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REVIEW ARTICLE (META-ANALYSIS)

Effectiveness of Home-Based Exercise for Nonspecific Shoulder Pain: A Systematic Review and Meta-analysis

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Abstract

Objective: To evaluate the effectiveness of home-based exercise to treat nonspecific shoulder pain (NSSP).

Data Sources: MEDLINE, Embase, Cumulative Index to Nursing and Allied Health, Cochrane Controlled Register of Trials, and Physiotherapy Evidence Database were searched from inception to January 2022.

Study Selection: Independent reviewers selected randomized controlled trials that compared the effects of home-based exercise alone with no treatment or other conservative treatments in individuals with nonsurgical painful shoulder disorders. The primary outcomes were shoulder pain intensity and function, and the secondary outcome was shoulder range of motion (ROM).

Data Extraction: Two reviewers independently conducted data extraction. The risk of bias was assessed using the Cochrane Risk of Bias 2.0 tool, and the overall quality of the evidence was evaluated using the Grading of Recommendation Assessment, Development, and Evaluation approach.

Data Synthesis: Twelve studies were included in the review, and 10 studies were included in the meta-analysis. Low to moderate quality of evidence indicated that home-based exercise alone and other conservative treatments showed equal improvements in pain intensity reduction (mean difference [MD], 0.27; 95% confidence interval [CI], −0.12 to 0.65; I^2=30%), function (standardized mean difference [SMD], 0.12; 95% CI, −0.14 to 0.38; I^2=16%), flexion ROM (MD, 4.61; 95% CI, −1.16 to 10.38; I^2=54%), and abduction ROM (MD, 3.74; 95% CI, −12.44 to 19.93; I^2=82%). Very low quality of evidence indicated that home-based exercise alone was more effective than no treatment for pain intensity reduction (MD, −1.47; 95% CI, −2.33 to -0.61) and function improvement (SMD, −0.81; 95% CI, −1.31 to -0.31; large effect).

Conclusions: Home-based exercise alone may be equally effective as other conservative treatments and superior to no treatment for the treatment of NSSP. To draw firmer conclusions, further research is required to validate these findings.

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Shoulder pain is one of the most common musculoskeletal pains in primary care, exceeded only by back and neck pain.[1] The point prevalence of shoulder pain in the adult population varied between 7% and 27%, 1-year prevalence varied between 5% and 47%, and lifetime prevalence varied between 7% and 67%.[2] Individuals with shoulder pain usually have active and passive range of motion (ROM) restrictions and functional limitations that may negatively affect the ability to work or perform domestic and recreational activities, thereby causing a high burden of disease for both the individual and society.[3,4] The mean total costs of a patient during the 6 months after the first consultation for shoulder pain in primary care have been estimated at €689.[5]

The most frequent diagnoses in patients with shoulder pain are rotator cuff tendonitis, adhesive capsulitis, subacromial pain syndrome, and acromioclavicular joint disorders.[6] However, diagnoses of shoulder pain are not always straightforward because of the lack of recognized diagnostic criteria, lack of any diagnostic test considered a criterion standard, poor specificity of commonly used clinical tests, and frequent coexistence of multiple shoulder pathologies.[7-10] Therefore, clinical trials and clinical practice tend to use the term *nonspecific shoulder pain* (NSSP) rather than a

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specific diagnosis.[11] NSSP has been described as shoulder pain without clearly defined pathology or physical signs.[12]

Physical therapy is often the first-line treatment for shoulder pain, and exercise therapy is the cornerstone of physical therapy for shoulder pain.[13-15] A systematic review by Abdulla et al[16] found that supervised stretching and strengthening exercises are as effective as corticosteroid injections or multimodal programs of care in the treatment of NSSP. Supervision is critical in the early stage of rehabilitation, where patients need help and support to deal with pain and dysfunction and to perform the exercise correctly.[17] However, supervised exercises require substantial and specific resources and may be difficult to apply clinically.[18] In recent years, 2 meta-analyses showed that supervised exercise therapy is equally effective as home-based exercise in improving pain intensity and function for patients with subacromial pain syndrome[19,20]; however, no study has assessed the effectiveness of home-based exercise for the treatment of NSSP.

Therefore, this study aimed to conduct a systematic review with meta-analysis to study the effect of home-based exercise in adults with NSSP compared with no treatment or other conservative treatments on pain intensity, function, and ROM. The data were analyzed according to the type of comparison intervention.

Methods

This study was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. The protocol for this study was registered in PROSPERO (registration ID: CRD42020180134).

Search strategy

Searches were conducted in the following electronic databases: MEDLINE, Embase, Cumulative Index to Nursing and Allied Health, Cochrane Controlled Register of Trials, and Physiotherapy Evidence Database from the earliest available time until January 8, 2022. The search strategy was based on Medical Subject Headings of the National Library of Medicine terms, text words, and word variations for crucial concepts of shoulder pain, rehabilitation, and home exercise. The detailed search strategy for each of the databases is displayed in appendix 1. The reference lists of all included studies were also checked manually to identify other eligible trials. Two reviewers (J.L., X.R.) independently screened search results to determine if they satisfied eligibility criteria. Any disagreement on the inclusion of trials was resolved through consensus discussion with a third reviewer (S.H.).

Eligibility criteria

The population, intervention, comparison, outcome, and study design framework was used to assess the eligibility of studies. (1) Population: male or female participants 18 years or older with symptoms in the shoulder region diagnosed with subacromial pain syndrome, impingement syndrome, rotator cuff tendonitis, rotator cuff tear, bursitis, periarthritis, osteoarthritis, adhesive capsulitis, or frozen shoulder. Studies including participants with the general diagnosis of shoulder pain were also included. (2) Intervention: any types of unsupervised home-based self-training programs that consist of therapeutic exercises (eg, stretching and strengthening, neuromuscular control, proprioception, scapular stabilization, rotator cuff) aimed to treat shoulder disorders. The details of exercise interventions needed to be clearly described, including types and doses of exercise. The intervention had to be the only treatment, and active monitoring for the intervention should be limited to a maximum of 1 interaction per week. (3) Comparison: no treatment (defined as placebo or sham treatment); other conservative treatments (defined as other types of active or passive physical therapy interventions, pharmacologic interventions, or multimodal conservative interventions). (4) Outcome: at least 1 of the following outcome measures had to be reported: pain intensity, functional disability, or ROM flexion and abduction. (5) Study design: randomized controlled trials or randomized controlled trials that were published in English. Studies were excluded based on the following criteria: (1) participants had infections, inflammatory disorders, neoplasms, hemiplegia, fractures, dislocations, glenohumeral instability, or a history of surgery in the shoulder region; (2) different types of home-based exercises were compared with one another; and (3) a home-based exercise program acted as an active control that was not aimed to treat shoulder disorders.

List of abbreviations:

CI	**confidence interval**
GRADE	**Grading of Recommendations Assessment, Development, and Evaluation**
LFK	**Luis Furuya-Kanamori**
MCID	**minimal clinically important difference**
MD	**mean difference**
NSSP	**nonspecific shoulder pain**
ROM	**range of motion**
SMD	**standardized mean difference**

Data extraction

Two independent reviewers (J.L. and X.R.) extracted data from the included studies. Descriptive data were extracted on study characteristics, intervention descriptions, participant characteristics, and outcome measures. Data regarding the intervention descriptions were reported using the Template for Intervention Description and Replication checklist as a guide.[21] The primary outcomes were shoulder pain intensity and function, and the secondary outcome was ROM. The mean and SD for the change from baseline to post intervention was extracted. When mean or SD was missing, we tried to use the available data (eg, *P* values, confidence interval [CI], SE, median, interquartile range) to estimate the value.[22] If data were missing, the corresponding author was contacted via email. If no response was obtained from the author (after 2 attempts) or if the author could not provide the requested data, the study outcome was excluded from the analysis. Any disagreements between the independent reviewers were resolved in a consensus meeting with a third reviewer (S.H.).

Assessment of risk of bias

The risk of bias of the included studies was assessed using the Cochrane Risk of Bias 2.0 tool by 2 independent reviewers (J.L., R.Z.), with disagreement resolved by discussing with a third reviewer (Y.Y.).[23] There are 6 domains used for the assessment of each study, including randomization process, deviation from intended interventions, missing outcome data, measurement of the outcome, selection of the reported result, and overall bias. Overall bias was rated as "low risk" if the study was rated as "low risk" in all domains, "some concerns" if there was at least one domain that was rated "some concerns" but not "high risk" in any other, and

"high risk" if there was at least 1 domain was rated "high risk" or multiple domains rated "some concerns".

Data analysis

The mean difference (MD) with corresponding 95% CI was calculated for outcomes with the same measurement tool, and the standardized mean difference (SMD) with corresponding 95% CI was calculated for outcomes with a different measurement tool. An inverse-variance random-effects model was used for all meta-analyses because of the design variability between included studies that could influence the treatment effect.[24] The SMD was interpreted as having a small effect if 0.2, a moderate effect if 0.5, and a large effect if 0.8.[25] The clinically meaningful threshold of the treatment effect was determined based on the minimal clinically important difference (MCID), defined as 1 point for pain intensity, the effect size of 0.45 for function, and 10 degrees for ROM.[26] Statistical heterogeneity was measured using the I^2 statistic, with a value >50% representing high heterogeneity.[27] The subgroup analysis was performed to assess or confirm the effectiveness of home-based exercise compared with different conservative treatments in the control groups. Where there was high heterogeneity in a meta-analysis, the sensitivity analysis was performed, excluding studies with extreme results to explain potential heterogeneity. All meta-analyses were performed using Review Manager software (RevMan, version 5.4).[a] Statistical significance was set at $P<.05$. Small-study effects (publication bias, etc) were examined using the Doi plot and Luis Furuya-Kanamori (LFK) index, both of which have been shown to be more robust than the traditional funnel plot and Egger's regression intercept test.[28] LFK values within ±1, between ±1 and ±2, and >±2 were considered to represent no, minor, and major asymmetry, respectively.

Assessment of quality of evidence

The Grading of Recommendation Assessment, Development, and Evaluation (GRADE) approach was used to determine the quality of each body of evidence.[29] The GRADE approach assesses the quality of evidence for a specific outcome based on the following principal measures: study design limitations because of risk of bias (more than 75% of studies in the meta-analysis were not rated at low risk of bias),[22] inconsistency of evidence (unexplained high heterogeneity [I^2>50%] or wide variance of point estimates across studies or when only a single study was included in the meta-analysis),[30,31] indirectness of evidence (if there were significant differences between populations or outcome measures across studies),[32] imprecision of results (sample sizes did not meet the optimal information size or if the upper or lower CI crossed the MCID for MD or the effect size of 0.45 for SMD in either direction),[26,33] and publication bias (LKF index presented major asymmetry). Each nonsatisfied item decreased the quality of evidence by 1 for each outcome. The quality of evidence for each outcome was consequently graded as high, moderate, low, or very low quality.[34] Two independent reviewers rated the overall quality of the evidence for each outcome (J.L., R.Z.), with disagreement resolved by discussing with a third reviewer (Y.Y.).

Results

Study selection

Figure 1 shows the details of the study selection flow diagram. A total of 960 studies were initially identified. After removing duplicates, 559 studies remained for the screening process. A total of 505 studies were excluded after screening the titles and abstracts. The full text of 54 studies were analyzed, of which 12 were included in the qualitative synthesis, and 10 were included in the meta-analysis. Only 1 study was excluded in the full-text screening because the home-based exercise program acted as a control and was not aimed at treating shoulder disorders.[35]

Study characteristics

The characteristics of all included studies are summarized in table 1. These 12 studies were published between 2003 and 2018. Of these, 8 studies (67%) were randomized controlled trials,[17,37-41,43,45] and 4 studies (33%) were randomized controlled trials.[13,36,42,44] The sample size in each study varied from 30-250 participants, with a total number of 935 participants. The mean age at baseline ranged from 38.0-55.1 years. Four studies (33%) included patients with shoulder pain.[13,36,38,39] Four studies (33%) included patients with subacromial pain syndrome.[17,41,42,44] One study (8%) included patients with rotator cuff tendinopathy.[37] One study (8%) included patients with rotator cuff tears.[40] One study (8%) included patients with adhesive capsulitis,[45] and 1 study (8%) included patients with supraspinatus tendinopathy.[43] The duration of symptoms ranged from 25 days to 17 months. One study (8%) included patients with acute shoulder pain (symptoms <6 weeks),[37] 5 studies (42%) included patients with chronic shoulder pain (symptoms >3 months),[13,17,36,44,45] and 6 studies (50%) did not report the duration of symptoms.[38-43]

Four studies (33%) compared home-based exercise with supervised exercise.[17,38,39,43] Two studies (17%) compared home-based exercise with supervised exercise combined with physical modalities.[40,42] Four studies (33%) compared home-based exercise with home-based exercise combined with physical modalities.[13,36,37,44] One study (8%) compared home-based exercise with home-based exercise combined with corticosteroid injections,[45] and 1 study (8%) compared home-based exercise with no treatment.[41] Most studies (92%) used a short treatment period (≤3 months) varying from 2-12 weeks, except for 1 study (8%) that used a midterm treatment period (>3 and ≤9 months) of 20 weeks.[38] The treatment frequency varied from 3-7 times per week. Most studies (75%) used the same follow-up period as their treatment period, but 3 studies (25%) assessed the treatment effects 2 weeks post intervention.[36,37,41]

Risk of bias

The risk of bias assessment for all included studies is displayed in fig 2. For the overall risk of bias, 3 studies (25%) were rated as "low risk,"[17,37,39] 7 studies (58%) were rated as "some concerns,"[13,36,38,40,41,44,45] and 2 studies (17%) were rated as "high risk."[43,42] In the randomization process, 6 studies (50%) were rated as "some concerns,"[13,38,40-43] and 6 studies (50%) were rated as "low risk."[17,36,37,39,44,45] For the deviations from the intended interventions, 2 studies (17%) were rated as "high risk,"[42,43] and 5 studies (42%) were rated as "some

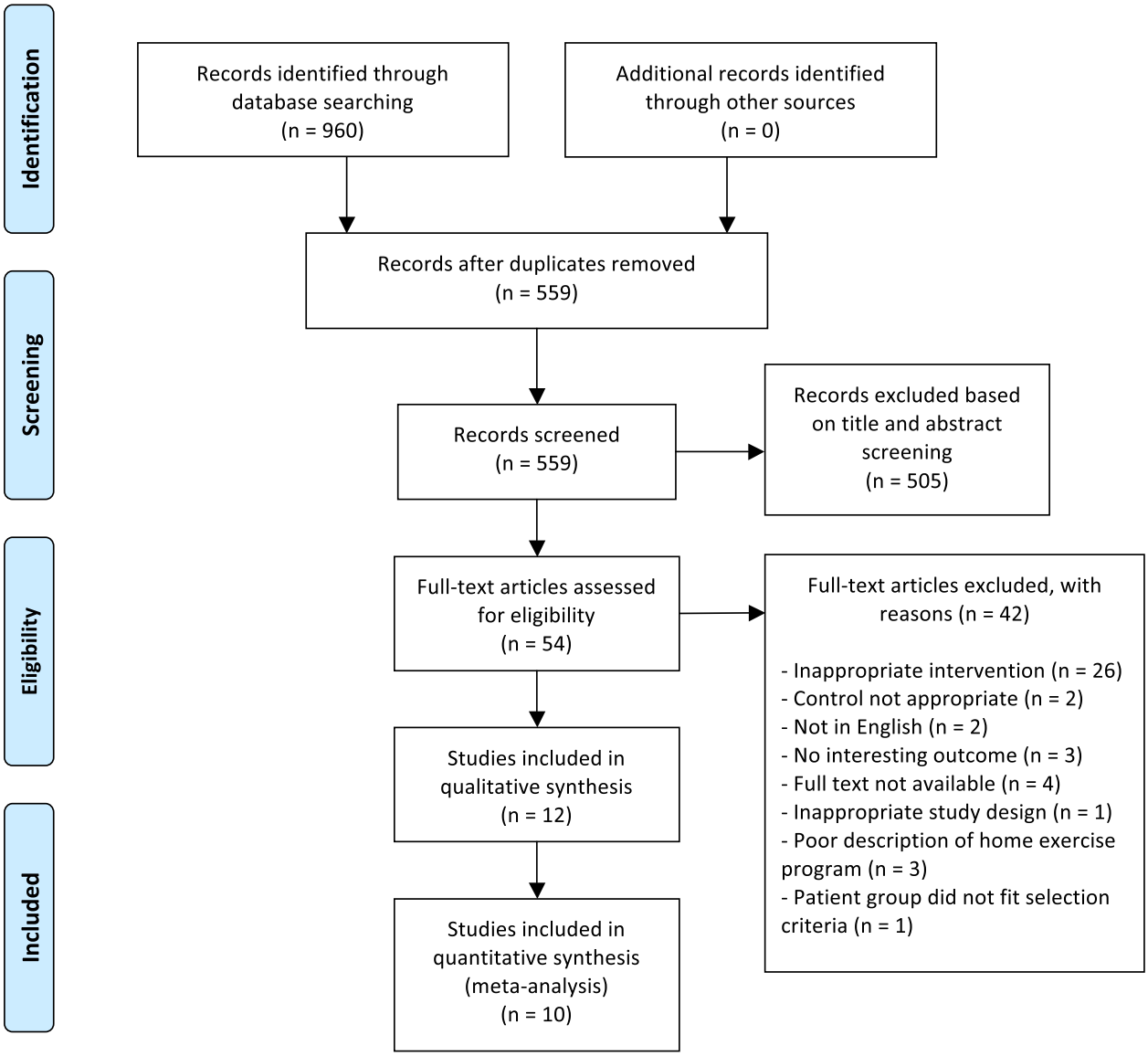

Fig 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of the study selection process.

concerns."[13,38,40,44,45] Moreover, bias in the missing outcome data were rated as "high risk" in 2 studies (17%),[42,43] while bias in the measurement of the outcome was rated as "some concerns" in 5 studies (42%).[38,40-43] Finally, 7 studies (58%) were rated as "some concerns" in the selection of the reported result.[13,36,38,40-43]

Quality of evidence (GRADE)

The quality of evidence for each reported outcome analyzed based on the GRADE approach is displayed in table 2. Reasons for the reduction of the quality of the evidence for each reported outcome are cited in the legend of each table.

Primary outcomes

Pain intensity

Eleven studies[13,17,36-39,42-44,45] investigated the effectiveness of home-based exercise compared with other conservative treatments for reducing pain intensity. Two studies[36,43] were not included in the meta-analysis because of insufficient data. The aggregated results showed no significant difference between home-based exercise and the comparison intervention (N=742; MD, 0.27; 95% CI, −0.12 to 0.65; I^2=30%; fig 3). The Doi plots showed a minor asymmetry (LFK index=−1.70; appendix 2A). Thus, there is moderate-quality evidence of no difference between home-based exercise and other conservative treatments on pain intensity reduction for individuals with NSSP in the short- to intermediate-term.

One study[41] compared the effectiveness of home-based exercise with no treatment on reducing pain intensity. There is very low-quality evidence that home-based exercise was significantly more effective than no treatment in reducing pain intensity for individuals with NSSP in the short-term (n=67; MD, −1.47; 95% CI, −2.33 to −0.61; appendix 3A). The change of 1.47 points in favor of home-based exercise meets the MCID for pain intensity of 1 point.

Subgroup analyses for conservative treatments showed that home-based exercise combined with corticosteroid injections

Table 1 Summary of characteristics of the included studies including Template for Intervention Description and Replication checklist

Study	Brief Name	Rationale	What Materials	What Procedures	Who Provided	How	Where	When and How Much	Tailoring	How Well	Participants	Outcomes
Coronado et al[36]	IG: HEP CG 1: Shoulder thrust manipulation CG 2: Cervical thrust manipulation	To compare the effects of HEP and shoulder thrust manipulation and cervical thrust manipulation for shoulder pain treatment.	A handout with details of the HEP	IG: The group received formal training and supervision during the initial intervention, followed by self-training at home. The HEP consisted of standard ROM and isometric strengthening exercises. The ROM exercises included self-generated movements for shoulder flexion, abduction, and internal and external rotation. The isometric strengthening exercises focused on resisted internal and external rotation. CG 1: Shoulder thrust manipulation face-to-face sessions combined with the HEP (same as IG). CG 2: Cervical thrust manipulation face-to-face sessions combined with the HEP (same as IG).	Physiotherapists or chiropractors	IG: Home sessions CG 1: Face-to-face sessions and home sessions CG 2: Face-to-face sessions and home sessions	IG: Patients' homes CG 1: NR to face-to-face sessions, home sessions at patients' homes CG 2: NR to face-to-face sessions, home sessions at patients' homes	IG: ROM exercises (2 times daily for 2wk, each exercise 30s and 2 repetitions), isometric exercises (2 times daily for 2 wk, each exercise 10s and 5 repetitions) CG 1: 3 shoulder thrust manipulation sessions over 2 wk, the HEP (same as IG) CG 2: 3 cervical thrust manipulation sessions over 2 wk, the HEP (same as IG)	NR	NR	Patients with general shoulder pain IG: n=25 (15 M, 10 F), age=41.0±14.1 y, DOS=21.5±23.3 wk CG 1: n=27 (14 M, 13 F), age=46.2±7.5 y, DOS=21.5±48.8 wk CG 2: n=26 (13 M, 13 F), age=36.7±16.0 y, DOS=19.1±31.9 wk	Pain intensity (NRS) Function (PSS) Assessments: baseline and 4 wk
Dupuis et al[37]	IG: HEP CG: Cryotherapy	To compare the effects of HEP and cryotherapy for treating acute rotator cuff tendinopathy.	Written instructions with details of interventions, treatment diaries, mirrors, elastic bands, ice wraps	The first meeting after the baseline evaluation consisted of explanation and practice of the intervention to be carried out at home. The second meeting after 2 wk consisted of explanation and practice of the strengthening exercise program to be carried out at home. IG: The HEP included isometric lateral rotation and abduction exercises, pain-free active shoulder elevation movements in three planes, and resisted isotonic shoulder external and internal rotation exercises. CG: Cryotherapy home sessions combined with the HEP. The HEP included pain-free active shoulder elevation movements in three planes and resisted isotonic shoulder external and internal rotation exercises.	Physiotherapists	Home sessions	Patients' homes	Shoulder elevation movements (3 times daily for 2wk, each exercise 5 repetitions), strengthening exercises (daily for 4wk) IG: Isometric lateral rotation and abduction exercises (3 times daily for 2wk, each exercise 20-30s and 3-4 repetitions) CG: Cryotherapy (3 times daily for 2wk, each session 15min)	The intensity of isometric lateral rotation and abduction exercises was set at 50%-75% of each patient's maximum force.	Adherence was monitored by diaries Adherence rate: IG 62%, CG 76%	Patients with acute rotator cuff tendinopathy IG: n=20 (13 M, 7 F), age=33±7 y, DOS=27±9 d CG 1: n=23 (11 M, 12 F), age=43±13 y, DOS=25±7 d	Pain intensity (NRS) Function (DASH) ROM (flexion) Assessments: pain intensity and function were measured at baseline, 2 wk, and 6 wk; flexion ROM was measured at baseline and 2 wk
Ginn and Cohen[13]	G: HEP CG 1: MPM treatment CG 2: Corticosteroid injections	To compare the effects of HEP and other conservative interventions for treating chronic shoulder pain.	Methylprednisolone acetate, lignocaine, electrophysical modalities	IG: The group was supervised once per wk by face-to-face sessions. The HEP included stretches aimed at lengthening shortened shoulder muscles, exercises aimed at strengthening weakened shoulder muscles, and motor retraining aimed at restoring scapulohumeral rhythm during the performance of upper limb tasks. All exercises were to be pain-free. CG 2: The MPM treatment consisted of electrophysical modalities, passive joint mobilization, and ROM exercises. Electrophysical modalities and passive joint mobilization were conducted in face-to-face sessions. ROM exercises were performed in home sessions. CG 2: A single corticosteroid injection during the initial face-to-face session.	Physiotherapists and rheumatologists	IG: Home sessions CG 1: Face-to-face sessions and home sessions CG 2: Face-to-face sessions	IG: Patients' homes CG 1: NR to face-to-face sessions, home sessions at patients' homes CG 2: NR	IG: Daily for 5 weeks CG 1: Electrophysical modalities and passive joint mobilization (2 times weekly for 5wk), ROM exercises (daily for 5wk) CG 2: 40-mg methylprednisolone acetate under local anesthesia with lignocaine	The specific exercises or treatments for each patient in IG and CG 1 were determined individually using data from the initial interview and musculoskeletal assessment and any additional information.	NR	Patients with shoulder pain of local mechanical origin IG: n=48 (27 M, 21 F), age=52.6 y (range, 22-83y), DOS=7.3±8.1 mo CG 1: n=42 (26 M, 16 F), age=57.4 y (range, 29-90y), DOS=7.4±10.9 mo CG 2: n=48 (29 M, 19 F), age=55.4 y (range, 29-87y), DOS=7.4±11.2 mo	Pain intensity (VAS) Function (self-developed questionnaire) ROM (flexion and abduction) Assessments: baseline and 5 wk

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Table 1 (*Continued*)

Study	Brief Name	Rationale	What Materials	What Procedures	Who Provided	How	Where	When and How Much	Tailoring	How Well	Participants	Outcomes
Gram et al[38]	IG: Workplace training without supervision CG 1: Workplace training with supervision CG 2: No treatment	To investigate the effects of workplace neck/shoulder strength training with and without regular supervision on neck/shoulder pain.	Dumbbells	The workplace training consisted of 4 different dumbbell exercises (front raise, lateral raise, reverse flies, shrugs) for the neck and shoulder muscles. The participants performed warm-up exercises at the beginning of each training session (10 repetitions of each exercise with 50% of 1 RM). The intensity of the program increased gradually from 20 RM to 8 RM. IG: The group received supervision in 2 instructional sessions to learn the exercises correctly and then conducted self-training in the workplace. CG 1: The group performed exercises in the workplace with half of the sessions being supervised. CG 2: No treatment.	Training instructors	IG: Home sessions CG 1: Home sessions and face-to-face sessions	Participants' workplace	3 times weekly for 20 wk, each session 20 min	The intensity was set based on each participant's strength level.	Adherence was monitored by e-mail based questionnaires Adherence rate: IG 47%, CG 1 60%	Office workers with neck and shoulder pain IG: n=124 (52 M, 72 F), age=45±11 y, DOS=NR CG 1: n=126 (39 M, 87 F), age=46±10 y, DOS=NR CG 2: n=101 (42 M, 59 F), age=46±10 y, DOS=NR	Pain intensity (NRS) Assessments: baseline and 20 wk
Granviken and Vasseljen[17]	IG: HEP CG: SEP	To compare the effects of HEP and SEP for the treatment for treating subacromial impingement.	Written instructions with details of the HEP, training diaries, mirrors, elastic bands,	Exercises and overall training dose were the same for both groups. All patients started with the training of correct scapular placement. IG: The group had 1 supervised treatment session to set up a tailored home exercise program before the intervention. The HEP included scapular stabilizing exercises, rotator cuff exercises, pain-free ROM exercises, and stretching exercises. The exercises were performed with as little pain as possible. CG: The group received 10 treatments of supervised therapy, in addition to the HEP (same as IG).	Physiotherapists	IG: Home sessions CG 1: Face-to-face sessions and home sessions	IG: Patients' homes CG: NR to face-to-face sessions, home sessions at patients' homes	Stretching exercises (2 times daily for 6wk, each exercise 30s and 2 repetitions), other exercises (4-6 exercises, 2 times daily for 6wk, each exercise 3 sets and 30 repetitions)	Exercises were individually adapted.	Adherence was monitored by training diaries Adherence rate: IG 88%, CG 80%	Patients with subacromial impingement syndrome IG: n=23 (12 M, 11 F), age=48.2±9.8 y, DOS=12 mo (IQR 6-36mo) CG: n=23 (12 M, 11 F), age=47.6±10.0 y, DOS=17 mo (IQR 10-48mo)	Pain intensity (NRS) Function (SPADI) ROM (flexion and abduction) Assessments: baseline and 6 wk
Jakobsen et al[39]	IG: HEP CG: Workplace training with supervision	To compare the effects of HEP and workplace supervised training on pain intensity among health care workers.	Kettlebells, Swiss balls, elastic bands, posters with details of the HEP and recommendations for training progression	IG: The HEP consisted of strengthening exercises for the shoulder, back, and core muscles. Elastic bands were used for many of the exercises. The training sessions were performed as a circuit-training program. CG: The supervised strengthening exercise program combined with 5 group-based motivational coaching sessions. The strengthening exercise program aimed to strengthen the shoulder, back, and core muscles using elastic bands, kettlebells, and Swiss balls.	Training instructors	IG: Home sessions CG: Face-to-face group sessions	IG: Participants' homes CG: Hospital	IG: At least 4 out of 10 different exercises, 5 times weekly for 10 wk, each session 10 min CG: 4-6 of the 10 different exercises, 5 times weekly for 10 wk, each session 10 min	More resistant elastic bands were used when an exercise could be performed with more than 12 repetitions using the proper technique.	NR on how to monitor adherence Adherence rate: IG 20%; CG 44%	Health care workers with musculoskeletal pain in multiple body regions IG: n=89 (89 F), age=44±10 y, DOS=NR CG: n=111 (111 F), age=40±12 y, DOS=NR	Pain intensity (VAS) Assessments: baseline and 10 wk

(*continued on next page*)

Table 1 (*Continued*)

Study	Brief Name	Rationale	What Materials	What Procedures	Who Provided	How	Where	When and How Much	Tailoring	How Well	Participants	Outcomes
Krischak et al	IG: HEP CG: Occupational therapy	To compare the effects of HEP and occupational therapy in the conservative treatment of rotator cuff tears.	An exercise guide booklet with detailed instructions and demonstrations of the HEP, elastic bands	IG: Before the intervention, all the booklet contents were thoroughly discussed, and patients were taught how to perform the exercises correctly. The HEP consisted of exercises to restore neuromuscular control at the shoulder, strength, and ROM. CG: The occupational therapy program included prescribed formal occupational physiotherapy and supervised exercises. The content of the rehabilitation program was determined exclusively by the treating therapists.	Treating therapists	IG: Home sessions CG: Face-to-face sessions	IG: Patients' homes CG: NR	IG: 4-7 exercises, 2 times daily for 8 wk, each session 30 min CG: 3 times weekly for 8 wk	NR	NR	Patients with rotator cuff tears IG: n=16 (8 M, 8 F), age=53.7±12.9 y, DOS=NR CG: n=22 (16 M, 6 F), age=56.4±10.8 y, DOS=NR	Pain intensity (VAS) Function (CMS) ROM (flexion and abduction) Assessments: baseline and 8 wk
Ludewig and Borstad[41]	IG: HEP CG 1: Symptomatic control CG 2: Asymptomatic control	To evaluate a HEP intended to reduce pain and improve shoulder function.	Written instructions with details of the HEP, training diaries, mirrors, hand-held weights, elastic bands	IG: After 1 wk, participants received supervision to review the exercises and address questions. At 4 wk, participants were contacted by telephone to monitor compliance, discuss any problems, and ensure proper progression of the exercises. An optional 4-wk recheck was also scheduled if participants were uncertain about the exercises or having any difficulties performing the exercises. The HEP included stretching, upper trapezius relaxation exercises, serratus anterior strengthening, and external rotation strengthening. CG 1: No treatment. CG 2: No treatment.	Physiotherapists	Home sessions	Participants' homes	Stretching exercises (2 exercises, daily for 10wk, each exercise 30s and 5 repetitions), relaxation exercises (1 exercise, 5 times daily for 10wk), strengthening exercises (3 exercises, 3 times weekly for 10wk, each exercise 3 sets and 10-20 repetitions)	NR	Adherence was monitored by training diaries Adherence rate: 43% of participants had a high adherence rate (≥75%), 43% of participants had an intermediate adherence rate (≥25% and <75%), and 14% of participants had a low adherence rate (<25%)	Construction workers with shoulder impingement syndrome IG: n=34 (34 M), age=48.0±1.8 y, DOS=NR CG 1: n=33 (33 M), age=49.2±1.8 y, DOS=NR Construction workers without shoulder impingement syndrome CG 2: n=25 (25 M), age=49.4±2.5 y, DOS=NR	Pain intensity (NRS) Function (SRQ) Assessments: baseline and 10 wk
Senbursa et al[42]	IG: HEP CG: Manual therapy	To compare the effects of HEP and manual therapy to treat shoulder impingent syndrome.	Brochures with details of the HEP, elastic bands, ice wraps	IG: The HEP consisted of active ROM, stretching and strengthening exercises for rhomboids, levator scapulae, serratus anterior, and rotator cuff muscles. CG: The face-to-face treatment session included joint and soft tissue mobilization techniques, ice application, stretching and strengthening exercises, and patient education. The manual therapy included deep friction massage on supraspinatus muscle tendon, radial nerve stretching, scapular mobilization, glenohumeral joint mobilization, and proprioceptive neuromuscular facilitation techniques.	Physiotherapists	IG: Home sessions CG: Face-to-face sessions	IG: Patients' homes CG: Clinic	IG: At least 7 times weekly for 4 wk, each session 10-15 min CG: 3 sessions weekly for 4 wk	NR	NR	Patients with shoulder impingement syndrome IG: n=15 (gender NR), age=49.5±7.9 y, DOS=NR CG: n=15 (sex NR), age=48.1±7.5 y, DOS=NR	Pain intensity (VAS) Function (Neer-Score) ROM (flexion and abduction) Assessments: baseline and 4 wk
Senbursa et al[43]	IG: HEP CG 1: SEP CG 2: SEP with mobilization	To compare the effects of HEP and SEP and SEP with mobilization for treating supraspinatus tendinopathy.	A leaflet with details of the HEP	IG: The HEP consisted of active ROM, stretching and strengthening exercises for rhomboids, levator scapulae, serratus anterior, and rotator cuff muscles. CG 1: The SEP alone. The exercises of the SEP were the same as that of the HEP. CG 2: The SEP combined with joint and soft tissue mobilization sessions. The exercises of the SEP were the same as that of the HEP. The manual therapy session included deep friction massage on the supraspinatus muscle tendon, radial nerve stretching, scapular mobilization, glenohumeral joint mobilization, and proprioceptive neuromuscular facilitation techniques.	Physiotherapists	IG: Home sessions CG 1: Face-to-face sessions CG 2: Face-to-face sessions	IG: Patients' homes CG 1: NR CG 2: NR	IG: Daily for 12 wk, each exercise 3 sets and 10 repetitions CG 1: 3 times weekly for 12 weeks, each exercise 3 sets and 10 repetitions CG 2: The SEP (same as CG 1), manual therapy (3 times weekly for 12wk)	NR	NR	Patients with supraspinatus tendinopathy IG: n=22 (sex NR), age=48.0±9.0 y, DOS=NR CG 1: n=25 (sex NR), age=48.2±7.9 y, DOS=NR CG 2: n=30 (sex NR), age=50.5±10.6 y, DOS=NR	Pain intensity (VAS) Function (MASES) ROM (flexion and abduction) Assessments: baseline, 4 wk, and 12 wk

(*continued on next page*)

Table 1 (*Continued*)

Study	Brief Name	Rationale	What Materials	What Procedures	Who Provided	How	Where	When and How Much	Tailoring	How Well	Participants	Outcomes
Vinuesa-Montoya et al[44]	IG: HEP CG: HEP with cervicothoracic mobilization	To compare the effects of HEP and HEP with cervicothoracic mobilization to treat unilateral shoulder impingement.	Handouts with details of the HEP, elastic bands, bars	IG: The HEP was demonstrated to patients at the beginning of the intervention. The HEP consisted of stretching and strengthening exercises for the shoulder girdle. CG: The HEP (same as IG) combined with cervicothoracic manipulation face-to-face sessions. The cervicothoracic manipulation was applied to the lower, middle, and upper cervicothoracic spine. Patients also received a repetitive lateral translation from both sides at the beginning of the treatment.	Physiotherapists	IG: Home sessions CG: Face-to-face sessions and home sessions	IG: Patients' homes CG: Clinic and patients' homes	IG: 9 exercises, 2 times daily for 5 wk, each session 30 min CG: The HEP (same as IG), cervicothoracic manipulation (2 times weekly for 5wk)	NR	NR	Patients with unilateral shoulder impingement syndrome. IG: n=20 (13 M, 7 F), age=51.2±5.3 y, DOS=6.1±4.0 mo CG: n=21 (15 M, 6 F), age=46.9±8.0 y, DOS=6.3±3.6 mo	Pain intensity (VAS) Function (DASH) ROM (flexion and abduction) Assessments: baseline and 5 wk
Yoon et al[45]	IG: HEP CG 1: Low-dose corticosteroid injections CG 2: High-dose corticosteroid injections	To compare the effects of HEP and low-dose corticosteroid injections and high-dose corticosteroid injections to treat adhesive capsulitis.	Picture leaflets with details of the HEP, bars, lidocaine, triamcinolone acetonide	Patients received a single injection session before the HEP. The HEP was instructed to patients after the injection. Recommendation was also given at each follow-up examination to keep exercising. IG: The lidocaine injection (placebo) face-to-face session combined with the HEP. The HEP included stretching forward and bending down to a desk, Codman exercises, wall-climbing exercises, external and internal rotations with a bar, and posterior shoulder stretching. CG 1: The low-dose of triamcinolone acetonide injection face-to-face session combined with the HEP (same as IG). CG 2: The high-dose of triamcinolone acetonide injection face-to-face session combined with the HEP (same as IG).	Physiatrists	IG: Home sessions CG 1: Face-to-face sessions and home sessions CG 2: Face-to-face sessions and home sessions	IG: Patients' homes CG 1: Clinic and patients' homes CG 2: Clinic and patients' homes	IG: 5 mL of 1% lidocaine, HEP (3 times daily for 12wk, each session 12min) CG 1: 2 mL of 10 mg/mL triamcinolone acetonide+3 mL of 1% lidocaine, the HEP (same as IG) CG 2: 4 mL of 10 mg/mL triamcinolone acetonide+1 mL of 1% lidocaine, the HEP (same as IG)	NR	NR	Patients with primary adhesive capsulitis in the freezing stage IG: n=11 (5 M, 6 F), age=55.9±3.1 y, DOS=5.1±3.1 mo CG 1: n=20 (12 M, 8 F), age=52.2±3.8 y, DOS=4.7±2.1 mo CG 2: n=20 (10 M, 10 F), age=54.2±5.1 y, DOS=5.5±2.5 mo	Pain intensity (VAS) Function (SPADI) ROM (flexion and abduction) Assessments: baseline, 3 wk, 6 wk, and 12 wk

Abbreviations: CG, control group; CMS, Constant-Murley score; DASH, Disability of the Arm, Shoulder, and Hand; DOS, duration of symptoms; F, female; HEP, home-based exercise program; IG, intervention group; IQR, interquartile range; M, male; MASES, modified American Shoulder and Elbow Surgeons; MPM, multiple physical modalities; NR, not reported; NRS, numeric rating scale; PSS, pain shoulder score; RM, repetition maximum; SEP, supervised exercise program; SPADI, Shoulder Pain and Disability Index; SRQ, Shoulder Rating Questionnaire; VAS, visual analog scale.

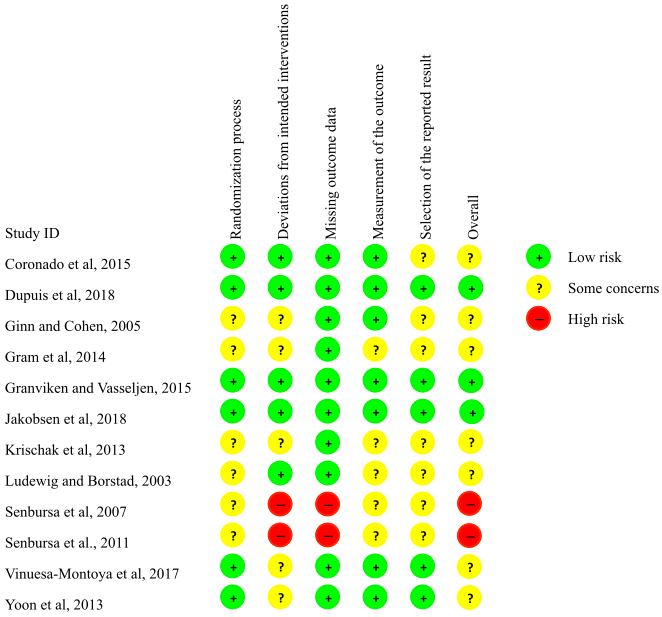

Fig 2 Risk of bias summary for each included study.

were more effective in reducing pain intensity than home-based exercise (1 study, n=31; MD, 1.60; 95% CI, 0.60-2.60; see fig 3). The change of 1.60 points in favor of corticosteroid injections meets the MCID for pain intensity of 1 point. There was no significant between-group difference between home-based exercise and supervised exercise, supervised exercise combined with physical modalities, or home-based exercise combined with physical modalities (see fig 3). The Doi plots showed a major asymmetry in the subgroup analysis of home-based exercise vs supervised exercise (LFK index=−3.77; see appendix 2B) and a minor asymmetry in the subgroup analysis of home-based exercise vs home-based exercise combined with physical modalities (LFK index=1.18; see appendix 2C). The overall quality of evidence for each comparison based on the GRADE rating was as follows: the comparison between home-based exercise vs home-based exercise combined with physical modalities presented with a moderate quality of evidence, the comparison between home-based exercise vs supervised exercise or supervised exercise combined with physical modalities showed a low quality of evidence, and the comparison between home-based exercise vs home-based exercise combined with corticosteroid injections presented with a very low quality of evidence.

Function

Nine studies[13,17,36,37,40,42-45] compared the effectiveness of home-based exercise with other conservative treatments for improving function. Only 6 studies[13,17,37,40,44,45] were included in the meta-analysis because 3 studies did not report sufficient data.[36,42,43] The aggregated results showed no significant difference between home-based exercise and the comparison intervention (n=279; SMD, 0.12; 95% CI, −0.14 to 0.38; I^2=16%; fig 4). The Doi plots showed no asymmetry (LFK index=0.87; see appendix 2D). Thus, there is moderate-quality evidence that, in the short-term, home-based exercise has similar effects on function improvement as other conservative treatments for individuals with NSSP.

One study[41] compared the effectiveness of home-based exercise with no treatment in improving function. There is very low-quality evidence that home-based exercise was significantly more effective than no treatment in improving function for individuals with NSSP in the short-term (n=67; SMD, −0.81; 95% CI, −1.31 to −0.31; large effect; see appendix 3B).

Subgroup analyses for different conservative treatments showed that home-based exercise combined with corticosteroid injections were more effective in improving function than home-based exercise (1 study, n=31; SMD, 0.92; 95% CI, 0.14-1.69; large effect; see fig 4). There were no significant between-group differences between home-based exercise vs supervised exercise, supervised exercise combined with physical modalities, or home-based exercise combined with physical modalities (see fig 4). The Doi plots showed no asymmetry in the subgroup analysis of home-based exercise vs home-based exercise combined with physical modalities (LFK index=−0.49; see appendix 2E). The overall quality of evidence for each comparison based on the GRADE rating was as follows: the comparison between home-based exercise vs home-based exercise combined with physical modalities presented with a moderate quality of evidence, the comparison between home-based exercise vs supervised exercise presented with a low quality of evidence, and the comparison between home-based exercise vs supervised exercise combined with physical modalities or home-based exercise combined with corticosteroid injections showed very low quality of evidence.

Secondary outcomes

ROM

Eight studies[13,17,37,40,42-45] compared the effectiveness of home-based exercise with other conservative treatments for improving ROM. Because of insufficient data, 2 studies[42,43] were not included in the meta-analysis on flexion ROM, while 3 studies[37,42,43] were not included in the meta-analysis on abduction ROM. The aggregated results showed that no significant differences between home-based exercise and the comparison intervention on flexion ROM (n=278; MD, 4.61; 95% CI, −1.16 to 10.38; I^2=54%; fig 5A) and abduction ROM (n=235; MD, 3.74; 95% CI, −12.44 to 19.93; I^2=82%; see fig 5B). Sensitivity analyses were conducted by removing the study by Yoon et al[42] that presented an extreme result. The pooled results showed an MD of 1.28 (95% CI, −2.89 to 5.45) for flexion ROM and an MD of −2.82 (95% CI, −11.40 to 5.77) for abduction ROM, both with no heterogeneity (I^2=0%; see appendices 3C and 3D). The Doi plots showed no asymmetry in the meta-analysis on flexion ROM (LFK index=0.84) and a minor asymmetry in the meta-analysis on abduction ROM (LFK index=−1.13; see appendices 2F and 2G). These findings suggest that home-based exercise and other conservative treatments have equal effects on flexion ROM and abduction ROM for individuals with NSSP in the short-term based on low-quality evidence.

Subgroup analyses for different conservative treatments showed that home-based exercise combined with corticosteroid injections were more effective than home-based exercise in improving flexion (1 study, n=31; MD, 15.10; 95% CI, 7.52-22.68; see fig 5A) and abduction ROMs (1 study, n=31; MD, 26.30; 95% CI, 17.69-34.91; see fig 5B). The changes in favor of corticosteroid injections both meet the MCID of 10 degrees for ROM. There were no significant between-group differences between home-based exercise vs supervised exercise, supervised exercise combined with physical modalities, or home-based exercise combined with physical modalities for flexion ROM (see fig 5A) and abduction ROM (see fig 5B). The Doi plots showed no

Table 2 Meta-analysis outcomes and GRADE results for reported outcomes

Outcomes	Risk of Bias	Inconsistency	Indirectness	Impression	Publication Bias	Quality of Evidence (GRADE)
Pain: Pooled effect of HBE vs OCT 9 studies, N=742; MD, 0.27; 95% CI, −0.12 to 0.65	Serious*	Not serious	Not serious	Not serious	Not serious	⊕⊕⊕⊖ Moderate
Pain: HBE vs SE 3 studies, n=478; MD, 0.31; 95% CI, −0.03 to 0.66	Serious*	Not serious	Not serious	Not serious	Serious†	⊕⊕⊖⊖ Low
Pain: HBE vs SE+PM 2 studies, n=68; MD, −0.70; 95% CI, −1.80 to 0.39	Serious*	Not serious	Not serious	Serious‡	Not assessed§	⊕⊕⊖⊖ Low
Pain: HBE vs HBE+PM 3 studies, n=165; MD, 0.13; 95% CI, −0.54 to 0.80	Serious*	Not serious	Not serious	Not serious	Not serious	⊕⊕⊕⊖ Moderate
Pain: HBE vs HBE+CSI 1 study, n=31; MD, 1.60; 95% CI, 0.60 to 2.60	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Pain: HBE vs No treatment 1 study, n=67; MD −1.47; 95% CI, −2.33 to −0.61	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Function: Pooled effect of HBE vs OCT 6 studies, n=279; SMD, 0.12; 95% CI, −0.14 to 0.38	Serious*	Not serious	Not serious	Not serious	Not serious	⊕⊕⊕⊖ Moderate
Function: HBE vs SE 1 study, n=44; SMD, −0.12; 95% CI, −0.71 to 0.47	Not serious	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊕⊖⊖ Low
Function: HBE vs SE+PM 1 study, n=38; SMD, 0.15; 95% CI, −0.50 to 0.79	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Function: HBE vs HBE+PM 3 studies, n=166; SMD, 0.03; 95% CI, −0.27 to 0.34	Serious*	Not serious	Not serious	Not serious	Not serious	⊕⊕⊕⊖ Moderate
Function: HBE vs HBE+CSI 1 study, n=31; SMD, 0.92; 95% CI, 0.14 to 1.69	Serious*	Serious ‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Function: HBE vs No treatment 1 study, n=67; SMD, −0.81; 95% CI, −1.31 to −0.31	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Flexion ROM: Pooled effect of HBE vs OCT 6 studies, n=278; MD, 4.61; 95% CI, −1.16 to 10.38	Serious*	Not serious	Not serious	Serious¶	Not serious	⊕⊕⊖⊖ Low
Flexion ROM: HBE vs SE 1 study, n=44; MD 2.00; 95% CI, −7.01 to 11.01	Not serious	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊕⊖⊖ Low
Flexion ROM: HBE vs SE+PM 1 study, n=38; MD, 2.80; 95% CI, −16.93 to 22.53	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Flexion ROM: HBE vs HBE+PM 3 studies, n=165; MD, 0.98; 95% CI, −3.87 to 5.83	Serious*	Not serious	Not serious	Not serious	Not serious	⊕⊕⊕⊖ Moderate
Flexion ROM: HBE vs HBE+CSI 1 study, n=31; MD, 15.10; 95% CI, 7.52 to 22.68	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Abduction ROM: Pooled effect of HBE vs OCT 5 studies, n=235; MD, 3.74; 95% CI, −12.44 to 19.93	Serious*	Not serious	Not serious	Serious¶	Not serious	⊕⊕⊖⊖ Low
Abduction ROM: HBE vs SE 1 study, n=44; MD, 1.00; 95% CI, −12.61 to 14.61	Not serious	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊕⊖⊖ Low
Abduction ROM: HBE vs SE+PM 1 study, n=38; MD, −4.10; 95% CI, −30.73 to 22.53	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low
Abduction ROM: HBE vs HBE+PM 2 studies, n=122; MD, −5.61; 95% CI, −17.78 to 6.57	Serious*	Not serious	Not serious	Serious‡	Not assessed§	⊕⊕⊖⊖ Low
Abduction ROM: HBE vs HBE+CSI 1 study, n=31; MD, 26.30; 95% CI, 17.69 to 34.91	Serious*	Serious‖	Not serious	Serious‡	Not assessed§	⊕⊖⊖⊖ Very low

Abbreviations: CSI, corticosteroid injection; HBE, home-based exercise; OCT, other conservative treatments; PM, physical modalities; SE, supervised exercise.

* More than 75% of studies in the meta-analysis were not rated at low risk of bias.

† Major asymmetry based on the LFK index of −3.77.

‡ Sample size did not meet the optimal information size for pain (118), function (90), or ROM (162).

‖ Only 1 study included in the meta-analysis.

§ No. of included studies <3.

¶ Optimal information size met, but the upper or lower CI crossed the MCID of 10 degrees.

asymmetry in the subgroup analysis of home-based exercise vs home-based exercise combined with physical modalities for flexion ROM (LFK index=0.38; see appendix 2H). The overall quality of evidence for each comparison based on the GRADE rating was as follows: the comparison between home-based exercise vs home-based exercise combined with physical modalities presented with a moderate quality of evidence for flexion ROM and a low quality of evidence for abduction ROM, the comparison between home-based exercise vs supervised exercise presented with a low quality of evidence, and the comparison between home-based exercise vs supervised exercise combined with physical modalities or home-based

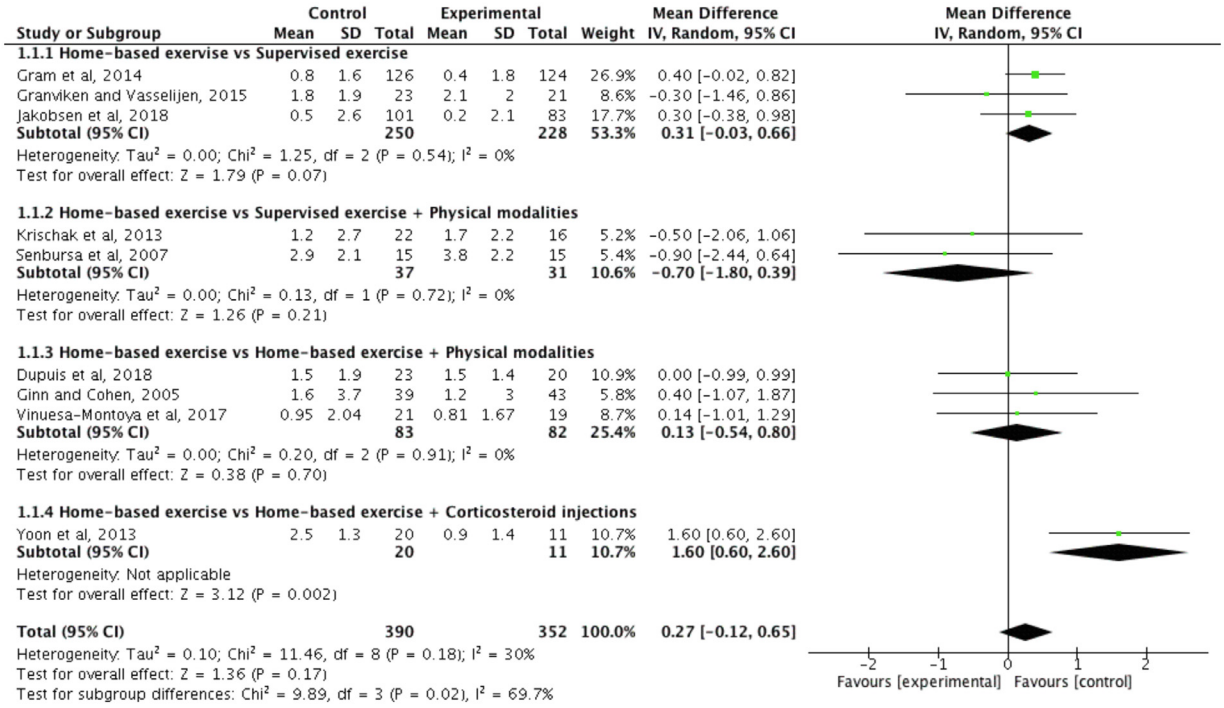

Fig 3 Forest plot of included studies comparing home-based exercise with other conservative treatments for pain intensity reduction in individuals with nonspecific shoulder pain.

exercise combined with corticosteroid injections showed very low quality of evidence.

Discussion

To our knowledge, this is the first systematic review and meta-analysis to specifically compare the effects of home-based exercise vs other conservative treatments or no treatment on pain intensity, function, and ROM in participants with NSSP. Twelve trials were included, with most having short-term follow-up. Overall, we found low to moderate quality evidence that home-based exercise and other conservative treatments have similar effects on alleviating pain intensity and improving function and ROM. There was very low quality of evidence that home-based exercise was superior to no treatment for pain intensity reduction and functional improvement.

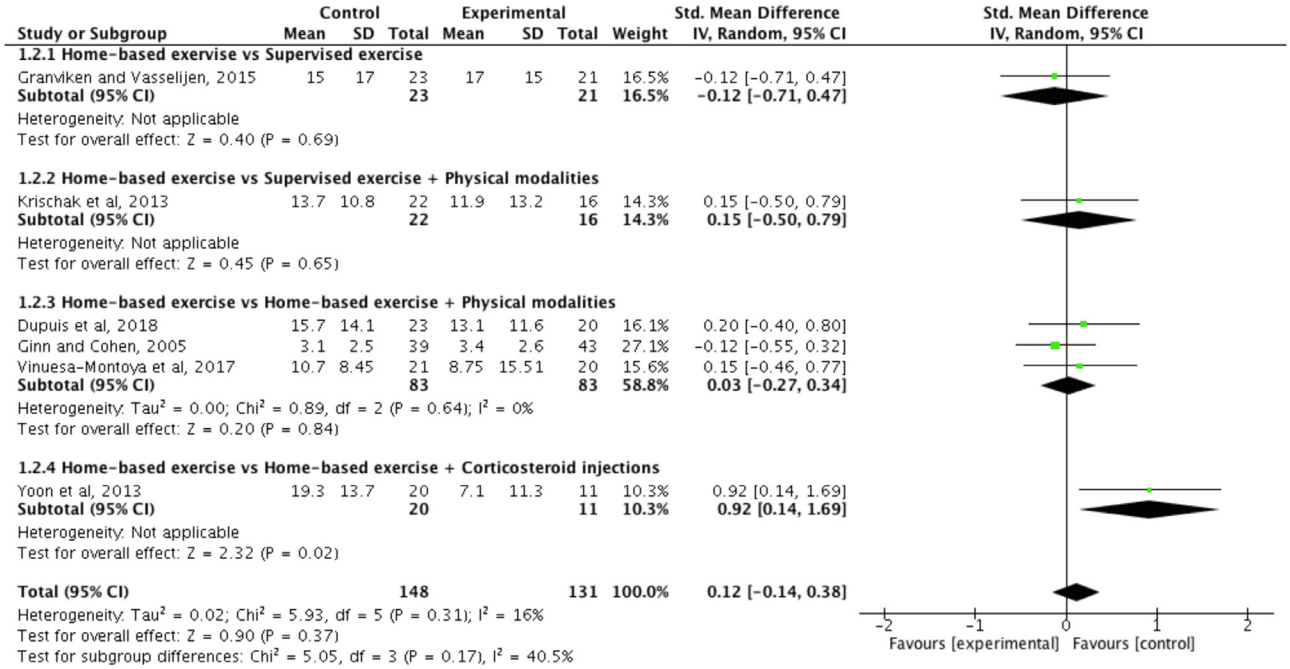

Fig 4 Forest plot of included studies comparing home-based exercise with other conservative treatments for function improvement in individuals with nonspecific shoulder pain.

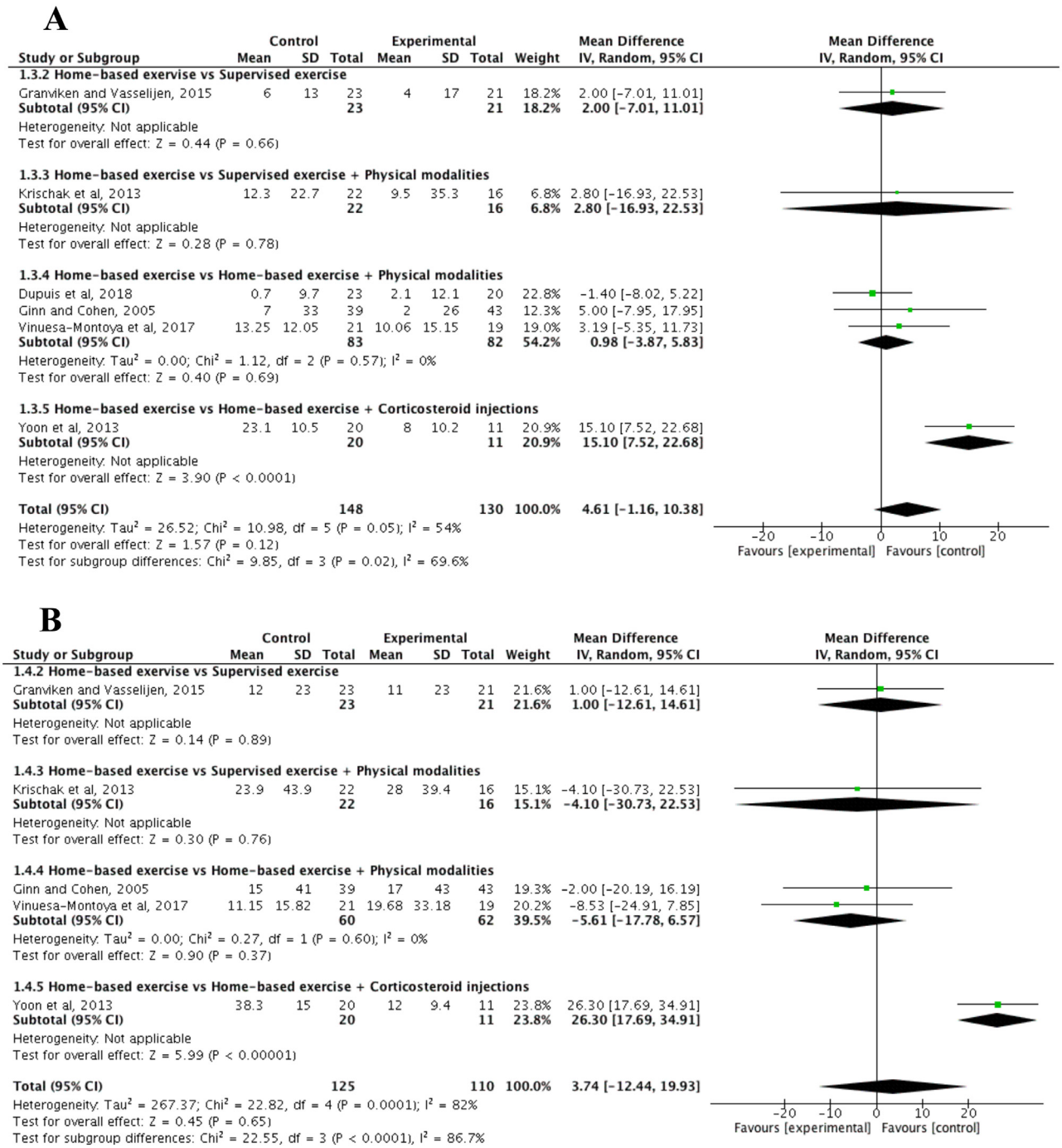

Fig 5 Forest plot of included studies comparing home-based exercise with other conservative treatments for flexion ROM (A) and abduction ROM (B) improvement in individuals with nonspecific shoulder pain.

To date, only 1 meta-analysis[3] has assessed the effectiveness of exercise for the treatment of NSSP. That study demonstrated high-quality evidence that exercise therapy resulted in significant improvement in pain intensity but not function compared with no treatment. This contrasts with our finding that there was very low quality of evidence that home-based exercise effectively improves pain intensity and function compared with no treatment. The inconsistent result in terms of function might be because we included only 1 study in the subgroup analysis for function. Therefore, the statement of evidence was based solely on the results of 1 study. In addition, in the meta-analysis by van den Dolder et al,[3] other than the factor that the follow-up period of 1 study[41] was 10 weeks, the follow-up period of the other included studies[46-48] was 5 weeks. Therefore, the inconsistent result in function might be because of the differences in the follow-up period.

There is low-quality evidence of no difference between home-based exercise and supervised exercise on the primary outcomes of pain intensity and function, which is in line with a recent meta-analysis.[20] In contrast, another recent meta-analysis[49] found

preliminary evidence that supervised exercise was more beneficial than home-based exercise for function and ROM. The significant result may be because of the previous study including only 1 with a long follow-up period in the subgroup analysis for function. We also found no difference between home-based exercise and supervised exercise combined with physical modalities (eg, cryotherapy, passive joint mobilization) on pain intensity, function, and ROMs, although the quality of evidence was low for pain intensity and very low for function and ROMs. This finding is supported by a previous meta-analysis[19]; however, the study did not assess the overall quality of evidence that may lead to overlooking important sources of bias and possibly neglecting their effect on the study results. Finally, the previous 3 studies[19,20,49] only included trials involving patients with subacromial pain syndrome or frozen shoulder, which only reflected results from studies of subarcomial pain syndrome or frozen shoulder rather than NSSP.

Exercise therapy is usually combined with other interventions and is usually not provided as a single intervention.[20,49] However, for home-based exercise, the evidence does not support additional benefits of home-based exercise combined with physical modalities in the treatment of NSSP. Our meta-analysis showed that low-to moderate-quality evidence that home-based exercise and home-based exercise combined with physical modalities (eg, cryotherapy, electrophysical modalities, passive joint mobilization, cervicothoracic manipulation) have similar effects for pain intensity, function, and ROMs. However, the types and doses of interventions used varied across the studies. Moreover, some studies did not provide sufficient details regarding the home-based exercise programs, while others were more specific in describing the exercise programs. Thus, consistent comparisons and conclusions about specific types of exercise are difficult to establish.

A recent review study made a moderate recommendation regarding the clinical significance of corticosteroid injection as an isolated treatment or in combination with exercise therapy.[50] Because only 1 study with some concerns included in the meta-analysis,[45] our results showed very low quality of evidence that corticosteroid injections combined with home-based exercise are superior to home-based exercise alone for the treatment of NSSP in the short-term. The short-term difference between the 2 treatments most likely because of the anti-inflammatory and analgesic properties of corticosteroid injections, which leads to the rapid relief of symptoms.[51,52] Nevertheless, clinicians and patients should be aware of the potential adverse reactions of corticosteroid injections for the management of shoulder pain, including local skin reaction, hyperglycemia, abnormal menstruation, flushing, arrhythmia, increased pain intensity, and headache.[53]

There are some discrepancies between the registered protocol in the PROSPERO registry and the final report of this review that need to be highlighted. Initially, only studies that used visual analog scales to measure pain intensity were eligible, but we decided to consider studies that used all types of measurement tools to measure pain intensity to include more studies. In addition, "function" was initially a secondary outcome, but we decided to define "function" as a primary outcome because we found that "function" was used as the primary outcome in many studies. Finally, the Physiotherapy Evidence Database scale was initially intended for assessing the risk of bias of included studies, but we decided to use the Cochrane Risk of Bias 2.0 tool to follow the methods for Cochrane review.

Implications for clinicians and research

In our meta-analysis, home-based exercise and other conservative treatments were equally effective for NSSP. Compared with other supervised treatments, home-based exercise is more cost-effective and more flexible in time. Therefore, home-based exercise alone may be considered a conservative treatment for NSSP. Corticosteroid injections are often combined with exercise therapy and/or physical modalities to treat NSSP in primary care. In our study, the conclusion that corticosteroid injections combined with home-based exercise were superior to home-based exercise alone for the treatment of NSSP was based on very low quality of evidence. Therefore, further studies are warranted to draw definitive conclusions on the effectiveness of corticosteroid injections combined with home-based exercise. Home-based exercise also has several disadvantages, including no guidance in relevant exercises, lack of motivation and encouragement, and low adherence. Perhaps the disadvantages of home-based exercise can be overcome with the help of information technology, such as virtual trainer systems and virtual reality systems. The effects of information technology-supported home-based exercise for NSSP should be confirmed in future studies. Further studies evaluating dose effects and type effects of home-based exercise programs would be beneficial for clinicians to design home-based exercise programs. Further studies are also needed to investigate the effectiveness of home-based exercise with midterm and long-term follow-up periods. Finally, the effects of home-based exercise compared with other conservative treatments or no treatment should be confirmed with high-quality studies.

Study limitations

Some potential limitations of this study should be acknowledged. Firstly, the search strategy in this study was limited to English-language publications. Therefore, relevant studies published in other languages may have been missed. Second, this study only evaluated the short-term effectiveness of home-based exercise; therefore, the midterm and long-term effects remain uncertain. Third, some comparisons in this study were made based on only 1 trial. Therefore, general conclusions cannot be drawn from these comparisons. Fourth, the effects of home-based exercise on NSSP may vary by the duration of symptoms but were not assessed in this study. Finally, the conclusions of some meta-analyses were based on very low− to low-quality evidence, and therefore the current effect estimates may be changed by future research.

Conclusions

Home-based exercise appears to be equally effective as other conservative treatments and superior to no treatment for the treatment of NSSP. Based on low to moderate quality of evidence, home-based exercise alone might be considered as an effective conservative therapeutic strategy for treating NSSP. To provide a more directive clinical recommendation, further research is needed to confirm the effects of home-based exercise alone on NSSP through large, well-designed randomized studies. Furthermore, the midterm and long-term effects of home-based exercise vs other conservative treatments or no treatment should be investigated in future studies.

Supplier

a. Review Manager (RevMan) 5.4 software; Nordic Cochrane Centre, Cochrane Collaboration.

Keywords

Conservative treatment; Exercise therapy; Meta-analysis; Rehabilitation; Shoulder pain

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Author contributions

The idea for the study was conceived and designed by J.L. and S. H. The literature search was performed by J.L., X.R., and S.H. The data analysis was performed by J.L., R.Z., and Y.Y. J.L. wrote the first draft of manuscript. S.H. and Y.Y. revised all drafts. All authors read and approved the final version of the manuscript.

References

1. Steuri R, Sattelmayer M, Elsig S, et al. Effectiveness of conservative interventions including exercise, manual therapy and medical management in adults with shoulder impingement: a systematic review and meta-analysis of RCTs. Br J Sports Med 2017;51:1340–7.
2. Luime JJ, Koes BW, Hendriksen IJM, et al. Prevalence and incidence of shoulder pain in the general population; a systematic review. Scand J Rheumatol 2004;33:73–81.
3. van den Dolder PA, Ferreira PH, Refshauge KM. Effectiveness of soft tissue massage and exercise for the treatment of non-specific shoulder pain: a systematic review with meta-analysis. Br J Sports Med 2014;48:1216–26.
4. Zheng XQ, Li K, Wei YD, Tie HT, Yi XY, Huang W. Nonsteroidal anti-inflammatory drugs versus corticosteroid for treatment of shoulder pain: A systematic review and meta-analysis. Arch Phys Med Rehabil 2014;95:1824–31.
5. Kuijpers T, van Tulder MW, van der Heijden GJ, Bouter LM, van der Windt DA. Costs of shoulder pain in primary care consulters: a prospective cohort study in The Netherlands. BMC Musculoskelet Disord 2006;7:83.
6. Östör AJK, Richards CA, Prevost AT, Speed CA, Hazleman BL. Diagnosis and relation to general health of shoulder disorders presenting to primary care. Rheumatology (Oxford) 2005;44:800–5.
7. Schwerla F, Hinse T, Klosterkamp M, Schmitt T, Rütz M, Resch KL. Osteopathic treatment of patients with shoulder pain. A pragmatic randomized controlled trial. J Bodyw Mov Ther 2020;24:21–8.
8. Schellingerhout JM, Verhagen AP, Thomas S, Koes BW. Lack of uniformity in diagnostic labeling of shoulder pain: time for a different approach. Man Ther 2008;13:478–83.
9. Gismervik S, Drogset JO, Granviken F, Rø M, Leivseth G. Physical examination tests of the shoulder: a systematic review and meta-analysis of diagnostic test performance. BMC Musculoskelet Disord 2017;18:41.
10. Hegedus EJ, Goode A, Campbell S, et al. Physical examination tests of the shoulder: a systematic review with meta-analysis of individual tests. Br J Sports Med 2008;42:80–92.
11. Peek AL, Miller C, Heneghan NR. Thoracic manual therapy in the management of non-specific shoulder pain: a systematic review. J Man Manip Ther 2015;23:176–87.
12. Miranda H, Viikari-Juntura E, Heistaro S, Heliövaara M, Riihimäki H. A population study on differences in the determinants of a specific shoulder disorder versus nonspecific shoulder pain without clinical findings. Am J Epidemiol 2005;161:847–55.
13. Ginn KA, Cohen ML. Exercise therapy for shoulder pain aimed at restoring neuromuscular control: a randomized comparative clinical trial. J Rehabil Med 2005;37:115–22.
14. Smith N, Liew Z, Johnson S, Ellard DR, Underwood M, Kearney R. A systematic review of the methods and drugs used for performing suprascapular nerve block injections for the non-surgical management of chronic shoulder pain. Br J Pain 2021;15:460–73.
15. van der Heijden GJ. Shoulder disorders: a state-of-the-art review. Baillieres Best Pract Res Clin Rheumatol 1999;13:287–309.
16. Abdulla SY, Southerst D, Côté P, et al. Is exercise effective for the management of subacromial impingement syndrome and other soft tissue injuries of the shoulder? A systematic review by the Ontario Protocol for Traffic Injury Management (OPTIMa) Collaboration. Man Ther 2015;20:646–56.
17. Granviken F, Vasseljen O. Home exercises and supervised exercises are similarly effective for people with subacromial impingement: a randomised trial. J Physiother 2015;61:135–41.
18. Karlsson L, Takala EP, Gerdle B, Larsson B. Evaluation of pain and function after two home exercise programs in a clinical trial on women with chronic neck pain - with special emphasises on completers and responders. BMC Musculoskelet Disord 2014;15:6.
19. Gutiérrez-Espinoza H, Araya-Quintanilla F, Cereceda-Muriel C, Álvarez-Bueno C, Martínez-Vizcaíno V, Cavero-Redondo I. Effect of supervised physiotherapy versus home exercise program in patients with subacromial impingement syndrome: a systematic review and meta-analysis. Phys Ther Sport 2020;41:34–42.
20. Liaghat B, Ussing A, Petersen BH, et al. Supervised training compared with no training or self-training in patients with subacromial pain syndrome: a systematic review and meta-analysis. Arch Phys Med Rehabil 2021;102:2428–41.
21. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: Template for Intervention Description and Replication (TIDieR) checklist and guide. BMJ 2014;348:g1687.
22. Higgins J, Green S. Cochrane handbook for systematic reviews of interventions version 5.1.0. London: Cochrane Collaboration; 2011.
23. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. BMJ 2019;366:14898.
24. Borenstein M, Hedges LV, Higgins JPT, Rothstein HR. A basic introduction to fixed-effect and random-effects models for meta-analysis. Res Synth Methods 2010;1:97–111.
25. primer Cohen JA power. Psychol Bull 1992;112:155–9.
26. Challoumas D, Biddle M, McLean M, Millar NL. Comparison of treatments for frozen shoulder: a systematic review and meta-analysis. JAMA Netw Open 2020;3:e2029581.
27. Higgins JPT, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. BMJ 2003;327:557–60.
28. Furuya-Kanamori L, Barendregt JJ, Doi SAR. A new improved graphical and quantitative method for detecting bias in meta-analysis. Int J Evid Based Healthc 2018;16:195–203.
29. Balshem H, Helfand M, Schünemann HJ, et al. GRADE guidelines: 3. Rating the quality of evidence. J Clin Epidemiol 2011;64:401–6.
30. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 7. Rating the quality of evidence - inconsistency. J Clin Epidemiol 2011;64:1294–302.
31. Smith BE, Hendrick P, Smith TO, et al. Should exercises be painful in the management of chronic musculoskeletal pain? A systematic review and meta-analysis. Br J Sports Med 2017;51:1679–87.
32. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 8. Rating the quality of evidence - indirectness. J Clin Epidemiol 2011;64:1303–10.
33. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines 6. Rating the quality of evidence - imprecision. J Clin Epidemiol 2011;64:1283–93.

34. Guyatt G, Oxman AD, Akl EA, et al. GRADE guidelines: 1. Introduction - GRADE evidence profiles and summary of findings tables. J Clin Epidemiol 2011;64:383–94.
35. Holmgren T, Hallgren HB, Öberg B, Adolfsson L, Johansson K. Effect of specific exercise strategy on need for surgery in patients with subacromial impingement syndrome: randomised controlled study. BMJ 2012;344:e787.
36. Coronado RA, Bialosky JE, Bishop MD, et al. The comparative effects of spinal and peripheral thrust manipulation and exercise on pain sensitivity and the relation to clinical outcome: amechanistic trial using a shoulder pain model. J Orthop Sports Phys Ther 2015;45:252–64.
37. Dupuis F, Barrett E, Dubé MO, McCreesh KM, Lewis JS, Roy JS. Cryotherapy or gradual reloading exercises in acute presentations of rotator cuff tendinopathy: a randomised controlled trial. BMJ Open Sport Exerc Med 2018;4:e000477.
38. Gram B, Andersen C, Zebis MK, et al. Effect of training supervision on effectiveness of strength training for reducing neck/shoulder pain and headache in office workers: cluster randomized controlled trial. Biomed Res Int 2014;2014:693013.
39. Jakobsen MD, Sundstrup E, Brandt M, Andersen LL. Effect of physical exercise on musculoskeletal pain in multiple body regions among healthcare workers: secondary analysis of a cluster randomized controlled trial. Musculoskelet Sci Pract 2018;34:89–96.
40. Krischak G, Gebhard F, Reichel H, et al. A prospective randomized controlled trial comparing occupational therapy with home-based exercises in conservative treatment of rotator cuff tears. J Shoulder Elbow Surg 2013;22:1173–9.
41. Ludewig PM, Borstad JD. Effects of a home exercise programme on shoulder pain and functional status in construction workers. Occup Environ Med 2003;60:841–9.
42. Senbursa G, Baltaci G, Atay A. Comparison of conservative treatment with and without manual physical therapy for patients with shoulder impingement syndrome: a prospective, randomized clinical trial. Knee Surg Sports Traumatol Arthrosc 2007;15:915–21.
43. Senbursa G, Baltaci G, Atay A. The effectiveness of manual therapy in supraspinatus tendinopathy. Acta Orthop Traumatol Turc 2011;45:162–7.
44. Vinuesa-Montoya S, Aguilar-Ferrándiz ME, Matarán-Peñarrocha GA, Fernández-Sánchez M, Fernández-Espinar EM, Castro-Sánchez AM. A preliminary randomized clinical trial on the effect of cervicothoracic manipulation plus supervised exercises vs a home exercise program for the treatment of shoulder impingement. J Chiropr Med 2017;16:85–93.
45. Yoon SH, Lee HY, Lee HJ, Kwack KS. Optimal dose of intra-articular corticosteroids for adhesive capsulitis: a randomized, triple-blind, placebo-controlled trial. Am J Sports Med 2013;41:1133–9.
46. Ginn KA, Herbert RD, Khouw W, Lee R. A randomized, controlled clinical trial of a treatment for shoulder pain. Phys Ther 1997;77:802–9.
47. Lombardi I, ÂG Magri, Fleury AM, Da Silva AC, Natour J. Progressive resistance training in patients with shoulder impingement syndrome: a randomized controlled trial. Arthritis Rheum 2008;59:615–22.
48. Wiener M, Mayer F. Effects of physiotherapy on peak torque and pain in patients with tendinitis of the supraspinatus muscle. Dtsch Z Sportmed 2005;56:383–7.
49. Mertens MG, Meert L, Struyf F, Schwank A, Meeus M. Exercise therapy is effective for improvement in range of motion, function and pain in patients with frozen shoulder: a systematic review and meta-analysis. Arch Phys Med Rehabil 2022;103:998–1012.
50. Pieters L, Lewis J, Kuppens K, et al. An update of systematic reviews examining the effectiveness of conservative physical therapy interventions for subacromial shoulder pain. J Orthop Sports Phys Ther 2020;50:131–41.
51. Burger M, Africa C, Droomer K, et al. Effect of corticosteroid injections versus physiotherapy on pain, shoulder range of motion and shoulder function in patients with subacromial impingement syndrome: a systematic review and meta-analysis. S Afr J Physiother 2016;72:318.
52. van der Windt DA, Koes BW, Deville W, Boeke AJP, De Jong BA, Bouter LM. Effectiveness of corticosteroid injections versus physiotherapy for treatment of painful stiff shoulder in primary care: randomised trial. BMJ 1998;317:1292–6.
53. van Doorn PF, Schiphof D, Rozendaal RM. The use and safety of corticosteroid injections for shoulder pain in general practice: a retrospective cohort study. Fam Pract 2022;39:367–72.