioural lifestyle interventions. A major concern is that the OA research community are failing to measure physical activity as a baseline covariant. There is a strong argument that physical inactivity should be included in baseline demographic profiling of all chronic disease trials, similar in priority to recording hypertension, obesity, smoking and metabolic dysfunction.\(^ {51}\)

Behavioural strategies and intervention delivery methods used to increase exercise and physical activity in osteoarthritis interventions
The majority of included studies implement a prescriptive approach to increase activity, following a defined timetable of supervised exercise. The benefit of this approach is a guaranteed exercise dose is received and supervision encourages compliance with the intervention. However, such delivery methods may not be economically feasible and may potentially fail to increase activity across domains (home environment, recreation and leisure, active transport and occupational activity) and may even decrease total activity. A number of interventions in the current review report a negative effect on maintained overall activity.

The majority of included studies are theoretically strong using defined behaviour change frameworks. These include arthritis self-management programmes based on Bandura’s self-efficacy theory\(^ {54}\) which aim to improve coping skills and self-determination to manage symptoms. As a result the studies adhere to established guidance for implementing behavioural interventions.\(^ {55,61,63,64}\) However, only a minority of trials measure the mediators of change in behaviour. As a result it is difficult to identify the active ingredients within the arthritis self-management programmes. Education, peer persuasion and self-monitoring were components of effective programmes but it is not clear how they shape the intervention process and outcomes. Measuring the mediators of change, which may be objective or subjective markers, may help to track the transition towards a defined behavioural outcome.\(^ {52,65}\)

Although arthritis self-management was the common behaviour programme, there was considerable variability in the delivery and intensity of the interventions. It is not possible from the current evidence base to reliably distinguish which delivery strategy is most successful. The majority of interventions deliver concentrated programmes in less than 6 months with high contact between participant and provider. To improve translation into clinical practice, further investigation of effectiveness for remote versus face-to-face interventions and supervised versus self-directed interventions and the associated costs and benefits of each intervention, are required.

Effectiveness of lower limb OA interventions to promote physical activity in comparison to interventions in the general population
The review identified a trend towards a small positive effect on increasing self-reported physical activity after 6
to 29 months follow-up. Effect of intervention is greatest in the first 12 months with a significant increase in physical activity compared to control in this time frame. The results are comparable to a Cochrane review of interventions in the general population using self-report physical measures which identified a positive moderate effect (SMD 0.28 95% CI 0.15 to 0.41, I² 83.5%).

One previous review discussed behavioural strategies and physical activity outcomes in a meta-analysis combining rheumatoid and OA interventions. The review reported an effect of 0.69 (95% CI 0.49 to 0.88) from control trials (n=23) but a limitation was the inclusion of studies with short follow-up (minimum of 4 weeks), introducing the risk of over estimating the true longitudinal effect of the exercise intervention. The meta-regression and subgroup analysis in the current review confirms intervention effectiveness declines with extended follow-up. The inclusion of the inflammatory arthritis population and distinctions in study inclusion criteria (single arm, before and after studies) prevent valid comparison with this review.

**IMPLICATIONS FOR RESEARCH AND PRACTICE**

Arthritis self-management programmes may support successful strategies for promoting physical activity in OA populations. However, there remain significant barriers to translating the evidence base into clinical practice. Barriers to translation which need to be addressed include:

1. Establishing a consensus on research methods and outcome reporting.
2. Establishing the infrastructure and training required to promote essential components of the self-management programmes (education, coping skills, goal setting, self-monitoring, peer persuasion and individual feedback).
3. Defining optimal delivery and communication strategies (peer lead, health professional facilitation, face-to-face interventions, remote interventions).
4. Identifying the optimal duration and intensity of intervention programme (daily, weekly, monthly contact).
5. Investigating the longitudinal effectiveness of interventions on cardiovascular morbidity in OA populations.

**CONCLUSION**

OA is a musculoskeletal diagnosis associated with significant risk of cardiovascular disease and increased mortality. Promoting sustained increase in physical activity behaviour has the potential to achieve pain and symptom control and to prevent secondary complications. Despite a significant volume of research investigating exercise for OA management the evidence base is deficient in physical activity reporting and methodological rigour. Generating the evidence base to incorporate behavioural intervention into clinical management will require consensus in research design, outcome reporting and investment in multicentre trials with multidisciplinary teams.

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**Contributors**

WW, CF, JN, NA, SK, JR, NR and PL made substantial contributions to the conception and design of the work, acquisition, analysis and interpretation of data for the work. WW, SK, JN, NA, JR, PL, and CF were involved in drafting the work or revising it critically for important intellectual content. WW, SK, JN, NA, JR, PL, and CF were involved in final approval of the version to be published.

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None declared.

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**Data sharing statement**

All available original materials are included in the original manuscript and additional online supplements.

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**REFERENCES**


## Supplementary File

### Appendix 1

### Excluded References

(PA physical activity, RA Rheumatoid Arthritis, OA Osteoarthritis)

<table>
<thead>
<tr>
<th>Year</th>
<th>Author</th>
<th>Paper</th>
<th>Explanation for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Aaboe(1)</td>
<td>Muscle strength and muscle mass one year after an initial 16 week intense weight loss: A randomized controlled trial</td>
<td>No PA outcome measure reported. Presenting data from CAROT study (Christensen et al)</td>
</tr>
<tr>
<td>2013</td>
<td>Abbott(2)</td>
<td>Manual therapy, exercise therapy, or both, in addition to usual care, osteoarthritis of the hip or knee: a randomized controlled trial. 1:for clinical effectiveness</td>
<td>No PA outcome measure</td>
</tr>
<tr>
<td>2013</td>
<td>Ackerman(3)</td>
<td>Factors limiting participation in arthritis self-management programmes: an exploration of barriers and patient preferences within a randomized controlled trial</td>
<td>No PA intervention</td>
</tr>
<tr>
<td>2008</td>
<td>Aglamis(4)</td>
<td>The effect of a 12 week supervised multicomponent exercise program on knee OA in Turkish Women</td>
<td>No PA outcome measure, less than 6 months follow-up</td>
</tr>
<tr>
<td>2008</td>
<td>An(5)</td>
<td>Baduanjin Alleviated the Symptoms of Knee Osteoarthritis</td>
<td>No PA outcome measure, less than 6 months follow-up</td>
</tr>
<tr>
<td>2013</td>
<td>Ay(6)</td>
<td>Is there an effective way to prescribe a home-based exercise program in patients with knee osteoarthritis? a randomized controlled study</td>
<td>No PA outcome measure, Less than 6 months</td>
</tr>
<tr>
<td>2001</td>
<td>Baker(7)</td>
<td>The efficacy of home based progressive strength training in older adults with knee osteoarthritis: a randomized controlled trial.</td>
<td>No PA outcome measure, less than 6 months follow-up</td>
</tr>
<tr>
<td>1997</td>
<td>Barlow(8)</td>
<td>Improving arthritis self-management among older adults: &quot;Just what the doctor didn’t order&quot;</td>
<td>Less than 6 months follow-up. RA and OA population, Insufficient PA data</td>
</tr>
<tr>
<td>1999</td>
<td>Barlow(9)</td>
<td>Instilling the strength to fight the pain and get on with life: learning to become an arthritis self-manager through an adult education programme</td>
<td>Less than 6 months follow-up. RA and OA population, Insufficient PA data</td>
</tr>
<tr>
<td>2000</td>
<td>Barlow(10)</td>
<td>A randomised controolled study of the arthritis self-management programme in the UK</td>
<td>RA and OA population. Insufficient PA data</td>
</tr>
<tr>
<td>2014</td>
<td>Bartholdy(11)</td>
<td>Standardized rescue training as part of an exercise program for knee osteoarthritis: Proof of concept</td>
<td>Less than 6 months, No PA outcome measure. Clinicaltrials.gov: NCT01545258</td>
</tr>
<tr>
<td>Year</td>
<td>Author(s)</td>
<td>Title</td>
<td>Study Design</td>
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<tr>
<td>------</td>
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</tr>
<tr>
<td>2011</td>
<td>Baruth(12)</td>
<td>Effectiveness of Two Evidence-Based Programs in Participants with Arthritis: Findings from the Active for Life Initiative</td>
<td>Non randomised trial</td>
</tr>
<tr>
<td>1997</td>
<td>Bautch(13)</td>
<td>Effects of exercise on knee joints with osteoarthritis: a pilot study of biologic markers. Arthritis Care and Research</td>
<td>No PA outcome measure, less than 6 months follow-up</td>
</tr>
<tr>
<td>2002</td>
<td>Belza(14)</td>
<td>Does Adherence Make a Difference? Results From a Community-Based Aquatic Exercise Program</td>
<td>Less than 6 months follow-up. No PA outcome measure</td>
</tr>
<tr>
<td>2012</td>
<td>Bennell(16)</td>
<td>A physiotherapist-delivered integrated exercise and pain coping skills training intervention for individuals with knee osteoarthritis: a randomised controlled trial protocol</td>
<td>Protocol</td>
</tr>
<tr>
<td>2011</td>
<td>Bennell(17)</td>
<td>Comparison of neuromuscular and quadriceps strengthening exercise in the treatment of varus maligned knees with medial knee osteoarthritis: a randomised controlled trial protocol</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Bennell(18)</td>
<td>Efficacy of a physiotherapy rehabilitation program for individuals undergoing arthroscopic management of femoroacetabular impingement - the FAIR trial: a randomised controlled trial protocol</td>
<td>Conference abstract</td>
</tr>
<tr>
<td>2013</td>
<td>Bennell(19)</td>
<td>Physiotherapist-delivered exercise and pain coping skills training is more effective than either intervention alone in knee osteoarthritis</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Bennell(20)</td>
<td>Type of exercise and presence of varus thrust influences pain outcomes in people with medial knee osteoarthritis</td>
<td>Conference abstract. Full data presented Bennell 2014 Arthritis and Rheumatology Protocol</td>
</tr>
<tr>
<td>2014</td>
<td>Bennell(21)</td>
<td>Neuromuscular versus quadriceps strengthening exercise in patients with medial knee osteoarthritis and varus malalignment: A randomized controlled trial</td>
<td>Conference abstract no PA outcome measure reported. Reporting data related to Bennell 2012 protocol</td>
</tr>
<tr>
<td>2014</td>
<td>Bennell(22)</td>
<td>Physiotherapist-delivered exercise and pain coping skills training is more effective than either intervention alone in knee osteoarthritis</td>
<td>Conference abstract presenting Bennell 2014 JAMA study. Study designed to evaluate manipulative physical therapy against sham ultrasound. The aim of the study was not to evaluate the effectiveness of exercise or a physical activity Behavioural intervention for OA management. Both groups received equal contact time with a physiotherapist. Week 1 is similar for both groups with physical assessment and feedback. The active</td>
</tr>
<tr>
<td>2014</td>
<td>Bennell(23)</td>
<td>Physical therapy for hip osteoarthritis: Randomised, placebo-controlled trial</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>Bennell(24)</td>
<td>Effect of physical therapy on pain and function in patients with hip osteoarthritis: a randomized clinical trial</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Author/Reference</td>
<td>Description</td>
<td>Note</td>
</tr>
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</tr>
<tr>
<td>2005</td>
<td>Bennell(25)</td>
<td>Efficacy of physiotherapy management of knee joint osteoarthritis: a randomised, double blind, placebo controlled trial</td>
<td>No PA outcome measure reported</td>
</tr>
<tr>
<td>2010</td>
<td>Bennell(26)</td>
<td>Hip strengthening reduces symptoms but not knee load in people with medial knee osteoarthritis and varus malalignment: a randomised controlled trial</td>
<td>Less than 6 months follow-up</td>
</tr>
<tr>
<td>2012</td>
<td>Bennell(27)</td>
<td>Addition of telephone coaching to a physiotherapist-delivered physical activity program in people with knee osteoarthritis: A randomised controlled trial protocol</td>
<td>Protocol</td>
</tr>
<tr>
<td>2012</td>
<td>Bossen(28)</td>
<td>Designing and testing a web-based physical activity intervention for patients with osteoarthritis in hip and/or knee</td>
<td>Non-randomised pilot study with 12 week follow-up</td>
</tr>
<tr>
<td>2013</td>
<td>Bossen(29)</td>
<td>Effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis: randomized controlled trial</td>
<td>Self-report Osteoarthritis with no verification of participant reported diagnosis</td>
</tr>
<tr>
<td>2013</td>
<td>Bossen(30)</td>
<td>The usability and preliminary effectiveness of a web-based physical activity intervention in patients with knee and/or hip osteoarthritis</td>
<td>Non-randomised study</td>
</tr>
<tr>
<td>2006</td>
<td>Braun(31)</td>
<td>Arthritis-friendly adaptations for weight management and physical activity promotion: Two 12-month interventions</td>
<td>No appropriate control, insufficient data</td>
</tr>
<tr>
<td>2007</td>
<td>Brismee(32)</td>
<td>Group and home-based tai chi in elderly subjects with knee osteoarthritis: a randomised controlled trial</td>
<td>No PA outcome measure, less than 6 months follow-up</td>
</tr>
<tr>
<td>2012</td>
<td>Brosseau(33)</td>
<td>The impact of a community-based aerobic walking program for older individuals with mild to moderate knee osteoarthritis: A knowledge translation randomized controlled trial. Part 1: The Uptake of the Ottawa Panel clinical practice guidelines (CPGs).</td>
<td>Physical activity data presented in Brosseau Part II. This paper presents behavioural constructs of trial</td>
</tr>
<tr>
<td>2012</td>
<td>Bruce-Brand(34)</td>
<td>Effects of home-based resistance training and neuromuscular electrical stimulation in knee osteoarthritis: a randomized controlled trial</td>
<td>No PA outcome measure, Less than 6 months follow-up</td>
</tr>
<tr>
<td>2006</td>
<td>Bruno(35)</td>
<td>Effectiveness of two Arthritis Foundation programs: Walk with Ease and You Can Break the Pain Cycle</td>
<td>Non-randomised, no measure of PA, less than 6 months follow-up</td>
</tr>
<tr>
<td>Year</td>
<td>Author(s)</td>
<td>Title</td>
<td>Notes</td>
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</tr>
<tr>
<td>2006</td>
<td>Buszewicz(36)</td>
<td>Self-management of arthritis in primary care: randomised controlled trial</td>
<td>No PA outcome measure</td>
</tr>
<tr>
<td>1995</td>
<td>Callaghan(37)</td>
<td>An evaluation of exercise regimes for patients with osteoarthritis of the knee: a single-blind randomised control trial</td>
<td>No PA outcome measure, less than 6 months follow-up</td>
</tr>
<tr>
<td>2014</td>
<td>Callahan(38)</td>
<td>Evaluation of active living every day in adults with arthritis</td>
<td>Population inclusive of any type of arthritis or joint pain</td>
</tr>
<tr>
<td>2008</td>
<td>Callahan(39)</td>
<td>A randomised controlled trial of the People with Arthritis Can Exercise Program: Symptoms, function, physical activity, and psychosocial outcome</td>
<td>Self-reported diagnosis with no physician clarification. Insufficient data as RA and OA data presented together</td>
</tr>
<tr>
<td>2012</td>
<td>Christensen(40)</td>
<td>Comparison of Three Different Weight Maintenance Programs on Cardiovascular Risk, Bone, and Vitamins in Sedentary Older Adults (CAROT Study)</td>
<td>Primary focus was weight loss with all participants being initiated on either low or very low energy Cambridge Formula Diets with no control. Then supplemented diets were stopped and participants randomised to exercise, weight maintenance or usual care. Lacks suitable control</td>
</tr>
<tr>
<td>2008</td>
<td>Chua(41)</td>
<td>Effects of an exercise and dietary intervention on serum biomarkers in overweight and obese adults with osteoarthritis of the knee</td>
<td>Secondary analysis of the ADAPT study. Messier et al</td>
</tr>
<tr>
<td>2012</td>
<td>Coleman(42)</td>
<td>A randomised controlled trial of a self-management education program for osteoarthritis of the knee delivered by health care professionals</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>2000</td>
<td>Deyle(44)</td>
<td>Effectiveness of Manual Physical Therapy and Exercise in Osteoarthritis of the Knee</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>2003</td>
<td>Dias(45)</td>
<td>Impact of an exercise and walking protocol on quality of life for elderly people with OA of the knee</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>2004</td>
<td>Eyigor(46)</td>
<td>A comparison of muscle training methods in patients with knee osteoarthritis</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
</tr>
<tr>
<td>2012</td>
<td>Feinglass(47)</td>
<td>Association of Functional Status with Changes in Physical Activity: Insights from a behavioral intervention for participants with Arthritis</td>
<td>Insufficient Data. Recruited both RA and OA patients. Authors unable to separate data</td>
</tr>
</tbody>
</table>

2005 Focht(50) Exercise, Self-Efficacy, and Mobility Performance in Overweight and Obese Older Adults with Knee Osteoarthritis No PA outcome measures

2012 Focht(51) Improving maintenance of physical activity in older, knee osteoarthritis patients trial-pilot (IMPACT-P): Design and Methods Protocol

2003 Foley(52) Does hydrotherapy improve strength and physical function in patients with osteoarthritis - a randomised controlled trial comparing a gym based and a hydrotherapy based strengthening program Less than 6 months Follow-up

2013 Foster(53) Management of primary care for people with knee osteoarthritis: The beep study (best evidence for exercise in knee pain) No results presented discussion of recruitment phase

2007 Foster(54) Acupuncture as an adjunct to exercise based physiotherapy for osteoarthritis of the knee: randomised control trial No PA outcome measures

2001 Fransen(55) Physical therapy is effective for patients with osteoarthritis of the knee: a randomized controlled trial. No PA outcome measures, less than 6 months follow-up

2007 Fransen(56) The Physical Activity for Osteoarthritis Management (PAFORM) study. A randomised controlled clinical trial evaluating hydrotherapy and Tai Chi classes No PA outcome measures

2010 Freburger(57) The effects of a physical activity program on sleep and health related quality of life in older persons with arthritis Secondary analysis of PACE study Callahan et al


2013 French(59) Exercise and Manual Physiotherapy Arthritis Research Trial (EMPART) for OA of the Hip: A multicentre Randomized Control Trial Less than 6 month follow-up. IPAQ results not reported in main study

1997 Fries(60) Patient Education in arthritis: randomized controlled trial of a mail-delivered program RA and OA population. Insufficient PA data

2009 Goeppinger(61) Mail-Delivered Arthritis Self-Management Tool Kit: A Randomized Trial and Longitudinal Follow-up RA and OA population. Insufficient PA data on outcomes of OA participants, no separation of data.

2012 Gudbergsen(62) Weight loss is effective for symptomatic relief in obese subjects with knee osteoarthritis independently of joint damage severity assessed by high-field MRI and radiography No PA outcome measures reported, less than 6 months follow-up. Presenting data from CAROT Study.
<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Study Title</th>
<th>Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Gur(63)</td>
<td>Concentric versus combined concentric-eccentric isokinetic training: effects on functional capacity and symptoms in patients with osteoarthrosis of the knee.</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
</tr>
<tr>
<td>2001</td>
<td>Halbert(64)</td>
<td>Primary Care–Based Physical Activity Programs: Effectiveness in Sedentary Older Patients With Osteoarthritis Symptoms</td>
<td>Nested study within general practice brief advice study, retrospective analysis of those reporting OA symptoms randomised to intervention.</td>
</tr>
<tr>
<td>2000</td>
<td>Hartman(65)</td>
<td>Effects of T'ai Chi Training on function and quality of life indicators in older adults with Osteoarthritis</td>
<td>No measure of PA, less than 6 months follow-up</td>
</tr>
<tr>
<td>2006</td>
<td>Hay(66)</td>
<td>Effectiveness of community physiotherapy and enhanced pharmacy review for knee pain in people aged over 55 presenting to primary care: pragmatic randomised trial.</td>
<td>No PA outcome measures. Group defined by knee pain, not exclusively OA.</td>
</tr>
<tr>
<td>2012</td>
<td>Henriksen(67)</td>
<td>Cartilage loss during symptomatic maintenance after a clinically significant weight loss in obese osteoarthrosis patients: A randomized controlled trial</td>
<td>No PA outcome measures reported. Presenting data from CAROT Study</td>
</tr>
<tr>
<td>2014</td>
<td>Henriksen(68)</td>
<td>Structural changes in the knee during weight loss maintenance after a significant weight loss in obese patients with osteoarthritis: A report of secondary outcome analyses from a randomized controlled trial</td>
<td>No PA outcome measures reported. Reporting data from CAROT Study</td>
</tr>
<tr>
<td>2007</td>
<td>Hinman(70)</td>
<td>Aquatic Physical Therapy for Hip and Knee Osteoarthritis: Results of a Single Blind Randomised Control Trial</td>
<td>Less than 6 months follow-up</td>
</tr>
<tr>
<td>2012</td>
<td>Hiyama(71)</td>
<td>A four-week walking exercise programme in patients with knee osteoarthritis improves the ability of dual-task performance: a randomized controlled trial</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
</tr>
<tr>
<td>2000</td>
<td>Hopman-Rock(73)</td>
<td>The effects of a health educational and exercise program for older adults with osteoarthritis of the hip or knee.</td>
<td>Less than 6 months follow-up</td>
</tr>
<tr>
<td>2003</td>
<td>Huang(74)</td>
<td>A comparison of various therapeutic exercises on the functional status of patients with knee osteoarthritis</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>2005</td>
<td>Huang(75)</td>
<td>Preliminary results of integrated therapy for patients with knee osteoarthritis. Arthritis Care and Research</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>2004</td>
<td>Hughes(76)</td>
<td>Impact of the Fit and Strong Intervention on Older Adults With Osteoarthritis</td>
<td>Preliminary data. Hughes et al 2006 main study, trial included</td>
</tr>
<tr>
<td>2010</td>
<td>Hughes(77)</td>
<td>Fit and Strong! Bolstering maintenance of physical activity among older adults with lower-extremity osteoarthritis.</td>
<td>Non-randomised comparative effectiveness</td>
</tr>
<tr>
<td>2012</td>
<td>Hurley(78)</td>
<td>Sustained improvement physical function following an integrated rehabilitation programme for chronic knee pain</td>
<td>No PA outcome measures</td>
</tr>
</tbody>
</table>
2004 Keefe(79)  Effects of spouse-assisted coping skills training and exercise training in patients with osteoarthritic knee pain: a randomized controlled study.  Less than 6 months follow-up

2012 Knoop(80)  Knee joint stabilization therapy in patients with osteoarthritis of the knee: A randomized, controlled trial  No PA outcome measures STABILITY study NTR1475

2012 Knoop(81)  Biomechanical factors and physical examination findings in osteoarthritis of the knee: associations with tissue abnormalities assessed by conventional radiography and high-resolution 3.0 Tesla magnetic resonance imaging  Cross Sectional Study

2014 Knoop(82)  Importance of adherence in outcome of exercise therapy in patients with knee osteoarthritis  No PA outcome measures STABILITY study

2014 Knoop(83)  Is the severity of knee osteoarthritis on magnetic resonance imaging associated with outcome of exercise therapy?  No PA outcome measures STABILITY study NTR1475

2013 Knoop(84)  Biomechanical mechanisms underlying treatment effects of exercise therapy in patients with knee osteoarthritis: Data from a randomized controlled trial  No PA outcome measures STABILITY study NTR1475

2014 Knoop(85)  Knee joint stabilization therapy in patients with osteoarthritis of the knee and knee instability: Subgroup analyses in a randomized, controlled trial  No PA outcome measures STABILITY study NTR1475

2013 Kou(86)  Long-term effects of video-based home exercise on clinical and radiographic outcomes in subject with knee osteoarthritis: A two year randomised control trial  Follow-up of Tohyama et al Insufficient Data. No PA outcome measures

1992 Kovar(87)  Supervised fitness walking in patients with osteoarthritis of the knee. A randomized, controlled trial.  Less than 6 months follow-up no measure of PA at baseline

2013 Kudo(88)  Analysis of effectiveness of therapeutic exercise for knee osteoarthritis and possible factors affecting outcome  No PA outcomes measures

2013 Li(89)  Capitalizing on the Teachable Moment: Osteoarthritis Physical Activity and Exercise Net for Improving Physical Activity in Early Knee Osteoarthritis  Protocol

2004 Lin(90)  Community rehabilitation for older adults with osteoarthritis of the lower limb: a control clinical trial  No PA outcome measures

2009 Lin(91)  Efficacy of 2 non-weight bearing interventions, proprioception training versus strength training, for patients with knee Osteoarthritis: A randomised control trial  No PA outcome measures, less than 6 months follow-up

1985 Lorig(92)  Outcomes of self-help education for patients with arthritis RA and OA population. Insufficient PA data on outcomes of OA participants, no separation of data.

1999 Lorig(94) Community-Based Spanish Language Arthritis Education Progam: A Randomised Trial RA and OA population. Insufficient PA data on outcomes of OA participants, no separation of data.

2004 Lorig(95) Long-term Randomization Controlled Trials of Tailor Printed and Small Group Arthritis Self-Management Interventions RA and OA population. Insufficient PA data on outcomes of OA participants, no separation of data.

2006 Mangani(96) Physical exercise and comorbidity. Results from the Fitness and Arthritis in Seniors Trial (FAST) Secondary analysis of Ettinger 1997

2012 Marra(97) Pharmacist-Initiated Intervention Trial in Osteoarthritis: A Multidisciplinary Intervention for Knee Osteoarthritis No PA outcome measures

2014 Matei(98) The place of kinetotherapy in rehabilitation program of knee osteoarthrosis patients No PA outcome measures

1999 Maurer(99) Osteoarthritis of the knee: isokinetic quadriceps exercise versus an educational intervention. No PA outcome measures, less than 6 months follow-up

2004 McCarthy(100) Supplementing a home exercise programme with a class-based exercise programme is more effective than home exercise alone in treatment of knee osteoarthritis No validated measure of PA or measure of PA at baseline.

2013 Messier(101) Effects of intensive diet and exercise on knee joint loads, inflammation, and clinical outcomes among overweight and obese adults with knee osteoarthritis: the IDEA randomized clinical trial No PA outcome measures

2013 Messier(102) Strength training for arthritis trial (START): Design and rationale Protocol

2000 Messier(103) Exercise and weight loss in obese older adults with knee osteoarthritis: a preliminary study Weight loss intervention. No PA outcome measures


2004 Messier(105) Exercise and Dietary Weight Loss in Overweight and Obese Older Adults With Knee Osteoarthritis The Arthritis, Diet, and Activity Promotion Trial No PA outcome measures

2013 Mielenz(106) Association of self-efficacy and outcome expectations with physical activity in adults with arthritis RA and OA population 3-months follow up only Rheumatoid Arthritis Population

2011 Mielenz(107) Item-response-theory analysis of two scales for self-efficacy for exercise behavior in people with arthritis No PA outcome measures

2006 Mikesky(108) Effects of strength training on the incidence and progression of knee osteoarthritis.

2012 Miller(109) Basal growth hormone concentration increased following a weight loss focused dietary intervention in older overweight and obese women No PA outcome measures
<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Title</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>Minor(110)</td>
<td>Efficacy of physical conditioning exercise in patients with rheumatoid arthritis and osteoarthritis</td>
<td>Insufficient data. RA and OA data collapsed into single analysis beyond 12 weeks. No separation of follow-up data at 9 months</td>
</tr>
<tr>
<td>2012</td>
<td>Neogi(111)</td>
<td>Role of non-operative treatment in managing degenerative tears of the medial meniscus posterior root</td>
<td>No control arm, not RCT</td>
</tr>
<tr>
<td>2010</td>
<td>Ng(112)</td>
<td>Efficacy of a progressive walking program and glucosamine sulphate supplementation on osteoarthritis symptoms of the hip and knee: feasibility trial</td>
<td>Attrition greater than 20% and analysis completed as a per protocol basis, with non-completers excluded from all analysis.</td>
</tr>
<tr>
<td>2010</td>
<td>Ni(113)</td>
<td>Tai Chi Improves Physical Function of Older Chinese Women with Knee OA</td>
<td>No PA outcome measure</td>
</tr>
<tr>
<td>2014</td>
<td>Nielsen(115)</td>
<td>Physical therapist-delivered cognitive-behavioral therapy: a qualitative study of physical therapists’ perceptions and experiences</td>
<td>Qualitative study referring to studies discussed by Bennell et al.</td>
</tr>
<tr>
<td>1999</td>
<td>O’Reilly(116)</td>
<td>Effectiveness of home exercise on pain and disability from osteoarthritis of the knee: a randomised controlled trial.</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>2007</td>
<td>Osborne(117)</td>
<td>Does self-management lead to sustainable health benefits in people with arthritis? A 2 year transition study in 452 Australians</td>
<td>Non randomised trial with no separation of OA and RA data</td>
</tr>
<tr>
<td>2001</td>
<td>Patrick(118)</td>
<td>Economic Evaluation of Aquatic Exercise for Persons with Osteoarthritis</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
</tr>
<tr>
<td>1999</td>
<td>Peloquin(119)</td>
<td>Effects of a Cross-Training Exercise Program in Persons with Osteoarthritis of the Knee A Randomised Controlled Trial</td>
<td>No PA outcome measures. Less than 6 months follow-up</td>
</tr>
<tr>
<td>1993</td>
<td>Peterson(122)</td>
<td>Effect of a Walking Program on Gait Characteristics in Patients with Osteoarthritis</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
</tr>
<tr>
<td>2000</td>
<td>Petrella(123)</td>
<td>Home based exercise therapy for older patients with knee osteoarthritis: a randomized clinical trial.</td>
<td>Less than 6 months follow-up</td>
</tr>
<tr>
<td>2014</td>
<td>Peungsuwan(124)</td>
<td>The Effectiveness of Thai Exercise with Traditional Massage on the Pain, Walking Ability and QOL of Older People with Knee Osteoarthritis: A Randomized Controlled Trial in the Community</td>
<td>No PA outcome measures</td>
</tr>
<tr>
<td>Year</td>
<td>Author(s)</td>
<td>Title</td>
<td>Study Type</td>
</tr>
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<tr>
<td>2010</td>
<td>Pisters(125)</td>
<td>Behavioural graded activity results in better exercise adherence and more physical activity than usual care in people with osteoarthritis: a cluster-randomised trial</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Poulsen(126)</td>
<td>Patient education with or without manual therapy compared to a control group in patients with osteoarthritis of the hip. A proof-of-principle three-arm parallel group randomized clinical trial</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>Quilty(127)</td>
<td>Physiotherapy, including quadriceps exercises and patellar taping, for knee osteoarthritis with predominant patello-femoral joint involvement: randomized controlled trial</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>Rahela(128)</td>
<td>Efficacy of physical exercise in patients with knee osteoarthritis</td>
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<td>2004</td>
<td>Ravaud(129)</td>
<td>Management of osteoarthritis (OA) with an unsupervised home based exercise programme and/or patient administered assessment tools. A cluster randomised controlled trial.</td>
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<td>2014</td>
<td>Rezende(131)</td>
<td>BMI and education in knee osteoarthritis</td>
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<td>2014</td>
<td>Rezende(132)</td>
<td>Parqve-project arthritis recovering quality of life by means of education. One year follow-up. Effects on pain, function, BMI and quality of life of the educational program, coping skills and level of education</td>
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<td>2013</td>
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<td>Parqve A- project arthritis recovering quality of lifeby means of education A- a pilot study in brazil</td>
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<td>1986</td>
<td>Rippey(134)</td>
<td>Computer-Based Patient Education for Older Persons with Osteoarthritis</td>
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<td>1998</td>
<td>Rogind(135)</td>
<td>The effects of a physical training program on patients with osteoarthritis of the knees</td>
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<td>1996</td>
<td>Schilke(136)</td>
<td>Effects of muscle-strength training on the functional status of patients with osteoarthritis of the knee joint.</td>
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<td>2012</td>
<td>Schlenk(137)</td>
<td>Integration of a healthy aging program into the arthritis foundation exercise program: Six-month results</td>
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<td>2009</td>
<td>Sevick(139)</td>
<td>Cost effectiveness of exercise and diet in overweight and obese adults with knee osteoarthritis</td>
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<td>2009</td>
<td>Seymour(140)</td>
<td>Comparison of Two Methods of Conducting Fit and Strong!</td>
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<td>2007</td>
<td>Silva(141)</td>
<td>Hydrotherapy Versus Conventional Land-Based Exercise for the management of patients with OA of the Knee: A Randomised Clinical Trial</td>
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<td>Skou(142)</td>
<td>Efficacy of multimodal, systematic non-surgical treatment of knee osteoarthritis for patients not eligible for a total knee replacement: A study protocol of a randomised controlled trial</td>
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<td>Smith-ray(143)</td>
<td>Fit and Strong! Plus: design of a comparative effectiveness evaluation of a weight management program for older adults with osteoarthritis</td>
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<td>Somers(144)</td>
<td>Pain coping skills training and lifestyle behavioral weight management in patients with knee osteoarthritis: a randomized controlled study</td>
<td>No PA outcome measures</td>
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<td>2003</td>
<td>Song(145)</td>
<td>Effects of Tai Chi exercise on pain, balance, muscle strength, and perceived difficulties in physical functioning in older women with osteoarthritis: a randomized clinical trial.</td>
<td>Attrition greater than 40%, no intention to treat, less than 6 months follow-up</td>
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<tr>
<td>2014</td>
<td>Sperber(146)</td>
<td>The role of symptoms and self-efficacy in predicting physical activity change among older adults with arthritis</td>
<td>Less than 6 months follow-up, secondary analysis previous presented data.</td>
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<td>2013</td>
<td>Sperber(147)</td>
<td>Differences in effectiveness of the active living every day program for older adults with arthritis</td>
<td>No PA outcome measures</td>
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<td>2013</td>
<td>Sperber(148)</td>
<td>Differences in osteoarthritis self-management support intervention outcomes according to race and health literacy Comparison Between Electro-Acupuncture and Hydrotherapy, Both in Combination with Patient Education and Patient Education alone, on the symptomatic treatment of OA of the Hip</td>
<td>No PA outcome measures</td>
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<td>1998</td>
<td>Sullivan(150)</td>
<td>One-Year Follow-up of Patients with Osteoarthritis of the Knee who Participated in a Program of Supervised Fitness Walking and Supportive Patient Education</td>
<td>No validated measure of PA or measure of PA at baseline.</td>
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<td>Tak(152)</td>
<td>The Effects of an Exercise Program for Older Adults with Osteoarthritis of the Hip</td>
<td>No measure of PA, less than 6 months follow-up</td>
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<td>2011</td>
<td>Teixeira(153)</td>
<td>Effects of impairment-based exercise on performance of specific self-reported functional tasks in individuals with knee osteoarthritis</td>
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<td>Thomas(154)</td>
<td>Home based exercise programme for knee pain and knee osteoarthritis: randomised controlled trial</td>
<td>No PA outcome measures</td>
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<td>2010</td>
<td>Tohyama(155)</td>
<td>Effectiveness of video-based home exercise for osteoarthritis of the knee: a randomised control trial</td>
<td>Insufficient Data. No measure of physical activity</td>
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<td>2002</td>
<td>Topp(156)</td>
<td>The effect of dynamic versus isometric resistance training on pain and functioning among adults with osteoarthritis of the knee</td>
<td>No measure of PA, less than 6 months follow-up</td>
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<td>1998</td>
<td>Van Baar(157)</td>
<td>The effectiveness of exercise therapy in patients with osteoarthritis of the hip or knee: a randomized clinical trial.</td>
<td>No measure of PA, less than 6 months follow-up</td>
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<td>Year</td>
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<td>2001</td>
<td>Van Baar(158)</td>
<td>Effectiveness of exercise in patients with osteoarthritis of hip and knee: nine months follow-up</td>
<td>Secondary analysis of Van Baar 2001 presenting insufficient physical activity data. Groups dichotomised into improved or reduce activity based on increase of 1min/week of physical activity.</td>
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<td>2005</td>
<td>Van Gool(159)</td>
<td>Effects of Exercise Adherence on Physical Function Among Overweight Older Adults with Knee Osteoarthritis</td>
<td>No PA outcome measure</td>
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<td>2006</td>
<td>Veenhof(160)</td>
<td>Effectiveness of Behavioral Graded Activity in Patients With Osteoarthritis of the Hip and/or Knee: A Randomized Clinical Trial</td>
<td>Lack of appropriate control. Both groups received similar physiotherapy treatments. Both groups received up to 18 sessions with a physical therapist in a 12 week periods. The intervention groups had up to a further 8 sessions between weeks 18 and 55</td>
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<td>2012</td>
<td>Walsh(161)</td>
<td>Exercise and self-management for people with chronic knee, hip or lower back pain: a cluster randomised controlled trial of clinical and cost-effectiveness. Study protocol</td>
<td>Protocol only</td>
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<td>2013</td>
<td>Wang(162)</td>
<td>Effects of tai chi program on neuromuscular function for patients with knee osteoarthritis: Study protocol for a randomized controlled trial</td>
<td>Protocol No PA outcomes</td>
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<td>2006</td>
<td>Wang(163)</td>
<td>Effects of aquatic exercise on flexibility, strength and aerobic fitness in adults with osteoarthritis of the hip and knee</td>
<td>Less than 6 months follow-up</td>
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<td>2009</td>
<td>Wang(164)</td>
<td>Tai Chi is Effective in Treating Knee Osteoarthritis: A Randomised Control Trial</td>
<td>No PA outcome measures.</td>
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<td>2009</td>
<td>Weng(165)</td>
<td>Effects of Different Stretching Techniques on the Outcomes of Isokinetic Exercise in Patients with Knee Osteoarthritis</td>
<td>No PA outcome measures.</td>
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<td>2001</td>
<td>Wyatt(166)</td>
<td>The effects of aquatic and traditional exercise programs on persons with knee osteoarthritis</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
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<td>2013</td>
<td>Yazigi(167)</td>
<td>The PICO project: aquatic exercise for knee osteoarthritis in overweight and obese individuals</td>
<td>Protocol, no results</td>
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<td>2010</td>
<td>Yennan(168)</td>
<td>Effects of aquatic exercise and land-based exercise on postural sway in elderly with knee osteoarthritis</td>
<td>No PA outcome measures, less than 6 months follow-up</td>
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References


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<tr>
<th>Author (Year)</th>
<th>Intervention and Control</th>
<th>Content and Strategies</th>
<th>No of Participants</th>
<th>Age (Years)</th>
<th>Gender Distribution (% Female)</th>
<th>Ethnic Demographic (% White)</th>
<th>Intervention Duration</th>
<th>Outcome measure</th>
<th>Follow-up Duration</th>
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<tr>
<td>Brosseau (2012)</td>
<td>Walking and Behavioural intervention (20x2hr sessions over 20 weeks) which included the supervised community-based aerobic walking program 3 x 1 hour weekly walking groups for 12 months. Compared to walking group/educational pamphlet (walking group) and educational pamphlet alone (self-directed group)</td>
<td>Program for Arthritis Control Through Education and Exercise (PACEex). PA education. Barriers identification. Symptom self-management, problem solving, goal setting and self-monitoring.</td>
<td>222</td>
<td>63.4</td>
<td>68.9</td>
<td>88.7</td>
<td>12 months</td>
<td>Self-Report Seven Day Physical Activity Recall (7-day PAR)</td>
<td>18 months</td>
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<td>Ettinger (1997)</td>
<td>Supervised Resistance Exercise 1 hour x 3 per week for 3 months followed by personalised exercise programme facilitated by 4 home visits and 6 telephone calls. Supervised Aerobic Exercise 1 hour x 3 per week for 3 months followed by personalised exercise programme facilitated by 4 home visits and 6 telephone calls, months 4-6 followed by monthly calls 7-18 months. Health education was the comparison group consisting of monthly group education, 90 minutes for 3 months followed by biweekly (3-6 months) then monthly (7-18 month) nurse telephone calls discussing arthritis, general health and medications.</td>
<td>No behaviour theory discussed</td>
<td>439</td>
<td>68.7</td>
<td>69</td>
<td>75</td>
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<td>Cardiovascular Fitness PeakVO2</td>
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<td>Study</td>
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<td>Farr (2010)</td>
<td>Self-Management Class and Resistance Training Compared to Resistance training alone and Self-Management Alone. 36 weeks of contact during self-management component. 12 weeks face to face. Resistance training included 3 sessions per week for 9 months (36 weeks)</td>
<td>9 months</td>
<td>254</td>
<td>No detail</td>
<td>9 months</td>
<td>Accelerometer</td>
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<td>Hughes (2006)</td>
<td>90 minutes education and exercise 3 times per week for 8 weeks. Control provided with copy of arthritis self-help book and list of exercise programmes in community.</td>
<td>8 weeks</td>
<td>215</td>
<td>73.3</td>
<td>8 weeks</td>
<td>Self-Reported Activities</td>
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<td></td>
<td>Bundura named theory. Problem Solving, goal setting, self-monitoring. Development of personal exercise plan followed constructs of motivational interviewing and promotion of autonomy</td>
<td></td>
<td></td>
<td>80.6</td>
<td>69.4</td>
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<tr>
<td>Lorig (2008)</td>
<td>Online Arthritis Self-Management Programme. Control usual care. Intervention ran for 6 weeks participants were encouraged to log on weekly and attend workshops on average participants accessed the site 31 times over 3 weeks. Control group received usual care.</td>
<td>6 weeks</td>
<td>292</td>
<td>52.3</td>
<td>89.8</td>
<td>12 months</td>
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<td></td>
<td>Arthritis Self-Management Programme – Bundura named theory Online environment provided a bulletin board, structured educational resources, self-monitoring tools and training to develop self-management strategies and coping skills including relaxation, visualisation, distraction and self-talk.</td>
<td></td>
<td></td>
<td>90.9</td>
<td>6 weeks</td>
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<td>Murphy (2008)</td>
<td>Occupational Therapy lead Activity Strategy Training inclusive of resistance exercises and home exercise programme (90 minutes x 8 over 4 weeks, 2 follow-up sessions) comparison group received resistance training and health education</td>
<td>No named theory Targeting self-management and self-efficacy, AST included symptom management, activity pacing, addressing individual barriers and environment specific discussions during home visit.</td>
<td>54</td>
<td>75.3</td>
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<td>89</td>
<td>6 months</td>
<td>Champs Self Report and Accelerometer</td>
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<td>Rosemann (2007)</td>
<td>Intervention Target professional education. General Practitioners were educated in the EULAR recommendations for OA management. GP's were encouraged to discuss coping strategies with patients. GP's were provided with ASMP CD's and Exercise Advice Pamphlets to provide every included patient. Group 1 received only GP support. Group 2 received GP support and nurse case management which included being able to expedite GP review, nurses discussed adherence to PA recommendations. Group 3 standard care.</td>
<td>Arthritis Self-Management Programme - self efficacy and coping skills</td>
<td>1021</td>
<td>66.1</td>
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<td>6 month</td>
<td>Self-Report Questionnaire IPAQ</td>
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<td>Schlenk (2011)</td>
<td>Self-Efficacy Staying Active with Arthritis. 6 weekly in person sessions followed by 9 biweekly telephone conversations. Control received usual care.</td>
<td>Self-efficacy based Staying Active with Arthritis (STAR) Arthritis Self-Management Programme, Bundura named theory. Strategies included increasing risk awareness, physical activity education, goal setting, behaviour modelling, social persuasion, self-monitoring, feedback</td>
<td>26</td>
<td>63.2</td>
<td>96</td>
<td>83</td>
<td>15 weeks</td>
<td>Self-Report. Walking Diary</td>
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IPAQ: International Physical Activity Questionnaire
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<th>Details</th>
<th>Outcome Measures</th>
<th>Duration</th>
<th>Methodology</th>
<th>Time Period</th>
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<tr>
<td>Svege (2013)</td>
<td>Hip School consisting of 3 group sessions (3 x 1hr) and 1 physiotherapy sessions at 2 months. Intervention Group received hip school plus 12 weeks of supervised exercise with offer of 2 sessions per week. (control hip school only)</td>
<td>Hip school included disease education and self-management strategies, exercise target of 30 mins MVPA per day. Pain education and management. Theoretical frameworks, Bandura social cognitive theory, coping theory and learned helplessness.</td>
<td>109</td>
<td>57.8</td>
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<td>Talbot (2003)</td>
<td>Arthritis Education Programme 1hr per week plus pedometer. Comparison group was education alone</td>
<td>Arthritis Self-Management Programme - Bandura</td>
<td>40</td>
<td>70.2</td>
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<td>Thorstensson (2005)</td>
<td>6 week intervention, 2 x 60 mins supervised plus daily home resistance exercise and 30 minutes walking per day. Control usual care consisting of 3 session in 6 months with physical therapist.</td>
<td>No behaviour theory discussed</td>
<td>69</td>
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## Appendix 3

### Risk of Bias and Quality Assessment of Included Trials

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<tr>
<th>Paper</th>
<th>Allocation Sequence Generation</th>
<th>Allocation Concealment</th>
<th>Incomplete Outcome Data</th>
<th>Selective Outcome Reporting</th>
<th>Comparable Groups at Base-Line</th>
<th>Contamination Between Groups</th>
<th>Validated Outcome Measures</th>
<th>Outcome Measures Applied Appropriately</th>
<th>Final Analysis Adjusted for Baseline Physical Activity</th>
<th>Outcome assessment independent and Blinded</th>
<th>Intention To Treat</th>
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Supplement 4

Behavioural Physical Activity Interventions in Participants with Lower-limb Osteoarthritis: A Systematic Review with Meta-analysis

Literature Search strategies


MEDLINE (Ovid)

1 exp Exertion/

2 Physical fitness/

3 exp “Physical education and training”/

4 exp Sports/

5 exp Dancing/

6 exp Exercise therapy/

7 (physical$ adj5 (fit$ or train$ or activ$ or endur$)).tw.

8 (exercis$ adj5 (train$ or physical$ or activ$)).tw.

9 sport$.tw.

10 walk$.tw.

11 bicycle$.tw.

12 (exercise$ adj aerobic$).tw.

13 (“lifestyle” or life-style) adj5 activ$.tw.

14 (“lifestyle” or life-style) adj5 physical$.tw.

15 or/1-14

16 Health education/

17 Patient education/

18 Primary prevention/

19 Health promotion/

20 Behaviour therapy

21 Cognitive therapy

22 Primary health care
23 Workplace/
24 promot$.tw.
25 educat$.tw.
26 program$.tw.
27 or/16-26
28 15 and 27

RCT filter (Dickersin 1995)

EMBASE
1.(((health-education) or (health-education-research)) or ((patient-education) or (patient-education-and-counseling)) or (healthpromotion) or (health-promotion-international)) or (primary-health-care) or ((workplace) or (workplace-)) or (promot*) or ((promot*) or ((educat*) or ((program*) and (((exertion) or (fitness) or (fitness-) or (fitness) or (fitness-) or (exercise) or (exercise) or (sport) or (walk*)))

2.((research) or (((((random-controlled) or (random-sample) or (randomisation) or (randomised) or (randomisation-) or (randomized) or (randomize) or (randomized) or (randomized-block) or (randomized-controlled) or (randomized-controlled-trial) or (randomized-control)) or ((double-blind) or (double-blind-procedure)) or ((single-blind) or (singleblind-procedure))) and (ec=human)) or (clinical) or (clin*) or (trial*) or (((clin* near trial*) in ti) and (ec=human)) or (clint*) or (trial*) or (((clin* near trial*) in ab) and (ec=human)) or (sing*) or (doub*) or (trebl*) or (tripl*) or (blind*) or (mask*) or (((sing* or doubl* or trebl* or tripl*) near (blind* or mask*)) and (ec=human)) or (((placebos) or (placebo-controlled)) or (placebo*) in ti) and (ec=human)) or (random* in ti) and (ec=human)) or (random in ab) and (ec=human)) or (research)) ec=human)

3.(((studies) or (prospective-study) or (follow-up) or (comparative) or (evaluation)) and (ec=human))

CINAHL
1.exact{controlled}
2.exact{randomized}
3.exact{random-assignment}
4.exact{double-blind}
5.exact{single-blind}
6.#1 or #2 or #3 or #4 or #5
7.exact{animal}
8.exact{human}
9.#6 not #7
10. exact{clinical}
11. (clin* near trial*) in ti
12. (clin* near trial*) in ab
13. (singl* or doubl* or trebl* or tripl*) near (blind* or mask*)
14. (#13 in ti) or (#13 in ab)
15. placebos
16. placebo* in ti
17. placebo* in ab
18. random* in ti
19. random* in ab
20. exact{research-methodology}
21. #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17
22. #18 or #19 or #20
23. #21 or #22
24. animal
25. human
26. #23 not #24
27. #26 or #9 or #8 or #25
28. exact{comparative}
29. study
30. #28 and #29
31. exact{evaluation}
32. studies
33. #31 and #32
34. exact{follow-up}
35. exact{prosective}
36. #35 and #32
37. control* or prosepctiv* or volunteer*
38. (#37 in ti) or (#37 in ab)
40. #39 not #24

41. #39 or #27 or #9

42. explode “exertion”/”/ all subheadings

43. “physical fitness”

44. explode “physical education and training”/ all subheadings

45. explode “sports”/ all subheadings

46. explode “dancing”/ all subheadings

47. explode “exercise therapy”/ all subheadings

48. (physical$ adj5 (fit$ or train$ or activ$ or endur$)).tw.

49. (exercise$ adj5 (train$ or physical$ or activ$)).tw.

50. sport$.tw.

51. walk$.tw.

52. bicycle$.tw

53. (exercise$ adj aerobic$).tw.

54. (”lifestyle” or life-style) adj5 activ$.tw.

55. (”lifestyle” or life-style) adj5 physical$.tw.

56. #42 or #43 or #44 or #46 or #47 or #48 or #49 or (exercise$) or (aerobic$) or (”lifestyle”) or (activ$) or (”lifestyle”) or (lifestyle)

or (physical$)

57. health education

58. patient education

59. primary prevention

60. health promotion

61. behaviour therapy

62. cognitive therapy

63. primary health care

64. workplace

65. promot$.tw.

66. educat$.tw.
PsycLIT

1. exertion
2. physical-fitness
3. exercise
4. explode exercise
5. sport
6. walk*
7. cycle
8. #1 or #2 or #3 or #4 or #5 or #6 or #7
9. health education
10. patient education
11. primary prevention
12. health promotion
13. behaviour therapy
14. cognitive therapy
15. primary health care
16. workplace
17. promot$.tw.
18. educat$.tw.
19. program$.tw.
20. #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19
21. #8 and #20
22. controlled
23. randomized
random-assignment

double-blind

single-blind

#22 or #23 or #24 or #25 or #26

animal

human

#27 not #28

clinical

(clin* near trial*) in ti

(clin* near trial*) in ab

(singl* or doubl* or trebl* or tripl*) near (blind* or mask*)

(#34 in ti) or (#34 in ab)

placebos

placebo* in ti

placebo* in ab

random* in ti

random* in ab

research-methodology

(placebos)

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53. studies
54. #52 and #53
55. follow-up
56. prospective
57. #56 and #53
58. control* or prospective* or volunteer*
59. (#58 in ti) or (#58 in ab)
60. #59 or #57 or #54 or #51
61. #60 not #45
62. #60 or #48 or #30
63. #62 and #21

**SPORTDISCUS**

1. ‘physical activity’
2. exercise
3. fitness
4. sedentary
5. housebound
6. aerobics or circuits or swimming or aqua or jogging or running or cycling or fitness or yoga or walking or sport
7. patient education
8. primary prevention
9. health promotion
10. behaviour therapy
11. cognitive therapy
12. primary health care
13. workplace
14. controlled
15. randomized
16. random-assignment
17. double-blind
18. single-blind
19. clinical
20. placebos
21. comparative
22. evaluation
23. study

SIGLE

1. explode “Exertion/”/ all subheadings
2. “Physical fitness”
3. explode “Physical education and training”/ all subheadings
4. explode “Sports”/ all subheadings
5. explode “Dancing”/ all subheadings
6. explode “Exercise therapy”/ all subheadings
7. (physical$ adj5 (fit$ or train$ or activ$ or endur$)).tw.
8. (exercise$ adj5 (train$ or physical$ or activ$)).tw.
9. sport$.tw.
10. walk$.tw.
11. bicycle$.tw.
13. ((“lifestyle” or life-style) adj5 activ$).tw.
14. ((“lifestyle” or life-style) adj5 physical$).tw.
15. #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or (exercise$) or (aerobic$) or (“lifestyle”) or (activ$) or (“lifestyle”) or (life-style) or (physical$)
16. Health Education
17. Patient education
18. Primary prevention
19. Health promotion
20. Behaviour therapy
21. Cognitive therapy
22. Primary health care
23. Workplace
24. promot$ tw.
25. educat$ tw.
26. program$ tw.
27. #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26
28. #15 and #27

SCISEARCH
1. ((promot$ or uptake or encourag$ or increas$ or start) near (physical adj activity))
2. (promot$ or uptake or encourag$ or increas$ or start) near exercise
3. (promot$ or uptake or encourag$ or increas$ or start) near (aerobics or circuits or swimming or aqua$)
4. (promot$ or uptake or encourag$ or increas$ or start) near (jogging or running or cycling)
5. (promot$ or uptake or encourag$ or increas$ or start) near ((keep adj fit) or (fitness adj class$) or yoga)
6. (promot$ or uptake or encourag$ or increas$ or start) near walking
7. (promot$ or uptake or encourag$ or increas$ or start) near sport$

Part 2. Search strategies 2012

CENTRAL
#1 MeSH descriptor: [Physical Fitness] this term only
#2 MeSH descriptor: [Physical Exertion] this term only
#3 MeSH descriptor: [Physical Education and Training] explode all trees
#4 MeSH descriptor: [Sports] explode all trees
#5 MeSH descriptor: [Dancing] this term only
#6 MeSH descriptor: [Exercise Therapy] explode all trees
#7 physical* near activ*
#8 physical* near train*
physical* near fit*
exercise* near train*
exercise* near activ*
exercise* near physical*
sport*
walk*
bicycle*
exercise* near aerobic*(life next style*) near activ*
life-style* near activ*
lifestyle* near activ*(life next style*) near physical*
lifestyle* near physical*

#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11
#12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22
#23 or #24

MeSH descriptor: [Health Education] this term only
MeSH descriptor: [Patient Education as Topic] this term only
MeSH descriptor: [Primary Prevention] this term only
MeSH descriptor: [Health Promotion] explode all trees
MeSH descriptor: [Behavior Therapy] this term only
MeSH descriptor: [Cognitive Therapy] this term only
MeSH descriptor: [Primary Health Care] this term only
MeSH descriptor: [Workplace] this term only
promot*
educat*
program*

#26 or #27 or #28 or #29 or #30 or #31 or #32 or #33 or #34 or #35 or #36
# MEDLINE Ovid

1. Physical Exertion/
2. Physical Fitness/
3. exp “Physical Education and Training”/
4. exp Sports/
5. Dancing/
6. exp Exercise Therapy/
7. exp Exercise/
8. (physical$ adj5 (fit$ or train$ or activ$ or endur$ or exertion$)).tw.
9. (exercis$ adj5 (train$ or physical$ or activ$)).tw.
10. sport$.tw.
11. walk$.tw.
12. bicycle$.tw.
13. ((exercise$ adj3 aerobic$) or aerobics).tw.
14. ((lifestyle or life-style) adj5 activ$).tw.
15. ((lifestyle or life-style) adj5 physical$).tw.
16. or/1-15
17. Health Education/
18. Patient Education as Topic/
19. Primary Prevention/
20. exp Health Promotion/
21. Behavior Therapy/
22. Cognitive Therapy/
23. Primary Health Care/
24. Workplace/
25. promot$.tw.
26. educat$.tw.
27. program$.tw.
28. or/17-27
29. 16 and 28
30. randomized controlled trial.pt.
31. controlled clinical trial.pt.
32. randomized.ab.
33. placebo.ab.
34. drug therapy.fs.
35. randomly.ab.
36. single blind procedure/
44. 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43
45. (animal/ or nonhuman/) not human/
46. 44 not 45
47. 28 and 46
48. (200412* or 2005* or 2006* or 2007* or 2008* or 2009* or 2010* or 2011* or 2012*).dd.
49. 47 and 48
50. limit 49 to embase

CINAHL Plus with Full Text EBSCO
S34 S33 Limiters - Exclude MEDLINE records
S33 S31 and S32
S32 EM 20041201-20121010
S31 S20 and S30
S30 S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29
S29 TX allocat*
S28 TX control*
S27 TX assign*
S26 TX placebo*
S25 (MH “Placebos”)
S24 TX random*
S23 TX (clinic* N1 trial?)

S22 PT clinical trial

S21 (MH “Clinical Trials+”)

S20 S10 and S19

S19 S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18

S18 (TI promot* or educat* or program*) or (AB promot* or educat* or program*)

S17 (MH “Work Environment”)

S16 (MH “Primary Health Care”)

S15 (MH “Behavior Therapy+”)

S14 (MH “Health Promotion”)

S13 (MH “Preventive Health Care”)

S12 (MH “Patient Education”)

S11 (MH “Health Education”)

S10 S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9

S9 (TI sport* or walk* or bicycle* or exercis* or aerobic*) or (AB sport* or walk* or bicycle* or exercis* or aerobic*)

S8 (TI physical N5 (fit* or train* or activ* or endur* or exert*)) or (AB phsycial* N5 (fit* or train* or activ* or endur* or exert*))

S7 (TI exercis* N5 (train* or physical* or activ*)) or (AB exercis* N5 (train* or physical* or activ*))

S6 (MH “Exercises+”) or (MH “Therapeutic Exercise+”)

S5 (TI (lifestyle* or life-style*) N5 (activ* or physical*)) or (AB (lifestyle* or life-style*) N5 (activ* or physical*))

S4 (MH “Sports+”) or (MH “Dancing+”)

S3 (MH “Physical Education and Training”)

S2 (MH “Physical Fitness”)

S1 (MH “Exertion”)

PsycINFO

1. exp exercise/
2. physical fitness/
3. physical activity/
4. exp sports/
5. physical education/
6. (physical$ adj5 (fit$ or train$ or activ$ or endur$ or exertion$)).tw.
7. (exercis$ adj5 (train$ or physical$ or activ$)).tw.
8. sport$.tw.
9. walk$.tw.
10. bicycle$.tw.
11. ((exercise$ adj3 aerobic$) or aerobics).tw.
12. ((lifestyle or life-style) adj5 activ$).tw.
13. ((lifestyle or life-style) adj5 physical$).tw.
14. or/1-13
15. health education/
16. client education/
17. health promotion/
18. prevention/
19. primary health care/
20. behavior therapy/
21. cognitive therapy/
22. cognitive behavior therapy/
23. workplace*.tw.
24. promot$.tw.
25. educat$.tw.
26. program$.tw.
27. or/15-26
28. 14 and 27
29. random*.tw.
30. trial.ab.
31. groups.ab.
32. factorial$.tw.
33. crossover$.tw.
34. cross over$.tw.
35. cross-over$.tw.
36. placebo$.tw.
37. assign$.tw.
38. allocat$.tw.
39. volunteer$.tw.
40. clinical trials/
41. (doubI$ adj blind$).tw.
42. (singl$ adj blind$).tw.
43. or/29-42
44. 28 and 43
45. (200412* or 2005* or 2006* or 2007* or 2008* or 2009* or 2010* or 2011* or 2012*).up.
46. 44 and 45

Web of Science
# 20 #19 AND #18
# 19 TS=(random* or blind* or allocat* or assign* or trial* or placebo* or crossover* or cross-over*)
# 18 #17 AND #8
# 17 #16 OR #15 OR #14 OR #13 OR #12 OR #11 OR #10 OR #9
# 16 TI=(promot* or educat* or program*)
# 15 TS=(workplace)
# 14 TS=(primary health care)
# 13 TS=(cognitive therap*)
# 12 TS=((behaviour or behavior) NEAR/2 therap*)
# 11 TS=(health NEAR/2 promot*)
# 10 TS=(primary prevent*)
# 9 TS=((health educat*) or (patient* educat*))
# 8 #7 OR #6 OR #5 OR #4 OR #3 OR #2 OR #1
# 7 TS=((lifestyle* or life-style*) NEAR/5 (activ* or physcial*))
# 6 TS=((exercis* NEAR/2 aerobic*) or aerobic*)
# 5 TS=(sport* or danc* or walk* or bicycle*)
# 4 TS=(physical* educat*)
# 3 TS=(exercis* NEAR/5 (train* or physical* or activ*))
# 2 TS=(physical NEAR/5 (fit* or train* or activ* or endur* or exert*))
# 1 TS=(exercis* therap*)

Part 3  Updated Search June 2014

Search numbers:

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Total: 927
Duplicates: 315
Final Total: 612

Limits:

Published or added to the databases since 2012
AMED:

1  exp Osteoarthritis/ 1959
2  Arthritis/ 954
3  (arthriti* or osteoarthriti* or osteo-arthriti*).ti,ab. 5070
4  1 or 2 or 3 5656
5  exp exercise/ or physical fitness/ or exp sports/ 12473
6  exp exercise therapy/ 5916
7  (physical* adj5 (fit* or train* or activ* or endur* or exert*)).tw. 6733
8  (physical* adj5 (fit* or train* or activ* or endur* or exert*)).tw. 6733
9  sport*.tw. 5467
10  walk*.tw. 8277
11  ((exercise* adj aerobic*) or aerobic*).tw. 1791
12  ((lifestyle or life-style) adj5 activ*).tw. 242
13  bicycle*.tw. 351
14  ((lifestyle or life-style) adj5 physical*).tw. 178
15  5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 29870
16  health education/ or exp patient education/ 2081
17  health promotion/ 1726
18  prevention/ 10876
19  behavior therapy/ or cognitive therapy/ 1658
20  Primary health care/ 467
21  Workplace/ 439
22  (promot* or educat* or program*).ti,ab. 29988
23  16 or 17 or 18 or 19 or 20 or 21 or 22 42602
clinical trials/ or randomized controlled trials/ or comparative study/ or double blind method/ or random allocation/

(random* or factorial* or crossover* or cross over* or placebo* or (doubl* adj blind*) or (singl* adj Blind*)) or assign* or allocat* or volunteer*).ti,ab.

27 25 or 26

28 24 and 27

29 (2012* or 2013* or 2014*).up,yr.

Central & DARE:

#1 MeSH descriptor: [Physical Fitness] explode all trees
#2 MeSH descriptor: [Physical Exertion] explode all trees
#3 MeSH descriptor: [Physical Education and Training] explode all trees
#4 MeSH descriptor: [Sports] explode all trees
#5 MeSH descriptor: [Dancing] explode all trees
#6 MeSH descriptor: [Exercise Therapy] explode all trees
#7 physical* near activ*:ti,ab,kw
#8 physical* near train*:ti,ab,kw
#9 physical* near fit*:ti,ab,kw
#10 physical* near fit*:ti,ab,kw
#11 exercise* near activ*:ti,ab,kw
#12 exercise* near physical*:ti,ab,kw
#13 sport*:ti,ab,kw
#14 walk*:ti,ab,kw
#15 bicycle*:ti,ab,kw
#16 exercise* near aerobic*:ti,ab,kw
#17 ((life next style*) near activ*):ti,ab,kw
#18 life-style* near activ*:ti,ab,kw
#19 lifestyle* near activ*:ti,ab,kw
#20 ((life next style*) near physical*):ti,ab,kw
#21 life-style* near physical*:ti,ab,kw
#22 lifestyle* near physical*:ti,ab,kw
#23 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22
#24 MeSH descriptor: [Health Education] this term only
#25 MeSH descriptor: [Patient Education as Topic] explode all trees
#26 MeSH descriptor: [Primary Prevention] this term only
#27 MeSH descriptor: [Health Promotion] explode all trees
#28 MeSH descriptor: [Behavior Therapy] this term only
#29 MeSH descriptor: [Cognitive Therapy] this term only
#30 MeSH descriptor: [Primary Health Care] this term only
#31 MeSH descriptor: [Workplace] this term only
#32 promot* or educat* or program*:ti,ab,kw
#33 #24 or #25 or #26 or #27 or #28 or #29 or #30 or #31 or #32
#34 MeSH descriptor: [Osteoarthritis] explode all trees
#35 MeSH descriptor: [Arthritis] this term only
#36 arthriti* or osteoarthriti* or osteo-arthritis*:ti,ab,
#37 #34 or #35 or #36
#38 #23 and #33 and #37
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**Embase** 1974 to 2014 June 16

44 42 and 43
43 (2012* or 2013* or 2014*).ed,dp,yr.
42 40 not 41
41 (animal/ or nonhuman/) not human/
40 33 and 39
39 34 or 35 or 36 or 37 or 38
38 single blind procedure/
37 randomized controlled trial/
36 double blind procedure/
35 crossover procedure/
34 (random* or factorial* or crossover* or cross over* or placebo* or (doubl* adj blind*)) or (singl* adj Blind*) or assign* or allocat* or volunteer*).ti,ab.
33 6 and 21 and 32
32 program*.tw.
31 educat*.tw.
30 promot*.tw.
29 workplace/
28 primary health care/
27 cognitive therapy/
26 behavior therapy/
25 health promotion/
24 primary prevention/
23 patient education/
22 health education/
21 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
20 ((lifestyle or life-style) adj5 physical*).tw.
19 bicycle*.tw.
18 ((lifestyle or life-style) adj5 activ*).tw.
17 ((exercise* adj aerobic*) or aerobic*).tw.
16 walk*.tw. 90599
15 sport*.tw. 59117
14 (exercis* adj5 (train* or physical* or activ*)).tw. 48979
13 (physical* adj5 (fit* or train* or activ* or endur* or exert*)).tw. 102687
12 exp kinesiotherapy/ 48116
11 dancing/ 2551
10 exp sport/ 101422
9 physical education/ 10001
8 fitness/ 28054
7 exp exercise/ 210873
6 1 or 2 or 3 or 4 or 5 266867
5 (ankle/ or elbow/ or hand joint/ or hip/ or knee/ or shoulder/ or wrist/) and pain/ 9664
4 arthritis/ or chronic arthritis/ 56592
3 osteoarthritis/ or hand osteoarthritis/ or hip osteoarthritis/ or knee osteoarthritis/ 77461
2 arthriti*.ti,ab. 172469
1 (osteoarthriti* or osteo-arthritis*).ti,ab. 51822
50 48 and 49
49 (2012* or 2013* or 2014*).ed,dp,yr.
48 36 and 47
47 45 not 46
46 exp animals/ not humans.sh.
45 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44
44 groups.ab.
43 trial.ab.
42 randomly.ab.
41 drug therapy.fs.
40 placebo.ab.
39 randomized.ab.
38 controlled clinical trial.pt.
37 randomized controlled trial.pt.
36 7 and 23 and 35
35 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34
34 program$.tw.
33 promot$.tw.
32 promot$.tw.
31 Workplace/
30 Primary Health Care/
29 Cognitive Therapy/
28 Behavior Therapy/
27 exp Health Promotion/
26 Primary Prevention/
25 Patient Education as Topic/
24 Health Education/
23 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22
22 ((lifestyle or life-style) adj5 physical$).tw.
21 ((lifestyle or life-style) adj5 activ$).tw.
20 ((exercise$ adj3 aerobic$) or aerobics).tw.
19 bicycle$.tw.
18 walk$.tw.
17 sport$.tw.
16 (exercis$ adj5 (train$ or physical$ or activ$)).tw.
15 (physical$ adj5 (fit$ or train$ or activ$ or endur$ or exertion$)).tw.
14 exp Exercise/
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PsycINFO 1967 to June Week 2 2014

39 37 and 38
38 (2012* or 2013* or 2014*).up,dp,yr.
37 32 and 36
36 33 or 34 or 35
35 ((singl* or doubl*) adj bind*).tw.
34 clinical trials/
33 (random*.tw. or trial.ab. or groups.ab. or factorial*.tw. or crossover*.tw. or cross over.tw. or placebo*.tw. or assign*.tw. or allocat*.tw. or volunteer*.tw.
29 educat$.tw.
28 promot$.tw.
27 workplace*.tw.
26 cognitive behavior therapy/
25 cognitive therapy/
24 behavior therapy/
23 primary health care/
22 prevention/
21 health promotion/
20 client education/
19 health education/
18 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17
17 ((lifestyle or life-style) adj5 physical$).tw.
16 ((lifestyle or life-style) adj5 activ$).tw.
15 ((exercise$ adj3 aerobic$) or aerobic$).tw.
14 bicycle$.tw.
13 walk$.tw.
12 sport$.tw.
11 (exercis$ adj5 (train$ or physical$ or activ$)).tw.
10 (physical$ adj5 (fit$ or train$ or activ$ or endur$ or exertion$)).tw.
9  exp sports/
8  exp sports/
7  physical activity/
6  physical fitness/
5  exp exercise/
4  1 or 2 or 3
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<td>DE &quot;OSTEOARTHRITE&quot;</td>
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Additional search methods:

OpenGREY – 1 result – 17/06/2014
Search terms = (arthritis OR osteoarthritis) AND (Exercise OR "physical activity" OR sport OR sports)

Knee osteoarthritis (origin, progression, therapy and prevention)
http://www.opengrey.eu/item/display/10068/893093

ClinicalTrials.gov http://clinicaltrials.gov – 146 results - 17/06/2014
Search terms = (arthritis OR osteoarthritis) AND (Exercise OR "physical activity" OR sport OR sports)