PAIN Publish Ahead of Print
DOI: 10.1097/j.pain.0000000000002302

The effects of booster sessions on self-management interventions for chronic musculoskeletal pain: a systematic review and meta-analysis of randomised controlled trials

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Conflicts of interest: There are no conflicts of interest.

ABSTRACT

Our objective was to investigate the effectiveness of booster sessions after self-management interventions as a means of maintaining self-management behaviours in the treatment of chronic musculoskeletal pain. We searched MEDLINE, EMBASE, Science Citation Index, Cochrane Central Register of Controlled Trials and PsycINFO. Two authors independently

identified eligible trials and collected data. We calculated the odds ratio (OR) for the analyses of dichotomous data, and standardised mean differences (SMD) with 95% confidence interval (CI) for continuous variables. Our search identified 14 studies with a total of 1695 patients. All studies were at high risk of bias and provided very low quality evidence. For the primary outcomes, booster sessions had no evidence of an effect on improving patient-reported outcomes on physical function (SMD-0.13, 95%CI -0.32 to -0.06; P=0.18), pain-related disability (SMD-0.16, 95%CI -0.36 to 0.03; P=0.11) and pain self-efficacy (SMD 0.15, 95%CI -0.07 to 0.36; P=0.18). For the secondary outcomes, booster sessions caused a significant reduction in patient-reported pain catastrophising (SMD-0.42, 95%CI -0.64 to -0.19; P=0.0004), and no evidence of an effect on patient-reported pain intensity, depression, coping or treatment adherence. There is currently little evidence that booster sessions are an effective way to prolong positive treatment effects or improve symptoms of long-term musculoskeletal conditions following self-management interventions. However, the studies were few with high heterogeneity, high risk of bias and overall low quality of evidence. Our review argues against including booster sessions routinely to self-management interventions for the purpose of behaviour maintenance.

Keywords: chronic pain, booster session, self-management, rehabilitation, systematic review.

BACKGROUND

Description of the condition

Chronic musculoskeletal pain (CMP) is one of the most common causes of morbidity worldwide [7]. It affects a third of the world's population, nearly 70% of people in higher-income countries, with an expected rise in the incidence as the worldwide population ages

[48]. CMP may be defined as pain arising from musculoskeletal structures that persists or recurs for more than three to six months [62,71]. CMP may be localised or widespread. It may occur secondary to an underlying disease process or as a condition in its own right, not accounted for by any specific underlying disease [38].

CMP places considerable burden on sufferers' lives, leading to poor physical functioning, psychological distress, fatigue, social isolation, and loss of employment, which all result in a diminished quality of life [30]. People with chronic pain are at greater risk of developing cardiovascular disorders, obesity, cancer, diabetes, depression and also at greater risk of premature death [32,43,45,53,60]. The high prevalence of CMP has economic consequences due to the high volume of healthcare utilisation and reduced labour productivity. In the US, chronic pain costs the economy $635 billion each year [26], and throughout the EU, €441 billion each year [67]. Back pain alone costs £12.3 billion for the UK and €48.96 billion for the German government each year [52,73]. In view of these vast economic and individual costs, it is of vital importance to effectively manage CMP.

Description of the intervention

Current opinion is strongly in favour of self-management as a first-line effective strategy in managing long term pain [8,58]. Self-management interventions aim to help participants become active agents in managing their own health condition. This would include identifying unhelpful behaviours and developing strategies for the management of their long-term conditions and make changes to improve functional capacity [14,21]. Self-management programmes are safe and cost-effective, although it is recognised that effect sizes are small and not sustained in the long term [18,21]. Maintaining self-management strategies is contingent on multiple inter-related factors. Following successful completion of exercise and rehabilitation programmes, self-management drive and activity levels diminish in over 30% of

participants [4,24]. Preventing this has proven challenging and the necessity of aftercare strategies are a subject of debate [24]. Relapse is in fact a problem in all behaviour change intervention including health behaviours such as smoking alcohol consumption and weight loss [47]. One proposed way to increase the effect size for self-management interventions and foster long-term maintenance of achieved outcomes is to add booster sessions to the main treatment [23].

How the intervention might work

CMP patients typically have a history of numerous years during which response habits, such as pain-related fear and avoidance of movement and activities, develop and become maintaining factors for pain-related disability [56]. During rehabilitation programmes, patients are encouraged to undertake lifestyle changes [4]. However, establishing enduring lifestyle change is challenging and the duration of current treatments are not sufficient to achieve this [35]. Booster sessions may remind patients of the importance of continuing self-management [4], reinforce the main treatment content and facilitate the transfer of new behaviours [54], subsequently increasing therapeutic effects.

Why it is important to do this review

Given the worldwide prevalence of CMP, the associated health burden for patients and its economic costs, improving its management is of significant importance. Multidisciplinary rehabilitation has been shown to be effective in the short to medium-term, but it is necessary to foster long-term maintenance of achieved outcomes. Booster sessions may be a way to maintain successful treatment effects. However, to date, no systematic reviews have investigated the effect of these additional interventions. This review aims to collate and synthesize the evidence on the effectiveness of booster sessions after CMP self-management

programmes. The findings will inform decision makers on whether these interventions should be offered routinely and will guide future research needs.

OBJECTIVES

This review aims to investigate whether patients who had booster sessions added to their CMP self-management programmes had better outcomes compared with patients who did not receive this additional support.

METHODS

In conducting this review, we followed PRISMA reporting guidance (Preferred Reporting Items for Systematic Reviews and Meta-analyses) [55] and the recommendations of the Cochrane Handbook for Systematic Reviews of Interventions [36].

Protocol and registration

The methods of this review were pre-specified in the protocol registered in the Prospero Database (CRD42019147315). We reported any deviations from the protocol in the 'Differences between protocol and review' section.

Criteria for considering studies for this review

Types of studies

We only included randomised controlled trials (RCTs). We excluded studies of other designs because of the risk of bias in such studies. We considered both published full-text papers and unpublished papers reported as abstract only, with no language restrictions applied for inclusion. We accepted cluster randomised and cross-over trials for eligibility.

Types of participants

We included trials that recruited adult (older than 18 years) patients with CMP (musculoskeletal pain lasting over three months) who participated in a self-management intervention in an inpatient or an outpatient setting. We excluded trials in which the patients suffered with acute pain or those that examined a mixed group of acute and chronic pain patients, or a mixed group of musculoskeletal and non-musculoskeletal chronic pain patients (e.g. people with headache, cancer pain, pelvic or abdominal pain).

Types of interventions

We only included trials where control patients received the same initial treatment as the intervention group but with no subsequent booster. We excluded studies that did not have a comparator arm, defined as patients who received the same treatment with no subsequent booster. We included studies in which (1) the main programme was defined by the authors as self-management intervention or included self-management intervention delivered face-to-face, (2) the treatment type for the main and booster sessions were single modality or multidisciplinary and (3) boosters took place after the original treatment. Studies in which additional boosters were added in alongside and at the same time as the main programme were not included. We considered all treatment intensities, any number and delivery methods of boosters (face-to-face or remote i.e. internet, telephone) for inclusion. We allowed for treatment to be delivered both by healthcare professionals or trained lay people. We excluded studies where the main treatment and/or boosters were not themselves self-management interventions e.g. pharmacological, complementary and alternative therapies or use of medical devices. We did not include trials in which additional follow-ups were for the purpose of information gathering only.

Types of outcome measures

We based the choice of outcomes on core domains for CMP clinical trials specified by IMMPACT (Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials) [72] and on the need for addressing behavioural and psychological domains for effective assessment [15]. We studied the following domains:

Primary outcomes

- Physical function
- Pain-related disability
- Pain self-efficacy (one's confidence in his/her own capability to deal with pain-related symptoms and limitations)

Secondary outcomes

- Pain intensity
- Depression
- Coping
- Pain catastrophising
- Treatment adherence

None of the aforementioned outcomes was appointed as an inclusion criterion. We only used patient-reported outcome measures (PROMs) for this review.

For measures of effect, we analysed the change in PROMs scores from baseline (end of main programme/prior to receiving booster sessions) to the last available follow-up after the booster sessions.

Search methods for identification of studies

Electronic searches

Before the main search, we conducted a pilot search in MEDLINE and Science Citation Index to identify key terms previously used for booster sessions. We, then searched the literature to identify potentially relevant studies in all languages. We translated non-English language papers and examined them for potential inclusion. We applied validated search filters to retrieve randomised trials only in conjunction with specific search terms for CMP management, common musculoskeletal disorders, pain management methods and boosters [29,36]. Search strategies are given in full in the appendices (available at http://links.lww.com/PAIN/B361).

We searched the following electronic databases on 29th February 2020 for potential studies for inclusion:

- MEDLINE (1946 to present; Appendix 1, available at http://links.lww.com/PAIN/B361)
- EMBASE (1947 to present; Appendix 2, available at http://links.lww.com/PAIN/B361)
- Science Citation Index Expanded (1900 to present; Appendix 3, available at http://links.lww.com/PAIN/B361)
- Cochrane Central Register of Controlled Trials (CENTRAL; Appendix 4, available at http://links.lww.com/PAIN/B361)
- PsycINFO (1806 to present; Appendix 5, available at http://links.lww.com/PAIN/B361)

Searching other resources

We hand searched the reference lists of all included studies and relevant review articles for additional potential references.

Data collection and analysis

Selection of studies

Two reviewers (EB and HK) independently screened records retrieved from the databases for inclusion using titles and abstracts. We then assessed full texts for a decision on final inclusion. Two reviewers (EB and HK) retrieved and independently read the full text of all potentially eligible studies and coded them as 'eligible' or 'excluded' and recorded reasons for exclusion of ineligible studies. Disagreements were resolved by discussion, moderated by a third author (RZ). We removed duplicate publications and linked together studies with multiple reports, with the study rather than the publication being the unit of analysis. We documented the process of selection in further detail in the PRISMA flow diagram (Fig. 1).

Data extraction and management

We used a standardised data extraction form for data collection, which we had piloted on at least three studies that were included in the review. Two review authors (EB and HK) independently collected all relevant study characteristics listed in the 'Characteristics extracted from included studies' table (Table 1).

Two review authors (EB and HK) independently extracted outcome data from measures obtained at baseline (end of the main programme, prior to receiving booster sessions) and after the booster sessions, at the last available follow-up of each study. In trials where an outcome was measured using more than one scale, we gave preference to the most appropriate

or most frequently used scale [74]. If an outcome was measured in subscales, we extracted the data from the most appropriate subscale in all included trials. EB added the outcome data to the RevMan 5 Software [64] for data management and a second author (HK) validated the entries. We resolved disagreements in data extraction by discussion with a third reviewer (AG).

Assessment of risk of bias in included studies

Two review authors (EB and HK) independently assessed risk of bias of each included study following the methods outlined in the Cochrane Handbook for Systematic Reviews of Interventions [36]. We resolved any disagreements by discussion. Any disagreements were moderated by a third author (AG).

We assessed risk of bias using the following domains:

1. Random sequence generation
2. Allocation concealment
3. Blinding of participants and personnel
4. Blinding of outcome assessment
5. Incomplete outcome data
6. Selective reporting
7. Source of funding
8. Other bias

We classified each potential source of bias as ‘unclear’, ‘high’ or ‘low’ risk and alongside, we provided a quote from the study authors or a comment to justify our judgement in the 'Risk of bias' tables (Table 2). We acknowledge that while appropriate blinding of participants and personnel is not possible due to the nature of interventions, blinding of outcome assessors is,

however, possible. We took into consideration the risk of bias when assessing the quality of evidence and interpreting treatment effects for each outcome measure.

Measures of treatment effect

For dichotomous data (adherence) we used odds ratio (OR) as the measure of treatment effect, and for the analyses of continuous variables (all other outcomes), we used standardised mean differences (SMD) as the measure of treatment effect. Where necessary, we reversed scores by subtracting the mean from the maximum score possible for the scale, to ensure that the meaning of higher scores is the same for all individual patient-reported outcomes, as described in the Cochrane Handbook for intervention reviews [36]. We have indicated the direction to the reader, and we have reported where reversal was necessary. We have combined outcome measures through meta-analyses, taking into account the similarity of the population, interventions and outcomes between studies to ensure meaningful comparisons. We expressed the uncertainty of the effects with 95% confidence interval (CI). We examined the magnitude of SMD and OR effect sizes using Cohen's categories [13] and their calculated equivalent [12], respectively. For SMD, 0.2 represented a small, 0.5 a moderate and 0.8 a large effect [13]. For OR, 1.5 represented a small, 3.5 a moderate and 5 a large effect [12].

Unit of analysis issues

We have included outcome data from cluster randomised trials in the meta-analyses, however, they were removed if the sensitivity analysis identified that the study significantly altered the results. In the case of cross-over trials, we used the data prior to the cross-over for analysis. Where a study reported multiple intervention groups, we have included only the relevant experimental arms. From trials with repeated observations, we obtained data only from the final follow-up of each study.

Dealing with missing data

We attempted to contact study investigators to verify key missing study characteristics and obtain missing outcome data. We used medians to impute the mean value for outcome data where necessary and we estimated standard deviations (SDs) from standard error, CIs and p values where necessary. Where the information was insufficient to calculate SDs for follow-up measurements we used SDs calculated from baseline measurements instead. If neither of these methods was possible to use, data could not be included in the analysis. We noted in the 'Notes' section of the 'Characteristics of included studies' table if any outcome data were reported in an impractical way (Table 2).

Assessment of heterogeneity

We quantified statistical heterogeneity among trials by using the I^2 statistic and decided on the amount of heterogeneity in line with the Cochrane Handbook [36]. Where we identified substantial statistical heterogeneity (>50-60%), we conducted further pre-specified subgroup analyses. We also assessed heterogeneity by evaluating the overlap of CIs.

Assessment of reporting biases

We sought published protocols of included trials to recognise selective outcome reporting bias. If at least ten studies were included in the meta-analysis, we planned to generate funnel plots and use visual inspection to detect possible publication bias [36].

Data synthesis

We performed data analyses with RevMan 5 Software [64]. The minimum number of studies for data synthesis is two. We examined the combined results using the inverse variance method. We used the fixed-effects model when there was no difference between fixed and

random-effects analyses. However, in the presence of heterogeneity, we used the more conservative method.

Subgroup analysis and investigation of heterogeneity

We planned subgroup analyses on the following parameters on the primary outcomes only:

1. Treatment type of the initial programme (single modality vs multidisciplinary)
2. Treatment intensity of the initial programme (daily intensive treatment vs weekly sessions)
3. Method of delivery of boosters (face-to-face vs remote e.g. telephone, web-based)

We used the chi-squared (Chi^2) test to identify variation between subgroups. Heterogeneity was indicated by a Chi^2 statistic greater than the df and a *p*-value less than 0.05 [36]. If it was not possible to categorise a trial because of insufficient information, we excluded it from the subgroup analysis.

Sensitivity analysis

In accordance with a Cochrane review on CMP management [6], we planned the following sensitivity analyses to investigate the robustness of treatment effects:

1. Including only low risk of bias studies (none of the domains was at unclear or high risk of bias).
2. Excluding those trials where means, SDs or both were substituted.
3. Excluding those studies with less than 20 participants per trial arm.
4. Excluding those studies with cluster randomised design.

'Summary of findings' table

We employed the GRADE approach to evaluate the quality of evidence for every outcome reported in this review [65]. We graded the available evidence according to the following considerations: design limitations, directness of evidence, consistency of results, imprecision of results and publication bias [65]. We have presented the overall assessment results in the 'Summary of findings for the main comparison' (Table 3) and 'Additional summary of findings' tables (Table 4) which we created using the GRADEpro software [31]. We have explained justifications for upgrading or downgrading the quality of the evidence in the footnotes and we provided additional comments if needed to facilitate the reader's understanding where necessary.

Differences between protocol and review

There are no differences between the registered protocol and review.

RESULTS

Description of studies

Results of the search

We identified 51,904 records through electronic searches. After removing duplicates, there were 40,770 references. We excluded 40,742 clearly irrelevant records through reading titles and abstracts. We obtained full texts for the 28 potentially related articles. Of these 28 papers, 10 did not fulfil the inclusion criteria and were excluded. We have summarised the reasons for exclusion in the 'Characteristics of excluded studies' table (Table 5) and 'Excluded studies' section. Ultimately, this review was based on 14 studies (18 references) (Included studies).

One study required translation from German language [54, first reference only]. The selection process is summarised in the study flow diagram (Fig. 1).

Included studies

Details of included studies are included in the 'Characteristics of included studies' table (Table 2).

Design

All studies were parallel arm RCTs. There were no cross-over trial designs in the articles retrieved for inclusion. One intervention used cluster randomised design [50]. Two studies were four-armed [1,22], two studies were three-armed [50,51] and the remaining trials were two-armed.

Settings

Eight trials were conducted in Europe, four in North America and two in Australasia. Apart from one study [50], all studies were published in or after 2008. Initial rehabilitation was held in hospital settings (e.g. inpatient or outpatient pain clinics, rehabilitation and medical centres) and one programme was held in community sites [50]. The main treatment was carried out face-to-face in all trials. Booster sessions were delivered face-to-face in five studies [1,5,22,50,68], whilst in the other trials, remote delivery methods (internet-based and telephone-delivered) were used.

Patients

A total of 1695 patients were randomised to the booster (820) and no booster (875) groups. Sample sizes ranged from 38 to 589. The mean age of participants was 54 (ranging from 39 to

65). One study only included females [46]. The other interventions included both sexes. Overall, females made up 92% of all patients across all trials. Studies focused on the treatment of various musculoskeletal disorders. Four trials involved patients with knee OA [1,3,5,22], one with hand OA [69], and one with arthritis with the type and location not specified [50]. One study examined treatment effects on neck pain [27], two on lower back pain [51,54], one study involved mainly patients with fibromyalgia [46], and the remaining studies recruited participants with CMP in other parts of the body. Five studies did not report symptom duration [3,50,51,54,69]. In the other studies, pain duration ranged from 1 to 15 years. Patients reported high baseline pain intensity (pain score over 60% of the maximum possible score on the pain scale used [42]) in five of the included studies [10,22,27,46,57]. In the other trials, pain intensity ranged from 26% to 50% of the maximum score. The inclusion and exclusion criteria of the included trials have been noted in the 'Characteristics of included studies' table (Table 2).

Interventions

The treatment type of the main programme was a single modality in six studies: five were exercise-based [1,3,5,22,27], with predominantly exercise-based booster sessions, and one was a psychological intervention [57] with the booster being a predominantly behavioural intervention. In three of the exercise-based trials, the boosters also provided additional counselling on goal setting, overcoming barriers to exercise adherence [3,5] or advice on flare-ups [27].

In the remaining eight studies, the initial interventions employed a multidisciplinary approach. Boosters were based on multidisciplinary care in seven trials [9,10,46,50,51,54,68]. One study did not reveal details of the therapy delivered during the booster [69]. For a full

description of the treatments provided see the 'Characteristics of included studies' table (Table 2).

The main treatment was described as group-based in four studies [3,51,57,69]. Boosters were individual sessions in one trial and group-based in one study [5,54; respectively]. The other trials did not specify if treatment was provided in a one-to-one or group-based setting. With regards to the initial rehabilitation intensity, five studies implemented intensive treatment (daily contact) of 1-4 weeks of duration [27,46,51,54,68]. However, the number of contact hours have not been reported by the authors. The other trials held one to three 30-120 minute sessions weekly with the total programme duration ranging between 2-9 weeks. One study had insufficient details about treatment intensity, therefore, it was not possible to categorise [9].

The number of booster sessions ranged from 1-42, and the time period during which they were delivered ranged from 4 weeks to 24 months. Treatments were given by various healthcare professionals (physical therapists, occupational therapists, psychologists and nurses), except in one study in which lay leaders were trained to supervise the sessions. The maximal post-treatment follow-ups ranged from 6 to 24 months after treatment. We summarised all patient-reported outcome measures that studies used for data collection in the 'Summary of clinical outcome measures' table (Table 6).

Excluded studies

We excluded 10 studies on full-text screening as described in the study flow diagram (Fig. 1) [11,16,17,20,25,34,37,70,76,77]. Reasons for exclusion are given in the 'Characteristics of excluded studies' table (Table 5).

Risk of bias in included studies

The final results of the quality of assessment revealed that all included trials were at high risk of bias (Fig. 2, Fig. 3). This was predominantly because none of the trials was blinded.

Allocation (selection bias)

Random sequence generation was not described in two studies [68,69]. The remaining 12 trials reported adequate randomisation procedures. No information was available on allocation concealment in four interventions [9,27,57,69], the other 10 studies were free of bias in this category.

Blinding (performance bias and detection bias)

All trials were at high risk of performance bias because in self-management interventions blinding of patients and healthcare providers is not possible. Eight studies were free of detection bias: two reported adequate blinding of outcome assessors [1,22], in one study there was no assessor but if help was needed to complete the questionnaire, an independent interviewer was available [68]. In five studies, the questionnaires were administered via the internet, mail or phone [3,5,9,50,51]. The remaining six trials did not address this aspect and were considered to be at unclear risk of detection bias.

Incomplete outcome data (attrition bias)

There was low risk of attrition bias in 11 trials: in nine studies, outcome data were reported in a way that fulfilled the criteria for completeness [1,3,9,10,22,51,54,57,68] and two trials had low numbers of dropouts [5,27]. One trial did not describe if there were any post-randomisation dropouts, therefore, it was classified as at unclear risk [69]. Two studies were at high risk of bias due to large dropout rates [46,50].

Selective reporting (reporting bias)

Protocols of eight included trials were available. Of these, three did not report some of the prespecified outcomes as per the registered protocol [1,5,22], and therefore were at high risk of reporting bias. The other five trials were at low risk, as authors adhered to the published trial registration [3,9,10,27,46]. For the other trials, where a protocol was unavailable, we considered there to be an absence of reporting bias if studies reported pain and either physical function or disability. Only one study was identified at unclear risk because not all important outcomes were assessed, and results for some measured outcomes were not stated [69]. We classified the remaining five trials as at low risk of bias, as these studies reported all the important outcomes [50,51,54,57,68].

Other potential sources of bias

Thirteen studies were at low risk of bias with regards to the funding source [1,3,5,9,10,22,27,46,50,51,54,57,68]. In general, funding was received from non-profit organizations, such as the government, research grants, research centres and hospitals. One study did not provide details on funding and was therefore considered to be at unclear risk of bias [69]. It was possible to construct funnel plots for physical function and pain intensity (Fig. 4; Fig. 5; respectively). Neither of the plots was indicative of publication bias.
Other sources of bias identified and considered as high risk were that one study was a cluster randomised trial [50], and in another study, both trial arms were offered usual care but authors failed to monitor the actual use of this, and therefore outcomes may have been influenced by the use of additional usual care therapies [57]. One study did not provide sufficient information to assess other sources of bias and was deemed as at unclear risk [69]. All other included trials were considered as free from any other sources of bias.

Effects of interventions

Of the 14 included trials, four studies contributed data to at least two and 10 studies only to one of the review's primary outcomes. Thirteen studies investigated at least one of the review's secondary outcomes. We have summarised the results for the primary outcomes in the 'Summary of findings for the main comparison' table and for the secondary outcomes in the 'Additional summary of findings' table (Table 3 and 4). We have presented the summary of effect estimates for each comparison in Table 7.

Primary outcomes

Eleven studies with 1288 participants investigated physical function [1,3,5,10,22,46,51,54,57,68,69]. Higher scores indicated worse functioning. To ensure the direction of all scales had the same meaning, outcome data were subtracted from the maximum score for seven studies [10,46,51,54,57,68,69]. Currently, there is no evidence that booster sessions provide additional benefits in terms of physical function in patients with CMP after a self-management intervention (SMD -0.13, 95% CI -0.32 to 0.06; P = 0.18; Analysis 1.1; Fig. 6).

Seven studies with 1027 participants investigated pain-related disability [9,10,27,46,50,51,54]. Higher scores indicated higher levels of pain-related disability. To ensure the direction of all scales had the same meaning, outcome data were subtracted from the maximum score for two studies [9,46; respectively]. There is no evidence that booster sessions had additional benefits with regards to pain-related disability in patients with CMP after a self-management intervention (SMD -0.16, 95% CI -0.36 to 0.03; P = 0.11; Analysis 1.2; Fig. 7).

Two studies with 331 participants investigated pain self-efficacy [10,51]. Higher scores indicated higher levels of pain self-efficacy. There is no evidence that booster sessions had

additional benefits with regards to pain self-efficacy in patients with CMP after a self-management intervention (SMD 0.15, 95% CI -0.07 to 0.36; P = 0.18; Analysis 1.3; Fig. 8). For the outcomes of physical function and pain-related disability, there were serious concerns with the risk of bias, inconsistency across the studies and serious imprecision in the results. For pain self-efficacy, there were serious concerns with the risk of bias, inconsistency across the studies and very serious imprecision in the results. The evidence was direct and publication bias was not detected for any of the outcomes. Overall, the quality of evidence for all primary outcomes was very low.

Secondary outcomes

Thirteen studies with 1548 participants investigated pain intensity [1,3,5,9,10,22,27,46,50,51,54,57,68]. Higher scores indicated higher pain intensity. To ensure the direction of all scales had the same meaning, outcome data were subtracted from the maximum score for one study [68]. Currently, there is no evidence that booster sessions provide additional benefits in terms of pain intensity in patients with CMP after a self-management intervention (SMD -0.22, 95% CI -0.46 to 0.02; P = 0.07; Analysis 1.4; Fig. 9). Eight studies with 1073 participants investigated depression [9,10,46,50,51,54,57,68]. Higher scores indicated higher levels of depression. To ensure the direction of all scales had the same meaning, outcome data were subtracted from the maximum score for six studies [10,46,51,54,57,68]. There is no evidence that booster sessions had additional benefits with regards to depression in patients with CMP after a self-management intervention (SMD -0.17, 95% CI -0.37 to 0.03; P = 0.10; Analysis 1.5; Fig. 10).

Four studies with 451 participants investigated coping with pain [9,10,51,57] with measures including various subscales. Outcome data were extracted from the 'Diverting attention' item. Higher scores indicated better coping ability. There is no evidence that booster sessions had

additional benefits with regards to coping in patients with CMP after a self-management intervention (SMD -0.28, 95% CI -0.99 to 0.42; P = 0.43; Analysis 1.6; Fig. 11).

Four studies with 304 participants investigated pain catastrophising [9,10,46,57]. Higher scores indicated higher levels of catastrophising. There is evidence that participation in booster sessions was associated with a significant reduction in pain catastrophizing in patients with CMP after a self-management intervention (SMD -0.42, 95% CI -0.64 to -0.19; P = 0.0004; Analysis 1.7; Fig. 12).

Three studies with 272 participants investigated treatment adherence [3,5,27]. Two of these trials [5,27] presented the outcome as dichotomous and one trial [3] as continuous data. Taking into account the potential bias and loss of information with dichotomising continuous data [36], we only pooled the two trials together with the same data type [5,27] and we presented the findings of the third trial separately [3]. Both data sets showed that currently there is no evidence that booster sessions had additional benefits with regards to treatment adherence in patients with CMP after a self-management intervention ((OR 1.9, 95% CI 0.98 to 3.87; P = 0.06; 168 participants; Analysis 1.8; Fig. 13); (SMD -0.38, 95% CI -1.70 to 0.94; P = 0.57; 104 participants; Analysis 1.9; Fig. 14)).

For pain intensity, depression and coping, there were serious concerns with the risk of bias, mainly pertaining to inconsistency across the studies and serious imprecision in the results. For pain catastrophising and treatment adherence, there were serious concerns with the risk of bias, inconsistency across the studies and very serious imprecision in the results. The evidence was direct and publication bias was not detected for any of the outcomes. Overall, the quality of evidence for all secondary outcomes was very low.

Heterogeneity

I^2 statistic was in excess of the 'substantial' threshold for pain intensity (80%), physical function (64%) and coping (91%). It was in-between 'moderate' and 'substantial' threshold for pain-related disability (57%), depression (58%) and treatment adherence (54%). However, for these outcomes, evaluation of the confidence intervals presented a poor overlap, indicating heterogeneity across the studies. There was no important heterogeneity for pain catastrophising (0%) and pain self-efficacy (0%) [36].

Subgroup analyses

We were able to perform all three pre-planned subgroup analyses on physical function, however, only one subgroup analysis was possible on pain-related disability. As we did not identify heterogeneity across trials that contributed data to pain self-efficacy, we did not carry out further subgroup tests on this outcome.

Treatment type of the initial programme: single modality versus multidisciplinary interventions

Subgroup analyses comparing single modality to multidisciplinary rehabilitation revealed that treatment type had no influence on physical function ($Chi^2 = 2.94$, df = 1 (P = 0.09), $I^2 = 66\%$; Analysis 1.10; Fig. 15). For pain-related disability, since only one trial investigated single modality treatment, the sample size was inadequate to perform this subgroup analysis.

Treatment intensity of the initial programme: intensive versus brief weekly sessions

It was not possible to categorise two studies due to insufficient information and these have been excluded from this subgroup analysis [9,69]. Investigation of the effects of intensive and brief weekly sessions showed no subgroup differences with regards to physical function (Chi^2

= 0.54, df = 1 (P = 0.46), I^2 = 0%; Analysis 1.11; Fig. 16) or pain-related disability (Chi^2 = 0.66, df = 1 (P = 0.42), I^2 = 0%; Analysis 1.13; Fig. 17).

Method of delivery: face-to-face versus remotely delivered boosters

Investigating the impact of face-to-face and remote delivery, the lack of subgroup differences indicated that delivery methods did not influence physical function (Chi^2 = 2.86, df = 1 (P = 0.09), I^2 = 65.1%; Analysis 1.12; Fig. 18). For pain-related disability, only one trial was available with face-to-face delivery, therefore, the small sample size did not allow for subgroup analysis.

Sensitivity analyses

We planned a sensitivity analysis to examine the treatment effects in trials with low risk of bias. However, all studies were at high risk, thus it was not possible to conduct this analysis. The second sensitivity analysis aimed at excluding trials with imputed means or SDs. There was only one trial [9] where SDs from the no booster group was not reported in the follow-up data which we replaced by pre-treatment measures. Removing this study from the analysis did not result in changes to the treatment effects. The third and fourth analyses were to exclude trials with less than 20 patients per trial arm and cluster randomised trials. From each analysis, only one study was excluded [1,50; respectively] and made no difference to the results earlier described.

DISCUSSION

Summary of main results

In this review, we aimed to investigate if adding booster sessions to CMP self-management interventions has additional benefits in sustaining treatment effects. We identified 14 RCTs (1695 patients; 820 booster, 875 no booster) that compared patients receiving booster interventions to patients with no subsequent boosters after completing the same initial treatment programme. Comparisons provided low quality evidence that supplementing self-management programmes with booster sessions significantly reduced pain catastrophising (four studies; 304 patients), one of the secondary outcomes. We did not find benefits to any of the primary outcomes of physical function (11 studies; 1288 patients), pain-related disability (seven studies; 1027 patients) and pain self-efficacy (two studies; 331 patients). Neither were there benefits to the secondary outcomes of pain intensity (13 studies; 1548 patients), depression (eight studies; 1073 patients), coping (four studies; 451 patients) or treatment adherence (three studies; 272 patients).

Subgroup analyses on the primary outcomes were done to find whether the intensity of the main intervention, the number of disciplines involved in intervention delivery and method of delivery (remote vs face to face) influenced the effect of the boosters. We found that the different intensities of the main intervention, did not influence physical function and pain-related disability, and treatment type and method of delivery of boosters did not affect physical function. For the latter two subgroup tests, data for pain-related disability were sparse and it was not possible to include this in the analyses.

The results of this review show that currently there is little evidence that booster sessions are an effective way to improve outcomes for CMP following self-management interventions.

Quality of the evidence

Overall, the quality of evidence is very low. The main reason for this is that all included studies were at high risk of performance bias. While blinding of participants may not be possible, blinding of the outcome assessors is. Other sources of bias were attrition bias and reporting bias. Aside from all studies being at high risk of bias, there were also small sample sizes and heterogeneity of interventions and participants which meant the overall quality of evidence is low.

Outcome reporting was inconsistent across the included studies and not all studies focussed on the recommended outcomes outlined by IMMPACT [19] and Core Outcome Measures in Effectiveness Trials (COMET) [75]. Use of surrogate outcomes may lead to the recommendation of treatments with little meaningful clinical benefit and reduces the ability to pool data across studies.

Adverse effects data were poorly recorded across the board. Of 14 included studies, ten did not report on adverse events. All four studies that did, were on participants with persistent knee pain: three RCTs reported an increase in knee pain for a total of 12 participants in the trials. One study did not find any harmful effects. Adverse events influence treatment compliance and failing to collect data on these is therefore a significant design oversight for studies that aim to improve behaviour maintenance.

Potential biases in the review process

We minimised the potential study selection biases by not restricting the language, sample size, status and year of publication of trials. All trials reported mean and SD outcome values, therefore, there was no need to impute any missing data. Although in one study, we replaced follow-up SD data for the control group by the baseline SD measures, when we removed this

study from the analysis it did not appear to impact the treatment effects. Funnel plot evaluation did not indicate the presence of publication bias, however, the possibility that trials with both positive and negative effects were not published should not be ignored.

This review's crucial biases can be attributed to the few numbers of trials and small study populations for most outcomes, the high clinical and methodological heterogeneity among trials and the high risk of bias in all included studies. In view of this, results of data analyses in this review are not robust, and publication of higher quality studies may substantially alter the magnitude and direction of effect estimates and thus the conclusions of this review.

Limitations and applicability of evidence

All included trials were performed in developed countries in Europe, North America and Australasia. It remains uncertain whether these outcomes can be applied to patients living in other cultural environments and less developed, lower-income countries.

In the included studies, 92% of all participants were female. This review considered patients with all types of CMP (e.g. OA, back pain, neck pain, fibromyalgia), and combined findings. Many of these conditions are more prevalent in women [28,49], in particular fibromyalgia, where 80-90% of cases are diagnosed in females [2]. The gender differences in patient referral to and participation in, chronic pain self-management interventions are not well known and the high proportion of female patients in this review may well reflect real world differences.

To be included in this systematic review, studies would have needed to identify themselves as experiments in self-management intervention. Self-management skills are also delivered in other settings, for example, multidisciplinary chronic pain rehabilitation programmes and psychological intervention programmes for pain but these would not have been included if the self-management component was not explicitly stated. In this respect, the long-standing calls

to standardise the description of all pain-related complex interventions would be useful in the future. [61].

Trials included participants who had suffered from CMP for a variable amount of time (e.g. 1-2 years, 3-5 years and 10 years or over), and some studies had patients with high, whereas others with low baseline symptom intensity. Higher baseline symptom levels and longer duration of pain are predictive factors of poor outcome following rehabilitation [40,42,44]. Although subgroup analysis was not pre-planned to examine the impact of these factors, it may be that those with a more severe, longer duration of baseline symptoms will not benefit as much from booster interventions as those who had suffered from less severe CMP for a shorter time. The observed effect estimates may have been influenced by these variations and these characteristics should be taken into account before extending the applicability of these results to any severity and any duration of symptoms. Additionally, there was considerable clinical heterogeneity in the booster interventions themselves. The therapies that were packaged together within these interventions were varied for example in the exercise regimes and in the components of cognitive and behavioural treatments. There was also an imbalance in the rehabilitation programmes in terms of placing emphasis on psychological, physical and social factors.

Moreover, there were inconsistencies across the scales used to report the outcome of the interventions, therefore, results were calculated and presented in SMD units. A major limitation of using this method is that their exact meaning is more difficult to interpret [33]. Self-management interventions are multicomponent behavioural interventions and are therefore complex by nature [61]. Wide variation in intervention design and trial methodology is a problem that is often encountered in reviews of complex interventions [21,41]. This heterogeneity is difficult to overcome [66] and there is a danger that it drives us to ignore what we can glimpse from the pooling of our knowledge. Our review shows that it is unlikely

that long-term outcomes after self-management interventions can be improved by simply doing more of the same in booster interventions. Only three of the 14 studies included in this review used behaviour change theories to guide the rationale of their booster intervention: one study stated that the booster interventions were guided by social cognitive theory, self-efficacy and the transtheoretical model [3], one trial tested booster interventions specifically targeting catastrophizing [9], and one study targeted fear avoidance and catastrophizing, specifically adding acceptance and commitment therapy and mindfulness components [46]. Although current opinion favours the use of behaviour theories in guiding the design and evaluation of behavioural interventions, a recent review shows that use of theory in self-care research is limited [39]. Our review adds to the literature that calls for a better understanding of behaviour change maintenance [47] and signals to clinicians and health policymakers that adding booster sessions to prolong self-management behaviour is likely to be more effective when they are done in the context of research supported by a clear theoretical framework.

Agreements and disagreements with other studies or reviews

To date, there have been no systematic reviews focusing on the effects of booster sessions following a self-management programme. Only one recent review paper which evaluated interventions aimed at enhancing therapeutic exercise adherence in older adults with musculoskeletal pain identified two studies examining booster sessions [59]. Their pooled analysis revealed from moderate-quality evidence a small but significant effect of booster sessions. The present review did not reach statistical significance, however, showed some signs of enhanced treatment adherence with boosters. These differences in findings may be attributable to the inclusion criteria of both reviews: only one of the two studies was included in the current review [5]. We marked the other trial ineligible because the experimental and control groups received different therapies in the main intervention [63] making the true

effects of the boosters impossible to conclude. None of the other outcomes investigated in the present review was assessed by Nicolson et al. [59], therefore it was not possible to compare findings for the other comparisons and support the results with an explanation.

AUTHOR'S CONCLUSIONS

Implications for practice

There is little evidence that adding booster sessions to CMP self-management programmes is an effective way to improve treatment gains achieved during the primary therapy. This review has found a significant reduction in pain catastrophising levels but given the negative results for all primary outcomes and every other secondary outcome, it is likely that this is a chance finding. Objectively, the studies were few with high heterogeneity, high risk of bias and very low quality of evidence, and at this stage, this would lead us to conclude that there is no clinical practice or health economic justification for adding booster sessions to self-management interventions. This finding is counterintuitive to many clinicians and patients rarely turn down booster sessions when offered. Although it is possible that booster interventions that give strong, better outcomes will be found, we should consider the possibility that the tendency to offer boosters is a reflection of as yet unexplored barriers to moving away from the medical model of care in both participants and health professionals.

Implications for research

Behaviour maintenance after self-management interventions is important to achieve. As complex interventions, studies on this subject should follow consensus-based guidance such as the framework published by the UK Medical Research Council (MRC) [61]. Utilising this framework, as well as clear outcomes measurement using IMMPACT and COMET

recommendations [19,75], would allow more meaningful interpretation of individual studies as well as reduced heterogeneity and more intelligent and robust comparison and pooling of results.

The MRC framework includes drawing on theories of behavioural change. Many behaviour change theories do not tackle the issue of behaviour maintenance [47] and we cannot assume that behaviour maintenance is influenced by the same factors as those that govern initial behaviour change at the time of delivery of the self-management intervention. When designing behaviour maintenance interventions with boosters, the rationale behind the chosen frequency and duration of boosters should be clarified and related to the chosen theoretical model and desired outcomes.

ACKNOWLEDGEMENTS

We thank Steven Bembridge, a member of the UCL Institute of Orthopaedics Library team, for his help creating the search strategy.

We would also like to thank the reviewers of this paper for their insightful suggestions and comments.

Funding sources: This study was supported by the UCL Physical Therapy in Musculoskeletal Healthcare and Rehabilitation MSc.

Conflicts of interest: There are no conflicts of interest.

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Figures

Figure 1. Study flow diagram.

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Table 1. Characteristics extracted from included studies

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Methods	Country, study design, initial treatment setting, initial treatment duration, initial treatment delivered by, delivery method of boosters, number of sessions, duration and time points of boosters, booster sessions delivered by.
Participants	Diagnosis, age, number of female and total number of participants, post-randomisation dropouts, reason for dropouts, revised sample size, number of patients in each group, pain duration, pain intensity, inclusion/exclusion criteria and adverse events.
Interventions	Treatment type, study groups, detailed treatments included in the initial and booster sessions.
Outcomes	List of outcomes which were interest of this review and assessed in the study, questionnaires used for assessment, details on questionnaires, comments on validation and time point of data collection.
Notes	Other outcomes measured and additional trial arms in the study, further comments on the intervention.

Table 2. Characteristics of included studies

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Abbott et al. [1]

Methods	**Country:** New Zealand **Study design:** parallel **Initial treatment setting:** Outpatient Physiotherapy and Orthopaedics Departments, Dunedin Hospital, New Zealand **Initial treatment duration:** booster: 8 x 45 mins initial plus 4 booster; no booster: 12 x 45 mins sessions within 9 weeks **Initial treatment delivered by:** one physical therapist **Delivery method of boosters:** face-to-face **Number of sessions, duration, time-points:** 4x in total; 2 booster sessions at 5 months, 1 booster session at 8 months, and 1 booster session at 11 months **Booster sessions delivered by:** one physical therapist
Participants	**Diagnosis:** knee OA **Age (mean, SD):** booster: 65±10, no booster: 64±10 **Female (n):** booster: 11, no booster: 11 **Total number of participant**s: 38 **Post-randomisation drop-outs:** 4 **Reason for drop-outs:** unable to contact (1), illness (1), personal reasons (1), unknown (1) **Revised sample size:** 34 **Number of patients in booster/no booster groups:** 18/16 (Analysed: 18/16) **Pain duration (booster/no booster; n):** less than 1y: 3/4, 1-2y: 2/3, 3-5y: 3/3, 5-10y: 9/4, more than 10y: 2/5 **Pain intensity at baseline (mean; booster/no booster):** 3.4/2.1 (Max score: 10) **Inclusion criteria:** 40 years of age or older; meet the American College of Rheumatology clinical criteria for a diagnosis of knee OA **Exclusion criteria:** rheumatoid arthritis; previous knee or hip joint replacement surgery of the affected joint; any other surgical procedure on the lower limbs in the previous 6 months; surgical procedure on the lower limbs planned in the next 6 months; initiation of opioid analgesia or corticosteroid or analgesic injection intervention for hip or knee pain within the previous 30 days; physical impairments unrelated to the hip or knee that would prevent safe participation in exercise, manual therapy, walking, or stationary cycling; inability to comprehend and complete study assessments or comply with study instructions; or stated inability to attend or complete the proposed course of intervention and follow-up schedule. **Adverse events:** 1 (booster)
Interventions	**Treatment type of the initial programme:** single modality (exercise therapy) **Study groups:** exercise therapy with booster sessions (ExB) vs. exercise therapy without booster sessions (Ex) **Initial treatment:** exercise therapy protocol consisted of a multimodal, supervised program of warm-up/aerobic, muscle strengthening, muscle stretching, and neuromuscular control exercises, additional exercise therapy interventions were prescribed individually for each participant, based on the physical examination findings **Treatment in booster sessions:** same as initial
Outcomes	1, Pain - 0-10 Numeric Rating Scale (no further details) 2, Physical function (pain, stiffness, physical function) - WOMAC Osteoarthritis Index (24 items, 0-to-10, total 0 to 240) - validated (Total scores) **Data collection:** 1 year
Notes	**Other measures not extracted from the study:** treatment success (OMERACT-OARSI responder criteria), NPRS (in the case of bilateral symptoms to identify most painful knee), timed up-and-go test, 30-second sit-to-stand test, and 40-meter fast-paced walk test

	Other trial arms: 4 arms: 1, exercise therapy without booster sessions, 2, exercise therapy with booster sessions, 3, exercise therapy plus manual therapy with no booster sessions, 4, exercise therapy plus manual therapy with booster sessions - groups 3 & 4 were not used for comparison. **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The random allocation sequence was generated...with an online service (http://www.randomization.com), included randomly permuted blocks of 8 and 12 participants per block".
Allocation concealment (selection bias)	Low risk	Quote: "Random allocation sequence...was concealed from recruitment staff, assessors, and treatment providers. Eligible participants were randomly allocated to each group by a researcher who was not involved in participant assessment or treatment.".
Blinding of participants and personnel (performance bias)	High risk	Quote: "Due to the nature of the interventions, it was not possible to blind treatment providers to group allocation".
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Baseline and follow-up testing was conducted by research staff blinded to group allocation".
Incomplete outcome data (attrition bias)	Low risk	Quote: "Multiple imputed and complete case analyses were performed...with the imputed analysis performed for the intention-to-treat analysis and the complete case analysis to reveal any sensitivity to the imputed values".
Selective reporting (reporting bias)	High risk	Comment: Outcomes, such as anxiety, depression and health-related quality of life prespecified as secondary outcomes in the registered protocol were not reported (Australian New Zealand Clinical Trials Registry: ACTRN12612000460808).
Source of funding	Low risk	Quote: "The study was supported in part by the New Zealand Lottery Grants Board, the New Zealand Society of Physiotherapists Scholarship Trust, the Health Research Council of New Zealand, and a University of Otago Research Grant. Dr Abbott was supported in part by a Sir Charles Hercus Health Research Fellowship from the Health Research Council of New Zealand. The funders have had no influence on the content of that work or the current article. The authors certified that they had no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article".
Other bias	Low risk	Comment: There was no other source of bias.

Baker et al. [3]

Methods	**Country:** USA **Study design:** parallel **Initial treatment setting:** group-based exercise class, no other information **Initial treatment duration:** 6 weeks, 12 sessions 2 sessions per week, minimum attendance of at least 8 of the 12 **Initial treatment delivered by:** trained exercise physiologist or physical therapist **Delivery method of boosters:** Computer-based telephone counseling (telephone linked communication (TLC) **Number of sessions, duration, time-points**: 2 years, calls were 1/week for the first six months, then 1/month for the remaining 18 months **Booster sessions delivered by:** n/a
Participants	**Diagnosis:** knee OA

	Age (mean, SD): booster: 65.8 ± 6.6, no booster: 64.5 ± 8.3 **Female (n):** booster: 42, no booster: 43 **Total number of participants:** 104 **Post-randomisation drop-outs:** 15 **Reason for drop-outs:** discontinued intervention (5), lost to follow-up (10) **Revised sample size:** 89 **Number of patients in booster/no booster groups:** 45/44 (Analysed: 52/52) **Pain duration (booster/no booster; n):** n/a **Pain intensity at baseline (mean; booster/no booster):** 5.43/5.08 (Max score: 20) **Inclusion criteria:** age 50 or older, self-reported physician diagnosed knee OA, a WOMAC pain subscale score of >=4 or notation of knee pain on most days in the previous month or most months in the previous year...being able to use a telephone and a successful screen for exercise readiness on the PAR-Q. **Exclusion criteria:** "a medical condition precluding exercise (stroke or myocardial infarction in the past 3 months, treatment for cancer, severe systemic disease), a medical condition that limited physical function more than the knee pain including back or hip pain, inflammatory arthritis, current regular strength training (one or more times per week) in the last 6 months, plan for knee replacement during the trial, bilateral knee replacement, and dementia or inability to follow exercise instructions and use the TLC system. The content of the BOOST-TLC counseling was based on Social Cognitive Theory, self-efficacy and the Transtheoretical Model...addressed common barriers to exercise...and ways to overcome the barriers...". **Adverse events:** n/a
Interventions	**Treatment type of the initial programme:** single modality (exercise therapy) **Study groups:** Boston Overcoming Osteoarthritis through Strength Training Telephone-Linked Communication (BOOST-TLC) vs. control **Initial treatment:** progressive resistive strength training program, "individualized for each study participant. Each session consisted of squats, stepups, pelvic tilts, hip abduction, and knee extension and flexion with ankle weights", weight was adjusted "to maintain a “somewhat hard” level of muscle intensity for 2 sets of 8-15 repetitions". **Treatment in booster sessions:** "components: 1) an assessment of exercise behavior over the previous two weeks determined by how often the participant performed the BOOST exercises, 2) exercise goal setting utilizing information from the previous and current calls, 3) counseling messages to overcome the most common barriers to exercise adherence for people with arthritis, 4) information on lapsing if participant was not currently exercising, and 5) alerts to the study team when the user experienced bad pain or an extended lapse in exercise (>4weeks)".
Outcomes	1, Adherence - single self-report item, 0 (not at all) to 10 (completely as instructed), “How would you rate your level of adherence to the prescribed BOOST exercise program, over the last 3 MONTHS? 2, Pain - WOMAC Osteoarthritis Index (0-20) - validated 3, Physical function - WOMAC Osteoarthritis Index (0-68) - validated **Data collection:** 24 months
Notes	**Other measures not extracted from the study:** other functional performance assessments **Other trial arms:** none **Other comments:** Both intervention and control participants "received the same monthly automated phone message reminding them to strength train and complete the exercise logs for 24 months". "The call did not contain any motivational programming and was not interactive." Both groups "had access to a booster session with an interventionist if they became sick and had difficulty resuming the prescribed exercise program". - Adherence in post-hoc analyses, the variable was dichotomized into no adherence (0-3) and adherence (4-10).

Risk of bias table

Bias	Author's judgement	Support for judgement

Random sequence generation (selection bias)	Low risk	Quote: "A computer generated the randomization list stratified by gender and age (<75 years, ≥ 75 years) and blocked with groups of 4".
Allocation concealment (selection bias)	Low risk	Quote: "Study investigators and data collectors were blinded to assignment and were unaware of the randomization scheme. Assignments were placed in sealed and opaque envelopes in numerical order maintained in a locked file by the study coordinator".
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Low risk	Comment: Outcome data was administered by phone.
Incomplete outcome data (attrition bias)	Low risk	Quote: "Analyses were performed using the intention-to-treat (ITT) approach. To prevent subject withdrawal from the study from compromising the ITT analyses, we used multiple imputation to fill in values for subjects missing visits after baseline and to fill- in missing covariate data if necessary".
Selective reporting (reporting bias)	Low risk	Comment: All outcomes were reported as per registered protocol (ClinicalTrials.gov: NCT01394874).
Source of funding	Low risk	Quote: "The authors report no financial conflicts of interest".
Other bias	Low risk	Comment: There was no other source of bias.

Bennell et al. [5]

Methods	**Country:** Australia **Study design:** parallel **Initial treatment setting:** private practices **Initial treatment duration:** 10-14x 30–40 minutes over 12 weeks + 4x/week home exercise **Initial treatment delivered by:** 9 physiotherapists (average 12ys experience) **Delivery method of boosters:** face-to-face individual exercise sessions **Number of sessions, duration, time-points:** 2x 30 mins, over 24-weeks, at weeks 8 and 16 (from the end of the original RCT) **Booster sessions delivered by:** 9 physiotherapists who delivered initial therapy
Participants	**Diagnosis:** knee OA **Age (mean, SD):** booster: 60.5±6.6, no booster: 63.7±7.0 **Female (n):** booster: 24, no booster: 33 **Total number of participants:** 78 **Post-randomisation drop-outs:** 4 **Reason for drop-outs:** had knee replacement (2), could not contact (1), death in the family (1) **Revised sample size:** 74 **Number of patients in booster/no booster groups:** 38/36 (Analysed: 38/36) **Pain duration (median (IQR) months):** booster: 66.0(36–120), no booster: 84.0(27–120) **Pain intensity at baseline (mean; booster/no booster):** 33/27.7 (Max score: 100) **Inclusion criteria:** average knee pain over the past week 25 on a 100-mm Visual Analog Scale, pain/tenderness predominantly over the medial knee region, and radiographic medial tibiofemoral joint OA, attended at least 10 of the 14 physiotherapy sessions of the initial programme **Exclusion criteria:** knee surgery or intraarticular corticosteroid injection within 6 months, systemic arthritic conditions, prior hip or knee joint replacement or tibial osteotomy surgery, body mass index (BMI) 36 kg/m2 **Adverse events:** 6 (4x booster, 2 no booster)
Interventions	**Treatment type of the initial programme:** single modality (exercise therapy) **Study groups:** booster group vs. no booster group **Initial treatment:** neuromuscular or quadriceps strengthening exercises, 1) weight-bearing neuromuscular exercises focusing on quality and control of movement, hip muscle strengthening, and balance, or 2) non–weight-bearing quadriceps strengthening exercises. Resistance was provided through ankle weights or elastic bands.

	Treatment in booster sessions: reviewing the home exercise program content and dose, increasing the dose, observing the patient performing the home exercises and correcting form if necessary, discussing progress and adherence, focusing on barriers to home exercise performance and strategies to overcome these barriers
Outcomes	1, Pain - Visual Analog Scale (0–100-mm) - validated 2, Physical function - WOMAC Osteoarthritis Index (17 items, 0–68) - validated 3, Adherence - by questionnaire about the number of times home exercises completed, self-rated overall average adherence (11-point numeric rating scale, 0-10) - unclear validation **Data collection:** 24-week
Notes	**Other measures not extracted from the study:** none **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Group allocation was randomized within random permuted blocks of 6 or 8 generated a priori, using a computer-generated random number table and stratified according to the type of exercise (neuromuscular or strengthening) performed by the participant in the original RCT".
Allocation concealment (selection bias)	Low risk	Quote: "...numbered, sealed opaque envelopes containing group allocation were prepared by a different researcher with no other involvement in the study and kept in a locked central location. Another researcher not involved in recruitment opened the next sequential envelope and informed the participant of their group allocation..."
Blinding of participants and personnel (performance bias)	High risk	Quote: "By necessity, neither the participants nor the physiotherapists were blinded to group allocation."
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Outcome measures were collected...at 24 weeks via mail.There was no outcome assessor as measures were self-report questionnaires".
Incomplete outcome data (attrition bias)	Low risk	Comment: Low dropout rate.
Selective reporting (reporting bias)	High risk	Comment: Outcomes, such as quality of life, self-efficacy, pain catastrophising, coping and adverse events were not reported as per registered protocol (Australian New Zealand Clinical Trials Registry: ACTRN12612000595819).
Source of funding	Low risk	Quote: "Supported by the National Health and Medical Research Council (631717). Dr. Bennell's work was supported by an Australian Research Council Future Fellowship. Dr. Hodges's work was supported by a National Health and Medical Research Council Senior Principal Research Fellowship (APP-1002190)".
Other bias	Low risk	Comment: There was no other source of bias.

Buhrman et al. [9]

Methods	**Country:** Sweden **Study design:** parallel **Initial treatment setting:** pain centre at the University hospital in Uppsala, Sweden **Initial treatment duration:** not reported **Initial treatment delivered by:** a CBT-trained psychologist, a physiotherapist, an occupational therapist, a social worker and a physician specialized in rehabilitation medicine **Delivery method of boosters:** Internet-based **Number of sessions, duration, time-points:** 8 weeks, 8 modules 1 module/week **Booster sessions delivered by:** therapists who were graduate students in their last term of clinical

	psychology studies, and were trained in CBT and received weekly supervision by a clinical psychologist
Participants	**Diagnosis:** chronic MSK pain (neck, back, shoulder, widespread e.g fibromyalgia) **Age (mean, SD):** booster: 39.9(9.13), no booster: 40.2(8.8) **Female (n):** booster: 26, no booster: 26 **Total number of participants:** 66 **Post-randomisation drop-outs:** 10 **Reason for drop-outs:** did not complete post-assessment and could not be reached (10) **Revised sample size:** 56 **Number of patients in booster/no booster groups:** 26/30 (Analysed: 36/36) **Pain duration (years; mean, SD):** booster: 6.4(2.13), no booster: 6.1(2.04) **Pain intensity at baseline (mean; booster/no booster):** 3.79/4.03 (Max score: 10) **Inclusion criteria:** patients who were 1–5 years post-completing the multidisciplinary pain treatment programme, participants had to have been medically investigated (within 1 year), have residual symptoms after the rehabilitation treatment (defined as functional impairment caused by their pain) and have access to the Internet **Exclusion criteria:** planned surgery, ongoing medical investigation that could impede participation in the study, suffering from acute physical or psychological conditions, confinement to wheelchair or not being fluent with the Swedish language **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary **Study groups:** treatment (Internet-based treatment programme) vs. control **Initial treatment:** multidisciplinary CBT-based rehabilitation programme with focus on behaviour change through the use of different strategies such as applied relaxation, cognitive techniques, physiotherapy exercises, pacing and education about ergonomics **Treatment in booster sessions:** CBT-based, consistent with the multidisciplinary clinical treatment programme and some new elements: education about chronic pain, CBT, stress, physical exercise and anatomy,relaxation, treatment goals, ergonomics, pacing, activity planning, cognitive restructuring, mindfulness, sleep hygiene, relapse and maintenance planning
Outcomes	1, Coping - Coping Strategies Questionnaire (50 items 8 scales) - validated 2, Catastrophising - CSQ as above 3, Depression - Hospital Anxiety and Depression Scale (14 items) - validated 4, Pain (pain severity) - Multidimensional Poverty Index (52 items 13 scales) - validated 5, Disability (activity engagement) - Chronic Pain Acceptance Questionnaire (0-66) - validated **Data collection:** 6 months (post-booster)
Notes	**Other measures not extracted from the study:** Other measures not extracted from the study: impression of improvement, pain and impairment relationship, chronic pain acceptance. **Other trial arms:** none **Other comments:** *The control group participated in an online discussion forum. To ensure that this did not influence results and given that control group outcome measures were not taken at 6 months follow-up, pre-treatment measures were extracted for comparison. *Patients participated in the initial programme 1-5 years prior to the boosters. Therefore, although follow-up was at 6 months after booster, this study can be treated as a long-term follow-up study (18 months+).

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was made by an independent person using a true random number service (http:// www.random.org)".
Allocation concealment (selection bias)	Unclear risk	Comment: This information was not available.

Blinding of participants and personnel (performance bias)	High risk	Quote: "Participants were informed about which group they had been randomly assigned to after the assessment procedures". Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Selfreport measures were administered via the Internet". Comment: Lack of blinding will not result in bias for this outcome.
Incomplete outcome data (attrition bias)	Low risk	Quote: "Data were analysed using the intention-to-treat principle with all available data regardless of completion of the actual treatment. Intention-to-treat analyses were conducted with PASW Missing Value Analysis (SPSS...) to impute all missing data on the continuous measures with the expectation–maximization method".
Selective reporting (reporting bias)	Low risk	Comment: All outcomes were reported as per registered protocol (ClinicalTrials.gov: NCT01491269).
Source of funding	Low risk	Quote: "M.B. was sponsored in part by the Multidisciplinary Pain Center at Uppsala University Hospital. G.A. was sponsored in part by Linköping University, Swedish Council for Working and Life Research, and a grant from Rehsam/Vårdalsstiftelsen".
Other bias	Low risk	Comment: There was no other source of bias.

Calner et al. [10]

Methods	**Country:** Sweden **Study design:** parallel **Initial treatment setting:** 17x healthcare centres **Initial treatment duration:** 2-3 sessions per week, for at least 6 weeks, 6-8 weeks **Initial treatment delivered by:** "at least three different healthcare professionals (physiotherapist, physician, occupational therapist, psychologist, or psychosocial counsellor, nurse" **Delivery method of boosters:** web-based **Number of sessions, duration, time-points:** access to the Web-Based Behaviour change programme 24/7, for 16 weeks, access restricted to one new module per week, for 8 weeks following MMR **Booster sessions delivered by:** n/a
Participants	**Diagnosis:** Persistent MSK pain (neck, back, shoulder plus other generalised) **Age (mean, SD):** booster: 44(10), no booster: 42(11) **Female (n):** booster: 47, no booster:37 (prior to dropout) **Total number of participants:** 99 **Post-randomisation drop-outs:** 19 **Reason for drop-outs:** discontinued study, organisational error (changing of rehabilitation coordinator, not being able to make contact with participant) **Revised sample size:** 80 **Number of patients in booster/no booster groups:** 44/36 (Analysed: Physical function, disability, depression: 44/36; Self-efficacy, catastrophising: 55/44; Pain intensity, coping: 55/43) **Pain duration in months (mean, SD):** booster: 79(97), no booster: 78(99) **Pain intensity at baseline (mean; booster/no booster):** 66.1/64.7 (Max score: 100) **Inclusion criteria:** (1) age between 18 and 63 years (2) persistent musculoskeletal pain from the back, neck, and shoulders, and/or a generalized pain condition with a duration of at least three months (3) an €Orebro Musculoskeletal Pain Screening Questionnaire score (€OMPSQ) ≥ 90 (screening for psychosocial factors that indicates an estimated risk for long-lasting pain conditions and future disability) (4) work ability of at least 25 percent; (5) ability to understand and speak fluent Swedish; (6) access to a computer with Internet connection **Exclusion criteria:** reduced cognitive ability (dementia, brain injury); current abuse of alcohol or drugs; need of other healthcare (e.g. advanced medical investigation, cancer treatment, terminal care); and pregnancy **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary

	Study groups: multimodal rehabilitation (MMR) vs. MMR-web **Initial treatment:** physical activity, physiotherapy treatment (“acupuncture, transcutaneous electric nerve stimulation, or manual therapy), ergonomics, activity planning, and functional training,” counselling therapy for behaviour change towards activity and participatory goals, pharmacological adaptions, education, relaxation, mindfulness **Treatment in booster sessions:** 8 modules on ”(1) pain, (2) activity, (3) behaviour, (4) stress and thoughts, (5) sleep and negative thoughts, (6) communication and self-esteem, (7) solutions, and (8) maintenance and progress, following cognitive and behavioural principles”
Outcomes	1, Pain - Visual Analog Scale (0-100mm) - validated 2, Disability - Pain Disability Index (7 subscales, 0-10) - Swedish version - original and Swedish versions validated 3, Physical functioning - SF-36 Short Form Survey (36 items, 8 subscales, 0-100) - Swedish version - both versions validated 4, Depression (mental health) - SF-36 as above 5, Self-efficacy - Arthritis Self-Efficacy Scale ("self-efficacy to control pain" - 5 items, 10-100) - Swedish version - both versions validated 6, Coping - Coping Strategies Questionnaire (2 items, 7 subscales, 0-6) - Swedish version - both versions validated 7, Catastrophising - CSQ as above **Data collection:** 12 months
Notes	**Other measures not extracted from the study:** web activity adherence, web program feasibility and treatment satisfaction, general self-efficacy, work-related behaviour, **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The allocation sequences, stratified for sex and separate for each healthcare centre, were obtained by a randomly computer-generated number sequence and provided by an independent statistician".
Allocation concealment (selection bias)	Low risk	Quote: Randomisation "by sealed, numbered opaque envelopes".
Blinding of participants and personnel (performance bias)	High risk	Quote: "The MMR team was not informed of the participants’ allocated intervention, unless the participants chose to mention so themselves". Comment: participants were not blinded and it is possible that the MMR team was told by the participants about the group allocation. Appropriate blinding of participants was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	Quote: "The participants met with the rehabilitation coordinator at the health care center and filled in a questionnaire". Comment: See above, it is unclear if the rehabilitation team was aware of the allocation.
Incomplete outcome data (attrition bias)	Low risk	Quote: Nordin 2016 - "Participants lost to follow-up were handled with intention-to-treat (ITT) analysis, with last observation carried forward (LOCF)". Quote: Calner 2017 - "The dropout analyses at 12 months, comparing baseline scores of those attending 12 month with those not attending, showed no significant differences for any outcome measure".
Selective reporting (reporting bias)	Low risk	Comment: All outcomes were reported as per registered protocol (ClinicalTrials.gov: NCT01475591).
Source of funding	Low risk	Quote: "The project is part of the national research project REHSAM (REHabilitering och SAMordning) in Sweden, and is financed by REHSAM. The REHSAM project is a cooperation between the Swedish Social Insurance Agency, the Ministry of Health and Social Affairs,

		the Swedish Association of Local Authorities and Regions, and the Vardal Foundation".
Other bias	Low risk	Comment: There was no other source of bias.

Fitzgerald et al. [21]

Methods	**Country:** USA **Study design:** parallel **Initial treatment setting:** outpatient clinic, physical therapy department **Initial treatment duration:** booster: 8 x 45 mins initial plus 4 booster; no booster: 12 x 45 mins sessions within 9 weeks **Initial treatment delivered by:** physical therapists **Delivery method of boosters:** face-to-face **Number of sessions, duration, time-points:** 4x in total; "2 booster sessions at 5 months, 1 booster session at 8 months, and 1 booster session at 11 months" **Booster sessions delivered by:** physical therapists
Participants	**Diagnosis:** knee OA **Age (mean, SD):** booster: 58.4(8.7), no booster: 58.3(10.0) **Female (n):** booster: 51, no booster: 52 **Total number of participants:** 151 **Post-randomisation drop-outs:** 20 **Reason for drop-outs:** not reported **Revised sample size:** 131 **Number of patients in booster/no booster groups:** 63/68 (Analysed: 76/75) **Pain duration (booster/no booster; n):** <1 year: 9/8,1-2 years: 10/12, 3-5 years: 19/14, 5-10 years: 18/25, >10 years: 20/16 **Pain intensity at baseline (mean; booster/no booster):** 6/5.4 (Max score: 10) **Inclusion criteria: "**40 years of age, meet the American College of Rheumatology's 1986 Clinical Criteria for knee OA" **Exclusion criteria: "**not in age range, had TKA, had history of excluding co-morbidity, did not meet the ACR criteria, were scheduled for total knee arthroplasty (TKA), had undergone total joint arthroplasty of any lower extremity joint, exhibited uncontrolled hypertension, answered "Yes" to the question at the time of recruitment: "Do you currently have back or leg pain in other areas besides your knee that affects your ability to perform physical activities?", or had history of neurological disorders that would affect lower extremity function (stroke, peripheral neuropathy, Parkinson's disease, multiple sclerosis)" **Adverse events:** 5 (2x booster, 3 no booster)
Interventions	**Treatment type of the initial programme:** single modality (exercise therapy) **Study groups:** exercise therapy with booster sessions (ExB) vs. exercise therapy without booster sessions (Ex) **Initial treatment: "**10 min aerobic warm-up, series of strengthening, stretching, and neuromuscular control (agility and balance training techniques) activities, in addition therapists had the option to select additional exercise activities, based on initial examination findings. These exercises addressed strength or flexibility in the hip and ankle if impairments were identified on initial examination + home programs twice/week or more and to engage in at least 30 min of aerobic exercise at least 3 times/week." **Treatment in booster sessions:** same as initial
Outcomes	1, Pain - 0-10 Numeric Rating Scale (no further details) 2, Physical function (pain, stiffness, physical function) - WOMAC Osteoarthritis Index - validated (Total scores) **Data collection:** 1 year
Notes	**Other measures not extracted from the study:** treatment success (OMERACT-OARSI responder criteria), in case of bilateral symptoms- worst knee pain, timed up-and-go test, chair-rise test, and 40-meter walk test **Other trial arms:** 4 arms: "1, exercise therapy without booster sessions, 2, exercise therapy with booster sessions, 3, exercise therapy plus manual therapy with no booster sessions, 4, exercise therapy plus manual therapy with booster sessions" - groups 3 & 4 were not used for comparison.

	Other comments: none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "A computer generated randomisation scheme with stratification based on study site and bilateral involvement was employed".
Allocation concealment (selection bias)	Low risk	Quote: "Automated randomised group assignment was triggered in the data entry system...The system ensured allocation concealment".
Blinding of participants and personnel (performance bias)	High risk	Quote: "It was not possible to blind participants from treatment they received or physical therapists from interventions they provided".
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Outcome assessors were blinded to treatment group allocation and did not perform interventions".
Incomplete outcome data (attrition bias)	Low risk	Quote: "All...randomised participants who completed baseline assessments, regardless of whether they completed follow-up assessments...were included. In addition to allowing the inclusion of all...participants on an intention-to-treat basis, the use of mixed models allowed to estimate treatment effects at 1 year using a single model per outcome. This approach assumes a missing completely at random missing data mechanism for dropout over time".
Selective reporting (reporting bias)	High risk	Comment: Change in outcomes, such as anxiety, depression and health-related quality of life prespecified as secondary outcomes in the registered protocol were not reported. Only baseline scores were reported as potential covariates in case it needed to be accounted in the final analysis. (ClinicalTrials.gov: NCT01314183).
Source of funding	Low risk	Quote: "This study was funded by a grant from the Agency for Healthcare Research and Quality (AHRQ), grant #R01HS019624-01. The study sponsors did not play a role in the study design, collection, analysis and interpretation of data; in the writing of the manuscript; and in the decision to submit the manuscript for publication".
Other bias	Low risk	Comment: There was no other source of bias.

Gialanella et al. [26]

Methods	**Country:** Italy **Study design:** parallel **Initial treatment setting:** outpatient rehabilitation department **Initial treatment duration:** 10x sessions over 2 weeks (5days/week) **Initial treatment delivered by:** physical therapists **Delivery method of boosters:** home-based telemedicine **Number of sessions, duration, time-points:** 6 months, fortnightly scheduled phone calls, patients could also phone the nurse at any time **Booster sessions delivered by:** nurse tutor and physiatrist
Participants	**Diagnosis:** chronic nonspecific neck pain **Age (mean, SD):** booster: 56.0(14.0), no booster: 60.1(11.0) **Female (n):** booster: 42, no booster: 42 **Total number of participants:** 100 **Post-randomisation drop-outs:** 6 **Reason for drop-outs:** 6 months follow-up evaluation was not performed **Revised sample size:** 94 **Number of patients in booster/no booster groups:** 47/47 (Analysed: 47/47)

	Pain duration (months): booster: 68.0(43.0), no booster: 89.2(64.0) **Pain intensity at baseline (mean; booster/no booster):** 6.8/6.6 (Max score: 10) **Inclusion criteria: "**older than 18 years; neck pain duration of more than 6 months; patients with neck pain, which could be reproduced by neck movement or provocation tests in an area limited between the occipital and the third thoracic vertebra" **Exclusion criteria: "**pain duration of less than 6 months; cognitive deficit (e.g., Alzheimer disease or senile dementia); history of fracture or operations around the neck region; presence of inflammatory rheumatic diseases, neurological diseases that could lead to neck pain; infections or tumours; pregnancy; previous rehabilitation for neck pain undergone within the last 12 months; inability to attend all exercise sessions of our outpatient rehabilitation program" **Adverse events:** no adverse effects
Interventions	**Treatment type of the initial programme:** single modality (exercise therapy) **Study groups:** home-based telemedicine (HBT) group vs. no HBT group **Initial treatment: "**6 stretching exercises repeated 6 times lasting 20 secs followed by a 10-second rest interval (forward neck flexion, backward neck extension, neck rotation, and lateral neck flexion toward the right and left)" **Treatment in booster sessions:** nurse – "collected information on disease status, pain, disability, prodromal symptoms of exacerbation, number of home exercise sessions performed, and use of nonsteroidal anti-inflammatory drugs; physiatrist - gave advice on solutions for persistent pain and any symptoms of exacerbation"
Outcomes	1, Pain - Visual Analog Scale (0-10) – validated 2, Neck disability - Neck Disability Index (10 items, 0-3, 0-50 total) - validated 3, Adherence - self-reported measures (no further details) - unclear validation **Data collection:** 6 months
Notes	**Other measures not extracted from the study:** disease burden, neck range of motion, opinion about programme **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "patients were randomised using a randomisation list provided by the statistical consultant".
Allocation concealment (selection bias)	Unclear risk	Comment: This information was not available.
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	Quote: "All patients were evaluated...by the same qualified physiatrist".No further information was available if the assessor was blinded.
Incomplete outcome data (attrition bias)	Low risk	Comment: Low dropout rate.
Selective reporting (reporting bias)	Low risk	Comment: All outcomes were reported as per registered protocol (ClinicalTrials.gov: NCT02736851).
Source of funding	Low risk	Quote: "The research was not supported by pharmaceutical companies. The research was supported by a grant from Lombardy Region...Financial disclosure statements have been obtained, and no conflicts of interest have been reported by the authors or by any individuals in control of the content of this article".
Other bias	Low risk	Comment: There was no other source of bias.

Kristjansdottir et al. [45]

Methods	**Country:** Norway **Study design:** parallel **Initial treatment setting:** inpatient multidisciplinary rehabilitation **Initial treatment duration:** 4 weeks **Initial treatment delivered by:** not reported **Delivery method of boosters: "**One face-to-face interview and four weeks of written communication via a smartphone" **Number of sessions, duration, time-points:** face-to-face session 1 hour - during the last week of inpatient programme, smartphone intervention - right after completion of the inpatient programme for 4 weeks **Booster sessions delivered by:** face-to-face session - nurse, feedback - therapists
Participants	**Diagnosis:** Chronic widespread pain (CWP), fibromyalgia **Age (mean, SD):** booster: 44.59(11.13), no booster: 43.80(11.20) **Female:** all participants were female **Total number of participants:** 140 **Post-randomisation drop-outs:** 58 **Reason for drop-outs:** 13 participants did not receive allocated intervention (met exclusion criteria (5), left the rehabilitation centre (1), decided not to participate (7)), discontinued intervention (15), lost to 11-months follow up (28) **Revised sample size:** 82 **Number of patients in booster/no booster groups:** 39/43 (Analysed: 39/43) **Pain duration (years; mean, SD):** booster: 13.11(8.78), no booster: 15.47(12.09) **Pain intensity at baseline (mean; booster/no booster):** 66.59/57.32 (Max score: 100) **Inclusion criteria: "**Chronic widespread pain for more than 6 months (with or without a diagnosis of fibromyalgia), female, 18 years or older, attended a 4-week inpatient multidimensional rehabilitation program for chronic pain, not primarily submitted for vocational rehabilitation, not participating in another research project at the rehabilitation centre, being able to use a smartphone, not being diagnosed with a profound psychiatric disorder" **Exclusion criteria:** not reported **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary **Study groups:** smartphone intervention vs. control **Initial treatment: "**multidimensional, education in pain mechanisms and CBT-based pain management (approximately 20 hours), various forms of aerobic exercise, stretching, relaxation, individual myofascial pain treatment, and medication was administered as needed" **Treatment in booster sessions: "**smartphone intervention was based on the cognitive behavioral fear-avoidance model, CBT, acceptance and commitment therapy, mindfulness exercises; during face-to-face session participants received information about their therapist for the intervention, web-based diaries, daily written personalised feedback from therapist according to participant's situation reported in the diary, reminders on the content of diaries, self-management information given at the centre, positive reinforcement, ACT exercises, reflective questions"
Outcomes	1, Pain - Visual Analogue Scales (0-100) – validated 2, Disability (distress and disability) - Chronic Pain Acceptance Questionnaire (0-6, 0-120 total) – validated 3, Physical functioning - SF8 Short-form Health Survey (no details) – validated 4, Depression (mental health) - SF8 as above 5, Catastrophising - Pain Catastrophising Scale (13 items, 0-4) - validated **Data collection:** "11 months after the smartphone intervention period (12 months after discharge from the inpatient programme)"
Notes	**Other measures not extracted from the study:** chronic pain acceptance, general health, importance and success in living, impact of fibromyalgia, SF-8 mental health, fatigue, sleep disturbance **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "A computer-generated sequence list with the 2 groups randomized in blocks of 4 was used".
Allocation concealment (selection bias)	Low risk	Quote: "A research assistant put the allocation information in sequentially numbered envelopes and sealed them. A researcher subsequently gave each participant a number and opened the matched envelope to reveal the group allocation".
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	Quote: "self-report administration mode at the rehabilitation center" Comment: No further information was available.
Incomplete outcome data (attrition bias)	High risk	Comment: High post-randomisation drop-outs. Intention-to-treat analysis were only applied for the primary outcome (catastrophising). In the secondary outcomes (all other outcome), only those were included who completed the intervention.
Selective reporting (reporting bias)	Low risk	Comments: All outcomes were reported as per registered protocol (ClinicalTrials.gov: NCT01236209).
Source of funding	Low risk	Quote: "The study is primarily funded by the Research Council of Norway (Grant No. 182014)".
Other bias	Low risk	Comment: There was no other source of bias.

Lorig and Holman [49]

Methods	**Country:** USA **Study design:** parallel, cluster randomised **Initial treatment setting:** community sites (libraries, senior citizens centres, churches, hospitals, shopping centres), groups, 12-18 participants **Initial treatment duration:** 6x 2 hours weekly sessions **Initial treatment delivered by:** lay leaders who received 15-18 hours of training **Delivery method of boosters:** Arthritis Reinforcement Course, same as initial self-management course **Number of sessions, duration, time-points:** same as initial self-management course, held 12 months after baseline of initial **Booster sessions delivered by:** not reported, possibly by lay leaders
Participants	**Diagnosis:** arthritis **Age (mean, SD):** 64(12.2) (of total participants) **Female (n):** 424 (of total participants) **Total number of participants:** 589 **Post-randomisation drop-outs:** 46 (plus 288 participants were offered a place in the reinforcement course but only 70 participated *see comment below) **Reason for drop-outs:** no reason given (28), “requested to be dropped for personal reasons (7), had illness other than arthritis (3), died (1), lost to contact (2), disliked the questionnaire (2), had surgery related to their arthritis (1)” **Revised sample size:** 543 **Number of patients in booster/no booster groups:** 70/153 (Analysed: 70/153) **Pain duration:** not reported **Pain intensity at baseline (mean; booster/no booster):** 4.2/4.2 (Max score: 10) **Inclusion criteria:** not reported, but “diagnosis and type of arthritis were confirmed by the subject’s physician” **Exclusion criteria:** not reported **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary

	Study groups: Arthritis Reinforcement Course (ARC) vs. Arhtritis Self-Management Course (ASMC) **Initial treatment: "**content included pathophysiology of arthritis, designing individualized exercise and relaxation programs, nutrition, medication usage, appropriate use of joints, patient/ physician communications and medical problem solving" **Treatment in booster sessions: "**the development of an endurance exercise program, cognitive pain management, communication skills and nutrition, similar educational processes used during the initial course"
Outcomes	1, Pain - Visual Analog Scale (0-10) – validated 2, Disability - Health Assessment Questionnaire (20 items, 8 categories) – validated 3, Depression - Beck Depression Scale (short version) - validated **Data collection:** 20 months
Notes	**Other measures not extracted from the study:** number of visits to physicians. **Other trial arms:** 3 arms: 1, ARC, 2, newsletter, 3, control (ASMC only, no reinforcement) - group 2 was not used for comparison; Of 288 participants offered to attend ARC 190 decided not to take part. Although separate outcome measures were taken for this group, but the originally randomised control group was used for comparison. **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Randomization was based on the site in which subjects took the ASMC". Comment: Clusters were possibly randomised at once.
Allocation concealment (selection bias)	Low risk	Quote: "Cluster-randomized trials often randomize all clusters at once, so lack of concealment of an allocation sequence should not usually be an issue" (Higgins et al., 2019).
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Data were collected by self-administered mailed questionnaires at baseline...and 20 months". Comment: Lack of blinding will not result in bias for this outcome.
Incomplete outcome data (attrition bias)	High risk	Comment: High post-randomisation drop-outs. Information about application of imputation was not reported.
Selective reporting (reporting bias)	Low risk	Comment: All important outcomes were reported.
Source of funding	Low risk	Quote: "This project is supported by NIH Multipurpose Arthritis Center Grant No. 20610-05 and the Northern California Chapter of the Arthritis Foundation and the Northern California Kaiser Permanente Hospitals".
Other bias	High risk	Comment: This study was a cluster randomised trial.

Mangels et al. [51]

Methods	**Country:** Germany **Study design:** parallel **Initial treatment setting:** Orthopedic rehabilitation hospital, inpatient, group size 10-12 **Initial treatment duration (mean, SD):** 27.9(1.1) days **Initial treatment delivered by:** psychotherapists, physiotherapists **Delivery method of boosters:** telephone **Number of sessions, duration, time-points:** 7x 20 mins, interval between 2 sessions varied from 4 weeks in the beginning to 3 months at the end

	Booster sessions delivered by: 2 trained clinical psychologists
Participants	**Diagnosis:** low back pain or other dorsopathies **Age(mean, SD):** booster: 48.3(15.8), no booster: 49.5(9.0) **Female:** booster: 90, no booster: 89 (prior to dropout) **Total number of participants:** 232 **Post-randomisation drop-outs:** 15 **Reason for drop-outs:** false address (7), no answer (4), refusal (3), death (1) **Revised sample size:** 217 **Number of patients in booster/no booster groups:** 111/106 (Analysed: 119/113) **Pain duration:** not reported **Pain intensity at baseline (mean; booster/no booster):** 18.9/18.5 (Max score: 40) **Inclusion criteria:** a musculoskeletal disease, "ability to understand German" **Exclusion criteria: "**surgeries during the previous 3 months, an intended length of treatment shorter than 3 weeks, an unexpectedly short admission process hindering the randomisation process" **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary **Study groups:** Behavioral-medical Rehabilitation+Booster vs. Behavioral-medical Rehabilitation **Initial treatment: "**medical care, physiotherapy, back school, occupational therapy, exercise therapy, psychologic pain management (9x90 mins cognitive-behavioral principles), massages, electrotherapy, hydrotherapy, thermotherapy, nutritional and social advice, muscle relaxation, psychotherapy" **Treatment in booster sessions:** review of the individual goals, transfer goals to everyday life, searching solutions of transfer problems, review of topics of inpatient programmes, homework incl. relaxation, pain coping strategies
Outcomes	1, Pain (sensory pain perception) - Pain Perception Scale (2 dimensions, 24 items, 1-4) - a German questionnaire – validated 2, Disability - Pain Disability Index (7 areas, 0-10) - German version – validated 3, Depression - Beck Depression Inventory (21 symptoms, 4-point scales, 0-63) German version - validated 4, Coping - Pain Management Questionnaire (24 items, 2 domains, 1-6) - German – validated 5, Self-efficacy - Pain Self-efficacy Questionnaire (1-6) German version - validated 6, Physical functioning - SF12 (German shortened version of the SF36) - validated **Data collection:** 1 year
Notes	**Other measures not extracted from the study:** life satisfaction. **Other trial arms:** 3 arms: 1, behavioral-medical rehabilitation treatment with subsequent booster sessions, 2, behavioral-medical rehabilitation treatment alone, 3, traditional orthopedic rehabilitation - group 3 was not used for comparison. **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Comment: Randomization was carried out using a list of random sequence numbers prepared at the study center.
Allocation concealment (selection bias)	Low risk	Quote: "Randomization was carried out by an administration secretary of the rehabilitation hospital... who was not involved in further treatment decisions".
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Low risk	Comment: Participants filled out self-reported questionnaires at their home and returned it to the clinic via mail. They received telephone reminders only if they did not return the form. Lack of blinding will not result in bias for this outcome.
Incomplete outcome data (attrition bias)	Low risk	Quote: "Missing values owing to dropout were imputed using the last known value carried forward, thus all of the patients were further analyzed as intended to treat."
Selective reporting (reporting bias)	Low risk	Comment: All important outcomes were reported.
Source of funding	Low risk	Quote: "Supported in part by the Deutsche Rentenversicherung Bund (the German Annuity Insurance Association)".
Other bias	Low risk	Comment: There was no other source of bias.

Moessner et al. [54]

Methods	**Country:** Germany **Study design:** parallel **Initial treatment setting:** multimodal pain therapy clinics **Initial treatment duration:** a least 1 week **Initial treatment delivered by:** therapists **Delivery method of boosters:** internet-based group chat sessions, groups of 10 **Number of sessions, duration, time-points:** 12-15 weeks, 90 mins/week, after initial treatment **Booster sessions delivered by:** therapist whom patient already met during initial treatment
Participants	**Diagnosis:** low back pain **Age (mean, SD):** booster:: 47.2(11), no booster: 46.3(10.9) **Female (n):** booster: 108, no booster: 105 **Total number of participants:** 334 **Post-randomisation drop-outs:** 90 **Reason for drop-outs:** not reported **Revised sample size:** 244 **Number of patients in booster/no booster groups:** 128/116 (Analysed: 128/116) **Pain duration:** not reported **Pain intensity at baseline (mean; booster/no booster):** 4.96/4.66 (Max score: 10) **Inclusion criteria:** ages 18 to 68, chronic low back pain, completed at least 1 week multimodal pain therapy, had Internet access, spoke German **Exclusion criteria:** tumour-related pain, bacterial infections of the spine, spinal claudication with back pain, neurogenic back pain and other specific causes that require specific therapy of the back pain **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary **Study groups:** aftercare group (CHAT) vs. treatment as usual (TAU) **Initial treatment:** not reported **Treatment in booster sessions:** self-monitoring module - participants completed a questionnaire before chat sessions, during chat sessions the same topics were covered as during the initial multidisciplinary treatment (e.g. transfer of behaviours to daily life)

Outcomes	1, Pain - German Pain Questionnaire (11 scale, 0-10) - German – validated 2, Disability - Roland Morris Disability Questionnaire (0-24) - German – validated 3, Physical function - SF-36 Short Form Health Survey - German – validated 4, Depression (mental health) - SF-36 Short Form Health Survey - German - validated **Data collection:** 12 months
Notes	**Other measures not extracted from the study:** grading of chronic pain status, satisfaction and acceptance of/with the programme. **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "The randomisation...followed a mutated block design with stratification to centre, age and gender".
Allocation concealment (selection bias)	Low risk	Quote: "The randomisation was conducted externally over the telephone".
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	Comment: This information was not available.
Incomplete outcome data (attrition bias)	Low risk	Comment: Intent-to-treat (ITT) and per-protocol (PP) analyses was conducted. In the ITT analyses missing values were estimated by multiple imputations and aggregated the results in the PP analysis.
Selective reporting (reporting bias)	Low risk	Comment: All important outcomes were reported.
Source of funding	Low risk	Quote: "This study was financially supported by a grant from the Stiftung Orthopadische Universitatsklinik. No competing financial interests exist. The funding source did not influence study design, data collection, data analysis, interpretation, or presentation".
Other bias	Low risk	Comment: There was no other source of bias.

Naylor et al. [57]

Methods	**Country:** USA **Study design:** parallel **Initial treatment setting:** medicine Clinic at the university medical centre, group (7-9/group) **Initial treatment duration:** 11 weeks, 90-minute sessions/week **Initial treatment delivered by: "**the author of this study who has extensive training in administering CBT" **Delivery method of boosters:** Therapeutic Interactive Voice Response (TIVR) **Number of sessions, duration, time-points:** 4 months **Booster sessions delivered by:** n/a
Participants	**Diagnosis:** chronic musculoskeletal pain **Age (mean, SD):** booster: 47(10.42), no booster: 46(12.4) **Female (n):** booster: 23, no booster: 21 **Total number of participants:** 55 **Post-randomisation drop-outs:** 4 **Reason for drop-outs: "**after randomisation met exclusion criteria (ongoing pain-related litigation, change in diagnosis to non-musculoskeletal pain due to malignancy or pancreatitis)" **Revised sample size:** 51 **Number of patients in booster/no booster groups:** 26/25 (Analysed: 26/25) **Pain duration (years):** booster: 13.60(9.53), no booster: 8.60(8.45)

	Pain intensity at baseline (mean; booster/no booster): 5.7/6.8 (Max score: 10) **Inclusion criteria: "**successful completion of the standard 11 weeks of group CBT (attending at least 3 of the first 4 group meetings and at least 8 of the 11 total sessions), at least 6 months of musculoskeletal pain (such as back pain, osteoarthritis, or fibromyalgia), met study threshold for severity of pain "over the past four weeks" of 4 or more on a 10-point scale measured at baseline on the McGill Pain Questionnaire short form, able to perform usual self-care, had ongoing healthcare from a physician, age 18 or older, had a touch-tone phone in the home" **Exclusion criteria: "**patients with malignancy, radiation, or chemotherapy causing or influencing chronic pain; awaiting a pain-related surgical procedure; involved in pain-related litigation; psychosis, an uncontrolled Axis I disorder, or a severe personality disorder that would interfere with participation in group therapy; inability to use the telephone-based TIVR due to cognitive or hearing impairment" **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** single modality (psychological - CBT) **Study groups:** Therapeutic Interactive Voice Response (TIVR) vs. control **Initial treatment: "**CBT intervention for pain management was designed to: 1) change cognition and decrease maladaptive catastrophizing, 2) enhance patients' ability to use attention diversion, and 3) change activity patterns to better control pain. 5 components: 1, cognitive poping strategies, 2, self-regulatory skills (relaxation techniques), 3, attention diversion methods, 4, changing activity patterns (activity pacing), 5, enhancing social support" **Treatment in booster sessions:** 4 components "1, daily self monitoring questionnaire, 2, didactic review of skills, 3, guided behavioural rehearsal of pain coping skills (practice sessions), 4, monthly therapist feedback message"
Outcomes	1, Pain (pain typical) - McGill Pain Questionnaire – validated 2, Physical function - SF-36 Physical Function Scale - validated 3, Depression (mental function) - SF-36 Mental Function scale – validated 4, Coping - Coping Strategies Questionnaire – validated 5, Catastrophising - Coping Strategies Questionnaire - validated **Data collection:** 8 months following CBT
Notes	**Other measures not extracted from the study:** medication intake **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Quote: "Consenting subjects were stratified by level of pain and by gender, and then randomised to one of the two study groups".
Allocation concealment (selection bias)	Unclear risk	Comment: This information was not available.
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	Comment: Assessment via self-reported questionnaires. No further information was available.
Incomplete outcome data (attrition bias)	Low risk	Quote: "An intent-to-treat approach was used. All subjects who successfully completed CBT and who agreed to be randomised were retained for the primary analyses. For three cases with missing data at the second or third follow-ups the average of the scores from the prior and following time points were used. Two subjects from the TIVR group who were missing the final set of questionnaires were assumed to have regressed to the baseline".
Selective reporting	Low risk	Comment: All important outcomes were reported.

(reporting bias)		
Source of funding	Low risk	Quote: "This research was supported by grants from the National Institute of Drug Addiction (NIDA) R21 DA016115, National Institute of Arthritis, Musculoskeletal Diseases (NIAMS) R01 AR052131, and National Institute on Alcohol Abuse and Alcoholism (NIAAA) R01 AA014270".
Other bias	High risk	Quote: "During the study, subjects in both study conditions received/were offered "treatment as usual", for example medications, massage therapy or steroid injections, managed by their primary care physicians...We did not monitor the frequency of doctor visits." Comment: Although the inclusion criteria of this review specified that the use of usual care was allowed, but without monitoring the actual use of this service there is a risk that the outcomes were influenced by the use of additional therapies.

Sorensen and Frich [68]

Methods	**Country:** Denmark **Study design:** parallel **Initial treatment setting:** Multidisciplinary Pain Centre (MPC) **Initial treatment duration (days):** booster: 24.7(14.0), no booster: 27(15.0) **Initial treatment delivered by:** not reported **Delivery method of boosters:** nurse follow-up visits **Number of sessions, duration, time-points:** over 2 year period, first right after discharge from MPC, after at 4, 8, 12, 16, 20 and 24 months **Booster sessions delivered by:** nurses
Participants	**Diagnosis:** chronic non-malignant pain **Age (mean, SD):** booster: 52(13.1), no booster: 52.5(12.9) **Female (n):** booster: 38, no booster: 34 (prior to dropout) **Total number of participants:** 102 **Post-randomisation drop-outs:** 12 **Reason for drop-outs:** died or diagnosed with cancer (3), dropped out for other reasons (9) **Revised sample size:** 90 **Number of patients in booster/no booster groups:** 43/46 (Analysed: 43/46) **Pain duration (n; booster/no booster):** 1–5 years: 15/9, 6–10 years: 13/18, 10+ years: 46/19 **Pain intensity at baseline (mean; booster/no booster):** 29.2/33.6 (Max score: 100) **Inclusion criteria:** "chronic non-malignant pain who had completed the treatment regime at the MPC" **Exclusion criteria:** not reported **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary **Study groups:** nurse follow-up visits vs. usual care **Initial treatment:** not reported **Treatment in booster sessions: "**(1) support the patient in maintaining relevant pharmacotherapy and in managing side effects, (2) guide the patient on relevant changes in pharmacotherapy and refer to the GP if needed, (3) reinforce the patient's knowledge about chronic pain, pain treatment and sleep disturbances due to pain, (4) reinforce the patient's knowledge about appropriate coping strategies, (5) support the patient in using appropriate coping strategies, and 6) detect symptoms of pain-associated depression at an early phase + encouragement to participate in activities"
Outcomes	1, Pain (bodily pain scale) - SF-36 Short Form Health Survey (0-100) - Danish - validated 2, Physical functioning - as above 3, Depression (mental health) - as above **Data collection:** 24 months
Notes	**Other measures not extracted from the study:** different cost assessments **Other trial arms:** none **Other comments:** none

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: This information was not available.
Allocation concealment (selection bias)	Low risk	Comment: Patients were randomised by sealed envelopes.
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Low risk	Quote: "Data on health outcomes were prospectively collected through self-completion of standardised questionnaires...supported by an independent interviewer if needed".
Incomplete outcome data (attrition bias)	Low risk	Quote: "Missing data were replaced by the last valid observation. In the sensitivity analysis missing data were also replaced by the baseline value".
Selective reporting (reporting bias)	Low risk	Comment: All important outcomes were reported.
Source of funding	Low risk	"This analysis was conducted as part of a medical technology assessment partly funded by the Danish Centre for Evaluation and Health Technology Assessment".
Other bias	Low risk	Comment: There was no other source of bias.

Stukstette et al. [69]

Methods	**Country:** Netherlands **Study design:** parallel **Initial treatment setting:** group **Initial treatment duration:** 4x sessions **Initial treatment delivered by:** specialized nurse and a hand therapist **Delivery method of boosters:** not reported **Number of sessions, duration, time-points:** 1 sessions 6 months after multidisciplinary treatment **Booster sessions delivered by:** not reported
Participants	**Diagnosis:** hand OA **Age (mean, SD):** 59(8) **Female (n):** 123 **Total number of participants:** 147 **Post-randomisation drop-outs:** not reported **Reason for drop-outs:** n/a **Revised sample size:** n/a **Number of patients in booster/no booster groups:** not reported (Analysed: 73/74) **Pain duration:** not reported **Pain intensity at baseline (mean; booster/no booster):** pain not measured **Inclusion criteria: "**hand OA, according to the clinical ACR classification criteria of whom complaints due to OA of hands were the most or second most important problem" **Exclusion criteria:** not reported **Adverse events:** not reported
Interventions	**Treatment type of the initial programme:** multidisciplinary **Study groups:** booster vs. no booster **Initial treatment:** multidisciplinary, no further details **Treatment in booster sessions:** not reported
Outcomes	1, Physical function (limitations in activities) - AUSCAN - validated **Data collection:** 1 year
Notes	**Other measures not extracted from the study:** self-efficacy - outcomes were not reported, OARSI responder criteria, grip strength and joint mobility

	Other trial arms: none **Other comments:** This paper is a conference abstract. Outcome measures for self-efficacy not reported.

Risk of bias table

Bias	Author's judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Comment: This information was not available.
Allocation concealment (selection bias)	Unclear risk	Comment: This information was not available.
Blinding of participants and personnel (performance bias)	High risk	Comment: Appropriate blinding of participants and personnel was not possible due to the nature of the intervention.
Blinding of outcome assessment (detection bias)	Unclear risk	Comment: This information was not available.
Incomplete outcome data (attrition bias)	Unclear risk	Comment: This information and dropout rate was not reported.
Selective reporting (reporting bias)	High risk	Comment: Some important outcomes which will generally be assessed were not reported.
Source of funding	Unclear risk	Comment: This information was not available.
Other bias	Unclear risk	Comment: Insufficient information to assess whether an important risk of bias exists.

Table 3. Summary of findings for the main comparison

Table 3. Summary of findings for the main comparison

Boosters compared to no boosters in the management of chronic musculoskeletal pain (primary outcomes)						
Patient or population: people with chronic musculoskeletal pain **Setting**: inpatient or outpatient pain clinics, rehabilitation and medical centres, community sites **Intervention**: booster **Comparison**: no booster						
Outcomes	**Anticipated absolute effects*** (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no booster	**Risk with booster**				
Physical function (Higher scores indicate worse functioning)	The mean physical function ranged across control groups from 13.9 to 75.9	SMD **0.13 SD lower** (0.32 lower to 0.06 higher)	-	1288 (11 RCTs)	⨁◯◯◯ VERY LOW [a,b,c]	This difference is neither statistically significant nor clinically relevant
Pain-related disability (Higher scores indicate higher levels of disability)	The mean disability ranged across control groups from 0.73 to 52.95	SMD **0.16 SD lower** (0.36 lower to 0.03 higher)	-	1027 (7 RCTs)	⨁◯◯◯ VERY LOW [a,b,c]	This difference is neither statistically significant nor clinically relevant
Pain self-efficacy (Higher scores indicate higher levels of self-efficacy)	The mean self-efficacy ranged across control groups from 43.2 to 46.9	SMD **0.15 SD higher** (0.07 lower to 0.36 higher)	-	331 (2 RCTs)	⨁◯◯◯ VERY LOW [a,b,d]	This difference is neither statistically significant nor clinically relevant
***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI). **CI:** Confidence interval; **SMD:** Standardised mean difference						
GRADE Working Group grades of evidence **High certainty:** We are very confident that the true effect lies close to that of the estimate of the effect **Moderate certainty:** We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different **Low certainty:** Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect **Very low certainty:** We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect						

Explanations

a. Downgraded by one level due to concerns with risk of bias within the studies.

b. Downgraded by one level due to heterogeneity across studies.

c. Downgraded by one level due to wide CIs (includes 0 and -0.25 or 0.25).

d. Downgraded by two levels due to small sample size (<400) and wide CIs (includes 0 and -0.25 or 0.25).

Table 4. Additional summary of findings

Table 4. Additional summary of findings

Boosters compared to no boosters in the management of chronic musculoskeletal pain (secondary outcomes)

Patient or population: people with chronic musculoskeletal pain

Setting: inpatient or outpatient pain clinics, rehabilitation and medical centres, community sites

Intervention: booster

Comparison: no booster

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no booster	Risk with booster				
Pain intensity (Higher scores indicate higher levels of pain)	The mean pain ranged across control groups from 3.1 to 66.7	SMD **0.22 SD lower** (0.46 lower to 0.02 higher)	-	1548 (13 RCTs)	⨁◯◯◯ VERY LOW a,b,c	This difference is not statistically significant but the small effect may be clinically relevant in this patient group
Depression (Higher scores indicate higher levels of depression)	The mean depression ranged across control groups from 3.7 to 60.2	SMD **0.17 SD lower** (0.37 lower to 0.03 higher)	-	1073 (8 RCTs)	⨁◯◯◯ VERY LOW a,b,c	This difference is neither statistically significant nor clinically relevant
Coping (Higher scores indicate better coping ability)	The mean coping ranged across control groups from 3 to 19.92	SMD **0.28 SD lower** (0.99 lower to 0.42 higher)	-	451 (4 RCTs)	⨁◯◯◯ VERY LOW a,b,c	This difference is not statistically significant but the small effect may be clinically relevant in this patient group
Pain catastrophising (Higher scores indicate higher levels of catastrophising)	The mean catastrophising ranged across control groups from 2.8 to 14.73	SMD **0.42 SD lower** (0.64 lower to 0.19 lower)	-	304 (4 RCTs)	⨁◯◯◯ VERY LOW a,b,d	This difference is statistically significant and is probably clinically relevant in this patient group
Treatment adherence (dichotomous) (Higher scores indicate higher levels of adherence)	590 per 1,000	**737 per 1,000** (585 to 848)	**OR 1.94** (0.98 to 3.87)	168 (2 RCTs)	⨁◯◯◯ VERY LOW a,b,e	This difference is not statistically significant but the small effect may be clinically relevant in this patient group
Treatment adherence (continuous) (Higher scores indicate higher levels of adherence)	The mean treatment adherence for the control group was 4.01	MD **0.38 lower** (1.7 lower to 0.94 higher)	-	104 (1 RCT)	⨁◯◯◯ VERY LOW a,b,f	This difference is not statistically significant but the small effect may be clinically relevant in this patient group

Boosters compared to no boosters in the management of chronic musculoskeletal pain (secondary outcomes)

Patient or population: people with chronic musculoskeletal pain

Setting: inpatient or outpatient pain clinics, rehabilitation and medical centres, community sites

Intervention: booster

Comparison: no booster

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no booster	Risk with booster				

***The risk in the intervention group** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

CI: Confidence interval; **SMD:** Standardised mean difference; **OR:** Odds ratio; **MD:** Mean difference

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

a. Downgraded by one level due to concerns with risk of bias within the studies.

b. Downgraded by one level due to heterogeneity across studies.

c. Downgraded by one level due to wide CIs (includes 0 and -0.25 or 0.25).

d. Downgraded by two levels due to small sample size (<400) and wide CIs (includes -0.25 or 0.25).

e. Downgraded by two levels due to small sample size (<400) and wide CIs (includes 1 and 0.75 or 1.25).

f. Downgraded by two levels due to small sample size (<400) and wide CIs (includes 0 and -0.25 or 0.25).

Table 5. Characteristics of excluded studies

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Study	Reason for exclusion
Carson et al. [11]	Following initial treatment all participants received follow-up care, but all 3 treatment arms received different programme (Pain coping skills training vs. PCST+maintenance training vs. arthritis education vs. standard care).
Desai et al. [16]	Same study population as another study excluded from this review (Hughes et al., 2010). All groups received some sort of maintenance treatment after initial exercise therapy. Investigated irrelevant outcomes to this study.
Domenech et al. [17]	Telephonic support and online program were received alongside the initial treatment of CBT.
Dysvik et al., [19]	No control group. Only changes within participants were measured.
Friedrich et al. [24]	Motivation interventions were during the initial exercise programme.
Hara et al. [33]	Admitted participants with both mental and somatic disorders (musculoskeletal or other chronic pain disorders, chronic fatigue or a common mental disorder).
Hughes et al. [36]	All groups received some sort of maintenance treatment after initial exercise therapy.
Thomas et al. [70]	There was no initial treatment, patients received 2 years of continuous exercise programme with monthly telephone calls alongside. Comparison of exercise only vs. exercise and monthly telephone calls (plus several other arms).
Yang et al. [76]	Control group continued to receive physiotherapy sessions, whilst intervention group received app-based self-management treatment.
Zuidema et al. [77]	No initial treatment. Study aims to explore the efficacy of the Web-based programme compared usual care.

Table 6. Summary of clinical outcome measures

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Outcomes	Outcome measures
Physical function	WOMAC Osteoarthritis Index AUSCAN Osteoarthritis Index SF-36 and its shortened versions SF-8, SF-12
Self-efficacy	Arthritis Questionnaire Pain Self-Efficacy Questionnaire
Pain intensity	WOMAC Osteoarthritis Index Numeric Rating Scale Visual Analog Scale Multidimensional Poverty Index Pain Perception Scale German Pain Questionnaire McGill Pain Questionnaire SF-36 Health Survey
Pain-related disability	Pain Disability Index Neck Disability Index Chronic Pain Acceptance Roland Morris Disability Questionnaire
Depression	Hospital Anxiety and Depression Scale SF-36, SF-8 Beck Depression Inventory
Coping and Catastrophising	Coping Strategies Questionnaire Pain Management Questionnaire Pain Catastrophising Scale
Treatment adherence	By asking patients about the number of times they completed the home exercises Rating their own level of adherence

Table 7. Comparison 1. Booster versus no booster

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Outcome or subgroup title	**No. of studies**	**No. of participants**	**Statistical Method**	**Effect Estimate**
1.1 Physical function	11	1288	SMD (IV, Random, 95% CI)	-0.13 [-0.32, 0.06]
1.2 Pain-related disability	7	1027	SMD (IV, Random, 95% CI)	-0.16 [-0.36, 0.03]
1.3 Pain self-efficacy	2	331	SMD (IV, Random, 95% CI)	0.15 [-0.07, 0.36]
1.4 Pain intensity	13	1548	SMD (IV, Random, 95% CI)	-0.22 [-0.46, 0.02]
1.5 Depression	8	1073	SMD (IV, Random, 95% CI)	-0.17 [-0.37, 0.03]
1.6 Coping	4	451	SMD (IV, Random, 95% CI)	-0.28 [-0.99, 0.42]
1.7 Pain catastrophising	4	304	SMD (IV, Random, 95% CI)	-0.42 [-0.64, -0.19]
1.8 Treatment adherence (dichotomous)	2	168	OR (IV, Fixed, 95% CI)	1.94 [0.98, 3.87]
1.9 Treatment adherence (continuous)	1	104	MD (IV, Fixed, 95% CI)	-0.38 [-1.70, 0.94]
1.10 Physical function: stratified by treatment type	11	1288	SMD (IV, Random, 95% CI)	-0.13 [-0.32, 0.06]
1.10.1 Single modality	5	414	SMD (IV, Random, 95% CI)	-0.34 [-0.67, -0.02]
1.10.2 Multidisciplinary	6	874	SMD (IV, Random, 95% CI)	0.00 [-0.22, 0.23]
1.11 Physical function: stratified by treatment intensity of the initial programme	11	1288	SMD (IV, Random, 95% CI)	-0.13 [-0.32, 0.06]
1.11.1 Daily intensive treatment	4	647	SMD (IV, Random, 95% CI)	-0.05 [-0.32, 0.22]
1.11.2 Brief weekly sessions	7	641	SMD (IV, Random, 95% CI)	-0.20 [-0.49, 0.09]
1.12 Physical function: stratified by method of delivery of boosters	10	1141	SMD (IV, Random, 95% CI)	-0.14 [-0.35, 0.08]
1.12.1 Face-to-face	4	348	SMD (IV, Random, 95% CI)	-0.33 [-0.56, -0.09]
1.12.2 Remote	6	793	SMD (IV, Random, 95% CI)	-0.01 [-0.29, 0.27]
1.13 Pain-related disability: stratified by treatment intensity of the initial programme	6	955	SMD (IV, Random, 95% CI)	-0.12 [-0.32, 0.08]
1.13.1 Daily intensive treatment	4	652	SMD (IV, Random, 95% CI)	-0.19 [-0.49, 0.11]
1.13.2 Brief weekly sessions	2	303	SMD (IV, Random, 95% CI)	-0.03 [-0.27, 0.21]

*SMD - Standardised mean difference, MD - Mean difference, OR - Odds ratio, IV - Inverse variance, Random - Random effects, Fixed - Fixed effects, 95% CI - 95% confidence interval