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A Systematic Review and Meta-analysis

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Published in:
Archives of Physical Medicine and Rehabilitation

DOI (link to publication from Publisher):
[10.1016/j.apmr.2021.03.027](https://doi.org/10.1016/j.apmr.2021.03.027)

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Publication date:
2021

Document Version
Publisher's PDF, also known as Version of record

[Link to publication from Aalborg University](#)

Citation for published version (APA):
Liaghat, B., Ussing, A., Petersen, B. H., Andersen, H. K., Barfod, K. W., Jensen, M. B., Hoegh, M., Tarp, S., Juul-Kristensen, B., & Brorson, S. (2021). Supervised Training Compared With No Training or Self-training in Patients With Subacromial Pain Syndrome: A Systematic Review and Meta-analysis. *Archives of Physical Medicine and Rehabilitation*, 102(12), 2428-2441.e10. <https://doi.org/10.1016/j.apmr.2021.03.027>

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REVIEW ARTICLE (META-ANALYSIS)

Supervised Training Compared With No Training or Self-training in Patients With Subacromial Pain Syndrome: A Systematic Review and Meta-analysis



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Abstract

Objective: To study the effects of supervised training in adults with subacromial pain syndrome.

Data Sources: Embase, MEDLINE, Cochrane Library, Cumulative Index to Nursing and Allied Health, and Physiotherapy Evidence Database were searched from inception to March 2020.

Study Selection: Independent reviewers selected randomized controlled trials comparing supervised training with (1) no training or (2) self-training in adults with subacromial pain syndrome lasting for at least 1 month. Critical outcomes were shoulder pain, function, and patient-perceived effect. Important outcomes included other potential benefits and adverse events at 3-month follow-up.

Data Extraction: Two independent reviewers extracted data for the meta-analysis. Risk of bias was assessed using the Cochrane Risk of Bias tool 1, and certainty of evidence was evaluated using the Grades of Recommendation Assessment, Development, and Evaluation (GRADE).

Data Synthesis: Ten studies (n=597, 43% female) were included. Supervised training resulted in larger improvements than no training on pain (at rest: n=286; mean difference [MD], 1.68; 95% confidence interval [CI], 0.31-3.06 on 0-10 scale; during movement: n=353; MD, 1.84; 95% CI, 0.91-2.76), function (n=396; standardized MD, 0.30; 95% CI, 0.07-0.52), and patient-perceived effect (n=118; risk ratio, 1.43; 95% CI, 0.87-2.34). Supervised training had potential benefits regarding quality of life, return to work, dropout, and training adherence, albeit more patients reported mild, transient pain after training. Supervised training and self-training showed equal improvements on pain (n=44) and function (n=76), with no data describing patient-perceived effect. Certainty of evidence was low for critical outcomes and low-moderate for other outcomes.

Conclusions: Supervised training might be superior to no training and equally effective as self-training on critical and important outcomes. Based on low-moderate certainty of evidence, these findings support a weak recommendation for supervised training in adults with subacromial pain syndrome. Archives of Physical Medicine and Rehabilitation 2021;102:2428–41

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Supported by the Danish Health Authority. The Parker Institute, Bispebjerg and Frederiksberg Hospital, is supported by a core grant from the Oak Foundation (OCAY-18-774_OFIL). PROSPERO Trial Registration No.: CRD42020164218. Disclosures: none.

Shoulder pain has a prevalence of 7%-26% in the general population and is often associated with poor improvement in symptoms.^{1,2} Subacromial pain syndrome (SAPS)³ describes the clinical entity of a painful and functionally impaired shoulder,

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<https://doi.org/10.1016/j.apmr.2021.03.027>

usually experienced when combining shoulder elevation and rotation. Different terms, including subacromial impingement syndrome, rotator cuff tendinopathy,⁴ and rotator cuff-related shoulder pain,⁵ have been used to describe these symptoms.

The pathogenesis of SAPS is unknown but has traditionally been linked to pathology in a variety of shoulder structures, that is, the rotator cuff muscles and tendons, the acromion, the coracoacromial ligament, and capsular or intra-articular tissue.⁶ Contributing factors have been suggested related to muscle dysfunction,⁷⁻⁹ altered shoulder kinematics,¹⁰ overuse due to sustained intensive work,¹¹⁻¹³ and slouched posture.^{14,15} Consequently, this has resulted in various treatments being investigated.¹⁶

Current guidelines provide inconsistent recommendations for subacromial surgery but generally advice against surgery for the treatment of SAPS as first line of treatment.^{17,18} Whereas a positive effect of training has been implicit for many years, most recently a high-impact review¹⁹ concluded a strong recommendation for exercise-based treatment in this patient group. Besides being as effective as surgery, training is safe and cost-effective.⁴ However, delivering methods vary from patients being offered a leaflet or a link to a video that introduces self-training to a training program with intensive weekly supervised sessions. Unfortunately, the delivery method is often not addressed in the conclusion about the effect of training in current recommendations. Therefore, it remains unknown whether the effect of supervised training exceeds the effect of no training and/or self-training, and the evidence behind the strong recommendations for training should be further evaluated and specified.

To our knowledge, no previous studies have reviewed training for SAPS using strict definitions of training interventions as being either supervised or self-training. Therefore, the objective of this systematic review and meta-analysis was to study the effect of supervised training in adult patients with SAPS for more than 1 month compared with (1) no training or (2) self-training on pain, function, and patient-perceived effect at 3-month follow-up.

Methods

This systematic review and meta-analysis was based on the guidelines of the Cochrane Collaboration²⁰ for systematic reviews of interventions. The study reporting adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses recommendations.²¹ The systematic review was conducted as part of the preparation of a national clinical guideline on treatment of non-traumatic shoulder pain published by the Danish Health Authority in 2020. The protocol was preregistered with PROSPERO (trial registration no. CRD42020164218).

List of abbreviations:

| | |
|-------|--|
| CI | confidence interval |
| GRADE | Grades of Recommendation Assessment, Development, and Evaluation |
| MD | mean difference |
| MID | minimal important difference |
| RCT | randomized controlled trial |
| RR | risk ratio |
| SAPS | subacromial pain syndrome |
| SMD | standardized mean difference |

Data sources and search strategy

The search consisted of 2 steps. First, a search for systematic reviews published from 2009-2020 was performed on January 13, 2020, to identify systematic reviews with relevant primary studies to be included in the synthesis. Second, a systematic search was performed on March 9, 2020, to identify individual randomized controlled trials (RCTs) based on the latest search date from the included systematic review by Page et al,²² which had the most comprehensive literature search. Searches were performed in Embase, MEDLINE, Cochrane Library, Cumulative Index to Nursing and Allied Health, and Physiotherapy Evidence Database. The search strategy included subject heading and text words related to the eligibility criteria, and no restrictions concerning publication status or language were applied (supplemental appendix S1, available online only at <http://www.archives-pmr.org/>).

Study selection

Duplicates were removed in RefWorks, and the remaining records were imported to Covidence (Covidence systematic review software^a). Records were screened by 2 independent reviewers for title and abstract (M.H., S.B.), and full-text articles were assessed independently for eligibility by 2 reviewers (B.L., S.B.). Any discrepancies between the 2 authors were resolved through discussion until consensus was reached. If necessary, the decision was adjudicated by a third author (A.U.). Authors were not blinded to study identification (authors and journal). Reference lists of the included studies were hand-screened for potentially further relevant studies. One additional study²³ was identified via communication with a shoulder expert.

We searched for RCTs in all languages if there was an English abstract, and no studies were excluded because of language. Non-randomized studies, unpublished studies (eg, conference abstracts, trial protocols), and animal studies were excluded. Prespecified eligibility criteria were based on the population, intervention, comparison, and outcome framework.²⁴

Population

Adult patients with nontraumatic shoulder pain and clinical symptoms of SAPS lasting for at least 1 month were included because many patients are assumed to seek professional advice if symptoms are not resolved within this time frame. Related terms for SAPS such as subacromial impingement syndrome, rotator cuff tendinopathy, and rotator cuff-related shoulder pain were included. Instead of setting strict diagnostic criteria, we accepted the studies' own criteria for SAPS. Exclusion criteria were post-traumatic pain, traumatic rotator cuff rupture, traumatic shoulder instability, frozen shoulder, symptomatic osteoarthritis of the shoulder or acromioclavicular joints, acute tendinitis calcarea, arthralgia and arthritis in connective tissue and joint diseases, neck disorders, pain triggered by other organ systems, pathology in and around the biceps tendon, neoplasms and metastases, neuropathic pain, and generalized pain in the body (eg, fibromyalgia).

Intervention

Supervised training was defined as training that was instructed, supervised, and monitored by a health care professional including 2 or more supervised sessions.

Comparator

For aim (1) we included studies with no training (defined as no treatment, wait-and-see, active following, and sham), whereas for aim (2) it was self-training (eg, self-training provided by a leaflet and/or 1-time instruction).

Outcome

Pain, shoulder function, and patient-perceived effect were classified as critical outcomes.²⁵ Pain could be measured by using a visual analog scale or Numeric Pain Rating Scale, with 0 indicating “no pain” and 10 indicating “extreme pain.” The minimal important difference (MID) was set at 1.5.¹⁷ Function could include different measurement tools, for example, the Constant score, a 100-point scale combining subjective (pain, activities of daily living) and objective (strength, range of motion) measurements (MID, 8.3),¹⁷ with higher scores indicating higher function; the Disability of the Arm, Shoulder, and Hand, with a score ranging from 0 (no disability) to 100 (most severe disability) (MID, 10.2)¹⁷; the Shoulder Pain and Disability Index with a 100-point scale similar to Disability of the Arm, Shoulder, and Hand (MID 8-13)^{26,27}; the Shoulder Rating Questionnaire, ranging from 17 (worse) to 100 (better) (MID, 12-13)²⁸; and the Neer shoulder scale, a 0-100 scale combining subjective (pain) and objective (muscle strength, reaching ability, stability, active range of motion, and an anatomic or radiological evaluation), with higher scores indicating higher function (MID unknown). Patient-perceived effect included Global Perceived Effect (1-7), Patient Global Impression of Improvement, or Clinical Global Impression. MIDs were defined as a score of 1 or 2 on Patient Global Impression of Improvement or Clinical Global Impression and a score of +3 or +2 on Global Perceived Effect. Pain, function, and patient-perceived effect were considered the critical outcomes to evaluate the effect of training in shoulder related problems. Patient-perceived effect is a broad effect measure of both satisfaction and experience of treatment effect that are not captured with the narrower effect measures, such as pain and function. Patient-perceived effect was considered a critical outcome because perceived effect is of great importance for the patient’s motivation and adherence to exercise.

Important (not critical) outcomes included quality of life, for example, European Quality of life scale, dropouts for all reasons, serious adverse events (eg, events requiring hospitalization), adverse events (eg, symptom flare up), return to work, and adherence or compliance to the training protocol.

The primary endpoint of interest for all outcomes was 3 months after starting the training intervention. However, this was extended to periods between 6 weeks and 6 months after looking through the retained studies.

Data extraction

Two authors (A.U., S.B.) independently extracted the data using a predefined extraction template: study design, study population, baseline characteristics, and outcome measures. Any discrepancies between the 2 authors were resolved through discussion until consensus was reached. If necessary, a third independent author (B. L.) was consulted. Where possible, missing values (eg, SD) were calculated from the available data (*P* value, *t* value, confidence interval [CI], or Standard error). Study authors were contacted for missing data.

Risk of bias

We assessed the internal validity of the systematic reviews using a Measurement Tool to Assess Systematic Reviews.²⁹ All included RCTs were assessed in Covidence for risk of bias using the Cochrane Risk of Bias tool 1 by 2 independent reviewers (S.B., A. U.), with disagreements resolved by discussion and a third author (B.L.) being consulted if consensus could not be reached.³⁰ Authors were not blinded to study identification (authors and journal).³¹ Each item was graded (unclear, low, or high risk of bias) based on randomization sequence generation, treatment allocation concealment, blinding of patients and personnel, blinding of outcome assessors, completeness of outcome data, selective outcome reporting, and other sources of bias.

Certainty of evidence

The Grades of Recommendation Assessment, Development, and Evaluation (GRADE)²⁵ approach was used to assess the overall certainty of evidence for each outcome deemed critical or important, using the GRADEpro Guideline Development Tool (<https://grade.pro.org/>). According to GRADE, RCTs begin as “high certainty” evidence and can be downgraded to “moderate,” “low,” or “very low certainty” based on limitations in study design, indirectness, imprecision, inconsistency, and publication bias. The overall certainty of evidence was determined by the lowest certainty level for the critical outcomes. No funnel plots were generated to judge publication bias because no more than 10 studies were included in each analysis.

Data analysis

Review Manager 5.3 software^b was used for data analysis, data synthesis, and creation of forest plots. Continuous outcomes were reported as mean difference (MD) with 95% CIs. For the function outcome in supervised compared with no training, the standardized mean difference (SMD) with 95% CI was reported because different scales were used in the included studies. Dichotomous outcomes (ie, patient-perceived effect in supervised compared with no training) were reported as risk ratios (RRs) with 95% CIs. Heterogeneity was assessed by visual inspection of the forest plot, by using the chi-square test, and the *I*² statistic. Because we anticipated variation between studies, meta-analysis was carried out using the random-effects model when 2 or more studies were included in the analyses; otherwise the fixed-effects model was used. The Inverse Variance method was used for continuous outcomes and the Mantel-Haenszel method for dichotomous outcomes.

Data were extracted for the duration and intensity of the intervention as well as the duration of pain at inclusion/baseline to describe the included studies and to report on the interpretation of duration and intensity of training interventions. A sensitivity analysis was conducted excluding studies with extreme results to explain potential heterogeneity.

Results

Study selection

After the initial search for systematic reviews and after duplicate removal, 1800 records were screened by title and abstract, 86 full-text articles were considered for inclusion, and 3 systematic

reviews^{22,32,33} were identified including 9 RCTs (published in 10 articles) of interest. The Cochrane review by Page et al²² reported adequate description of all the necessary domains assessed by a Measurement Tool to Assess Systematic Reviews (score 11/11) (supplemental appendix S2A, available online only at <http://www.archives-pmr.org/>). Based on this review, a search for primary studies from 2015 and onward was conducted, where 1401 additional records were identified plus 1 record identified through other sources, 29 full-text articles were considered, and 1

additional RCT was included. In total, 10 RCTs^{23,34-43} (11 articles) were included (fig 1), of which 1 was in German⁴³ and the others in English.

Study characteristics

The 10 eligible RCTs included 597 patients (43.4% female) of interest (table 1). The mean age at baseline was 21.9 years in 1 study³⁷ and ranged from 43-60.8 years in the rest. Nine studies

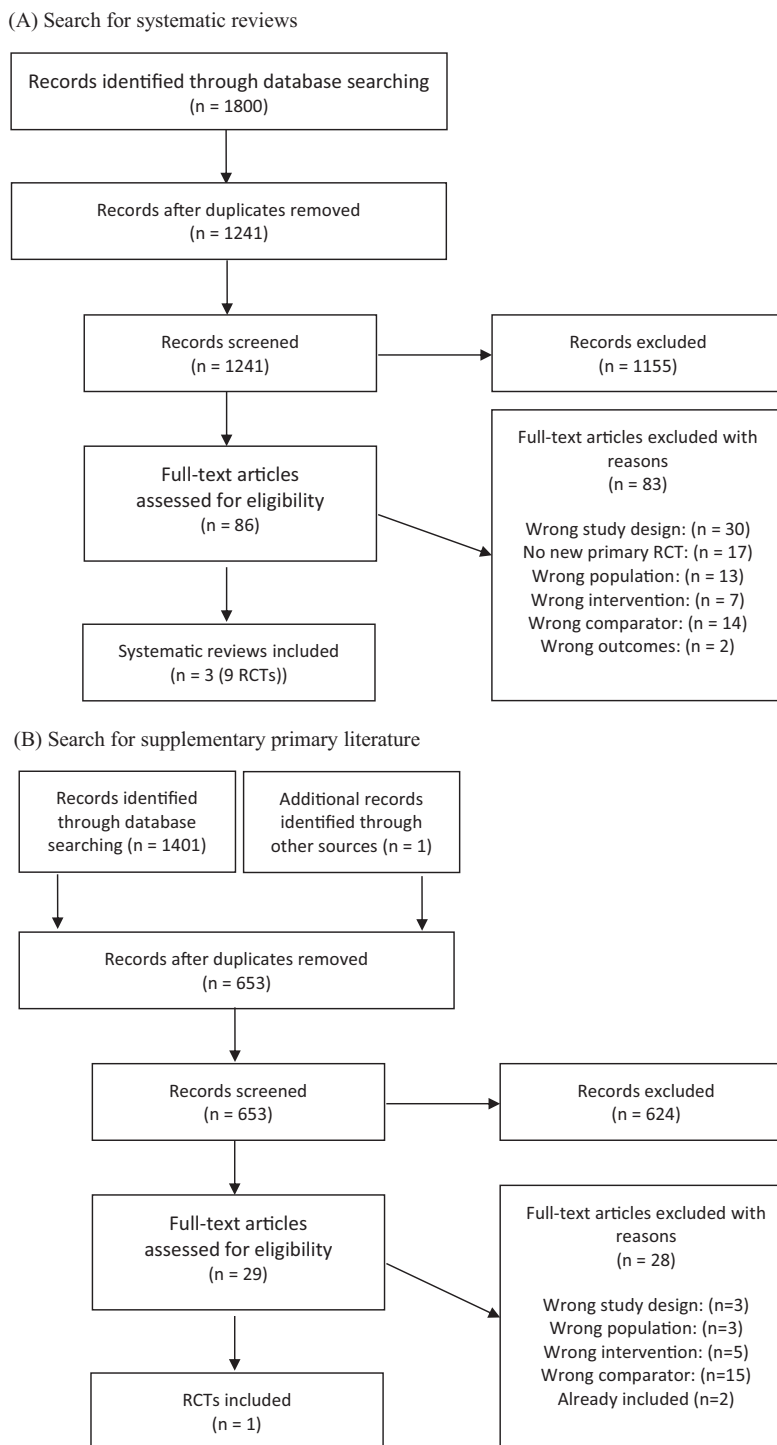


Fig 1 Flowchart showing the process of selecting (A) systematic reviews and (B) primary studies. The number of included studies and reasons for exclusion are provided.

Table 1 Study, participant, inclusion criteria, and characteristics of the intervention and outcome of the included studies

| Author, Country | Participants (n); Age (y), Mean \pm SD, Female, n (%) | Inclusion Criteria | Intervention | Comparison | Outcomes |
|---|--|--|---|--|--|
| Bennell et al ³⁴ Australia | n=20, Intervention 59.3 \pm 10.1 Control 60.8 \pm 12.4, 56 (47) | Age >18 y, shoulder pain >3 mo, pain on movement >3/10 (0-10 NRS), pain on active abduction or external rotation, and a positive quick test for shoulder impingement. | A manual therapy and home exercise program; 10 individual supervised sessions, 30-45 min each over 10 wk. For the following 12 wk, the group continued the home exercise program. Exercises: dynamic scapular control, strengthening scapular stabilizer and rotator cuff muscles, shoulder and thoracic posture, and range of motion of thoracic extension. | Inactive ultrasound therapy and application of an inert gel; 10 visits, 10 min each; 10 sessions of individual, standardized treatment over 10 wk. | Pain during movement (NRS) Pain at rest (NRS) Function (SPADI) Quality of life (SF-36) Patient-perceived effect (participants' perceived global rating of change) Adverse events Dropout adherence Endpoint: 10 wk |
| Brox et al ^{35,36} Norway | n=80 (125*), Intervention 47 \pm NA Control 48 \pm NA Arthroscopic surgery 48 \pm NA, 43 (54) | Aged 18-66 y; shoulder pain >3 mo, no effect of previous physiotherapy and anti-inflammatory drugs; dysfunction or pain on abduction; a normal passive glenohumeral range of movement; pain during 2 of the 3 isometric-eccentric tests (abduction at 0 and 30 ° and external rotation); and positive impingement tests. | Exercise regimen over 3-6 mo, supervised 2/wk (supervision was gradually reduced). On the other days they followed the same exercise program at home. Resistance was added gradually to strengthen the short shoulder rotator and the scapular stabilizing muscles. | 12 sessions of detuned soft laser treatment over 6 wk. | Pain during movement (NRS, 1-9) Pain at rest (NRS, 1-9) Function (Neer shoulder score) Return to work Endpoint: 3 mo |
| Cha et al ³⁷ Korea | n=30, Intervention 21.31 \pm 1.74 Control 22.57 \pm 1.79, 0 (0) | Baseball players with impingement symptoms: posterosuperior shoulder pain during throwing; pain during the apprehension test and pain relief during the relocation test; or a positive response in 1 of the abovementioned tests associated with another of the following diagnostic indicators: Neer, Hawkins, or Jobe for reproducible pain. | Physical therapy, warm-up, workout, and cooldown. Ultrasonic wave (5min) and laser therapy (10min). Warm-up with stationary cycling (15min) and standing stretching (5min). A supervised progressive rehabilitation program 3/wk. Exercises: targeting the shoulder and upper extremity. | Nonstructured training | Pain at rest (NRS) Pain strenuous activity (NRS) Pain normal daily activity (NRS) Endpoint: 12 wk |
| Dickens et al ³⁸ United Kingdom | n=85, Intervention 55 (range, 27-68) Control 54 (range, 26-73), 37 (44) | Patients on waiting list for subacromial decompression. Subacromial impingement: clinical history, clinical examination, and radiographic findings, together with diagnostic local anesthetic injections into the subacromial space and acromioclavicular joint. | Combination of supervised therapy at the hospital and a home exercise program, assessed regularly. 3 steroid injections into the subacromial space, given at 6 weekly intervals as part of an existing protocol. Optional joint mobilization. The exercise program was progressed to involve strengthening and lasted 6 mo, twice a day. Exercises: posture and recruitment and strength of scapulothoracic muscles. Progressed to involve strengthening of infraspinatus, subscapularis, and teres minor relative to the supraspinatus and deltoid with the use of resistance. | Nonstructured training | Function (CS) Dropout Endpoint: 6 mo |

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Table 1 (Continued)

| Author, Country | Participants (n); Age (y), Mean \pm SD, Female, n (%) | Inclusion Criteria | Intervention | Comparison | Outcomes |
|--|--|---|---|---|--|
| Erdem et al ²³ Turkey | n=32 (41 [†]), Intervention 47 (range, 27-63) Control 43 (range, 19-65), 13 (41) | Shoulder pain, positive painful arc test, and "extreme sensation" to palpation of biceps or rotator cuff tendons, pain aggravation due to resisted range of shoulder movements. | 6 wk of training, 3 times a day. Supervised group was appointed 2/wk. Exercises: pendulum exercises, wand exercises, and isometric exercises. | Same as intervention without supervision. | Function (SPADI) Function (DASH) Dropout Endpoint: 6 wk |
| Granviken et al ³⁹ Norway | n=46, Intervention 47.6 \pm 10.0 Control 48.2 \pm 9.8, 22 (48) | Aged 18-65 y, unilateral shoulder pain >12 wk. The following 3 tests positive: painful arc test, positive infraspinatus test (pain and/or weakness), and the Kennedy Hawkins test. Normal passive glenohumeral physiological range of motion. | 10 treatments of supervised exercise therapy, in addition to home exercises. Exercises were individually adapted. A thin rubber band was used for many of the exercises to reduce the arm load, control movement, or provide resistance. The exercises were performed with as little pain as possible. 3 sets of 30 repetitions for most exercises. 4-6 exercises twice a day every day. Optional stretching exercises. Exercises: reestablish normal shoulder movement patterns through awareness, correct scapula placement, scapular stabilizing exercises, rotator cuff exercises, and pain-free range of motion exercises. | Same as intervention without supervision. The home exercise group had 1 supervised treatment session with a physiotherapist to set up a tailored home exercise program. They were instructed in the progression opportunities for the appropriate exercises. | Pain average previous wk (NRS) Function (SPADI) Return to work Dropout Endpoint: 6 wk |
| Lombardi et al ⁴⁰ Brazil | n = 60, Intervention 56.3 \pm 11.6 Control 54.8 \pm 9.4, 46 (77) | A positive Neer test and Hawkins test and pain between 3 and 8 on the NRS in the arc of movement that produces the greatest shoulder pain. | Progressive resistance training program for the shoulder muscles, which was carried out twice a wk for 2 mo | Waiting list | Pain at rest (VAS, 0-10cm) Pain during movement (VAS, 0-10cm) Function (DASH) Quality of life (SF-36) Endpoint: 2 mo |
| Ludewig and Borstad ⁴¹ United States | n=67 (92*), Intervention 48 \pm 1.8 Control 49.2 \pm 1.8 Asymptomatic control 49.4 \pm 2.5, 0 (0) | At least 2 positive shoulder impingement tests (Neer, Hawkins/Kennedy, Yocum, Jobe, and/or Speeds tests) and pain reproduction during 2 of 3 of (1) painful arc; (2) tenderness to palpation of the biceps or rotator cuff tendons; and (3) pain with 1 or more resisted glenohumeral joint motions (flexion, abduction, internal rotation, external rotation). | A standardized 8-wk home exercise program including progressive resistance strengthening exercises 3 d/wk for 2 muscle groups. Supervision after 1 wk. Phone contact at 4 wk to monitor compliance, discuss any problems, and ensure proper progression of the exercises. 4-wk recheck optional. Exercises: stretching, upper trapezius relaxation exercise, serratus anterior strengthening; external rotation strengthening. | Nonstructured training | Pain during work (NRS) Function (SRQ score) Patient-perceived effect (Satisfaction score 0-10) Endpoint: 8-12 wk |
| Melegati et al ⁴² Italy | n=60 (90*), Intervention 53.66 \pm 7.35 Control 55.76 \pm 13.08 | Neer stage I and II subacromial impingement. | Exercises were performed under the supervision of a rehabilitation therapist; after the last session the participants were asked to continue the exercises at home on alternate days. Advice: (1) | Same advice as in the intervention group | Function (CS) Endpoint Intervention group: 8 mo after 15-wk training. Control: 8 mo after initial examination |

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Table 1 (Continued)

| Author, Country | Participants (n); Age (y), Mean \pm SD, Female, n (%) | Inclusion Criteria | Intervention | Comparison | Outcomes |
|---------------------------------------|--|---------------------------------------|---|------------------------|--|
| | Shock wave 53.66 \pm 8.98, 42 (70) | | during desk work, rest the elbow on a support abducting the shoulder 30-40°; (2) avoid long hanging of the upper limb; (3) avoid sleeping on the affected shoulder and apply a small pillow under the armpit on the affected side; (4) when handling loads keep the weight near the trunk to shorten the lever arm. Exercises: (1) Codman; (2) capsular stretching; (3) isometric for the rotators and deltoid; (4) elastic resistance for the rotators, deltoid, and trapezius. | | |
| Wiener et al ⁴³ Germany | n=17 Intervention NA Control NA 0 (0) | Diagnosis of supraspinatus tendinosis | Physiotherapy treatment consisting of 10 appointments, each lasting 30 min, and ice treatment and electrotherapy or ultrasonography. Exercises: stretching the chest muscles; strengthening the shoulder muscles near the spine, the rotator cuff, the humeral head depressors, and the deltoid muscle, supplemented by neurophysiological techniques with activation of entire muscle loops and transverse friction. | Nonstructured training | Pain (McGill Pain Questionnaire and Pain Disability Index) Endpoint: 35 d |

Abbreviations: CS, Constant score; DASH, Disabilities of the Arm Shoulder and Hand; NA, not applicable; NRS, Numeric Rating Scale; SF-36, 36-Item Short Form Survey; SPADI, Shoulder Pain and Disability Index; SRQ, Shoulder Rating Questionnaire; VAS, visual analog scale.

* Total no. of participants in the 3-arm study design, but we only extracted data from the intervention and comparator of interest.

† No. of randomized participants but only 32 participants included in analysis.

included patients with a clinical diagnosis of SAPS^{23,34-42} and 1 study⁴³ with supraspinatus tendinosis. Nine studies^{23,34-36,38-43} included adults from the general population, and 1 study³⁷ included young male baseball players only.

Two studies^{23,39} compared supervised training with self-training consisting of a maximum of 1 supervised session. Eight studies compared supervised training with no training: 4 studies compared with no training,^{37,38,41,43} 1 study kept the control group on a waiting list,⁴⁰ 1 study gave advice about joint protection,⁴² and 2 studies compared with sham treatment (detuned soft laser treatment^{35,36} and inactive ultrasonography³⁴). The included studies used various exercises and dosages, but all of them included components of strengthening the rotator cuff and scapular muscles. The extent of supervision also varied between the individual studies but included weekly appointments for most of them.

Critical outcomes

Supervised training resulted in larger improvements than no training on pain at rest (4 studies; $n=286$; MD, 1.68; 95% CI, 0.31-3.06 on 0-10 scale), pain during movement (5 studies; $n=353$; MD, 1.84; 95% CI, 0.91-2.76), and function (5 studies; $n=396$; SMD, 0.30; 95% CI, 0.07-0.52) (fig 2A-C). Supervised training resulted in higher patient-perceived effect (1 study; $n=118$; RR, 1.43; 95% CI, 0.87-2.34, mean absolute difference=127 of 1000 more patients get much better improvement) (fig 2D). In 1 study⁴¹ patient-perceived effect was reported on a scale from 0-10, and these data could therefore not be included in the analysis. A separate analysis of these data also favored supervised training ($n=67$; MD, 1.2; 95% CI, 0.24-2.16). Two studies^{42,43} were not included in the meta-analysis, of which 1 had a primary endpoint at 8 months, and 1 used McGill Pain Questionnaire and Pain Disability Index, which in this study was considered not relevant for the current predefined outcomes of interest. Both studies reported that supervised training was superior to no training.

Supervised training and self-training showed equal effect on pain (1 study; $n=44$; MD, 0.20; 95% CI, -1.07 to 1.47 on 0-10 scale) and function (2 studies; $n=76$; MD, 1.00; 95% CI, -8.80 to 10.79 on 0-100 scale) (fig 3A,B), whereas there were no available data about patient-perceived effect.

Two sensitivity analyses were performed to explain heterogeneity for supervised training compared with no training. For pain at rest, removing the study by Cha et al³⁷ because of the extreme results substantially reduced heterogeneity (MD, 0.96; 95% CI, 0.32-1.60; $I^2=20\%$). Risk of bias (rating the study by Bennell et al³⁴ as low risk) could not explain heterogeneity.

Important outcomes

Supervised training resulted in improvements in quality of life, return to work, adherence, and lower dropout compared with no training (see supplemental appendix S2B). Adverse events were relatively more frequent with training compared with no training (transient pain after training), but no serious adverse events were reported in the included studies (see supplemental appendix S2B).

Supervised training may reduce return to work (number of patients that have returned to work after the intervention) slightly compared with self-training (RR, 0.85; 95% CI, 0.53-1.36) and further reduces dropout compared with self-training (RR, 0.26; 95% CI, 0.07-0.94) (see supplemental appendix S2B).

Risk of bias assessment of individual studies

Regarding selection bias, 3 studies^{34,39,40} were rated as having low risk of bias, 6 studies^{23,35-38,42,43} had some concerns (unclear descriptions of the random sequence generation and/or allocation concealment), and 1 study⁴¹ was rated as having high risk of selection bias. We rated 9 studies^{23,35-43} as having high risk of performance bias because patients could not be blinded when answering the self-reported outcomes, and 1 study³⁴ was rated as having low risk of bias. Five studies^{34,35,36,38-40} ensured adequate blinding of outcome assessments and were rated as having low risk of detection bias, 7 studies^{34,35-37,39-41,43} had complete outcome data and were rated as having low risk of attrition bias, 3 studies^{40,41,43} did not have selective reporting of data and were rated as having low risk of reporting bias, and 5 studies^{34,37,39,40,43} as low risk of other bias (see supplemental appendix S2C).

Certainty of evidence (GRADE)

The certainty of evidence started as high because we only included RCTs. Regarding supervised training compared with no training, we downgraded 1 level for lack of blinding of patients in self-reported outcomes and 1 level for wide CIs for pain at rest and during movement, and for function we downgraded 1 level because of wide CIs and 1 level because of lack of blinding. For patient-perceived effect, we downgraded 1 level for lack of blinding and 1 level because only 1 study reported the relevant data. The overall certainty of evidence for supervised training compared with no training for the critical outcomes was therefore low (table 2).

Regarding supervised training compared with self-training, we downgraded 1 level for lack of blinding of patients in pain and 1 level because only 1 study reported the relevant data for pain, and for function we downgraded 1 level for lack of blinding and 1 level for wide CIs. Therefore, also here the certainty of evidence for supervised training compared with self-training for the critical outcomes was low (table 3).

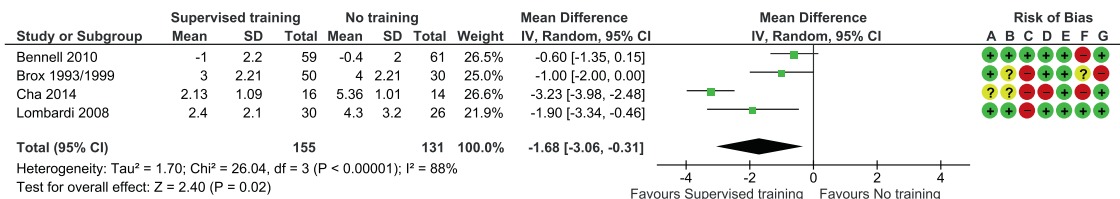
For important outcomes, certainty of evidence was graded as low to moderate for both study aims (see tables 2 and 3).

Discussion

Supervised training was superior to no training on the following primary outcomes: pain during rest and movement, shoulder function, and patient-perceived effect, albeit the effect on shoulder function was small. There were potential benefits related to quality of life, return to work, dropout, and training adherence. Supervised training and self-training were equally effective on pain and shoulder function. More people undergoing a training intervention experienced mild transient pain after training, which can be considered a minor adverse event to this intervention.

The difference in pain reduction between supervised training and no training was statistically significant and clinically relevant. However, when looking at the 95% CI, the reduction in pain for some patients with SAPS was not above the predefined MID.¹⁷ The small increase in function (SMD, 0.31) corresponded to an MD of 4.86 (95% CI, 1.41-8.15) on the Constant Score, calculated using the SD from the final mean value in the control group from a previous study⁴⁴ and was lower than the predefined MID of 8.3 for this outcome measure.¹⁷ However, an important caveat is that these MIDs are estimated from studies with differences related to

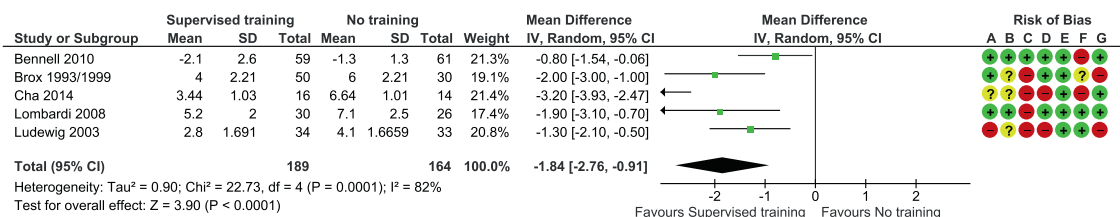
(A) Forest plot on pain at rest



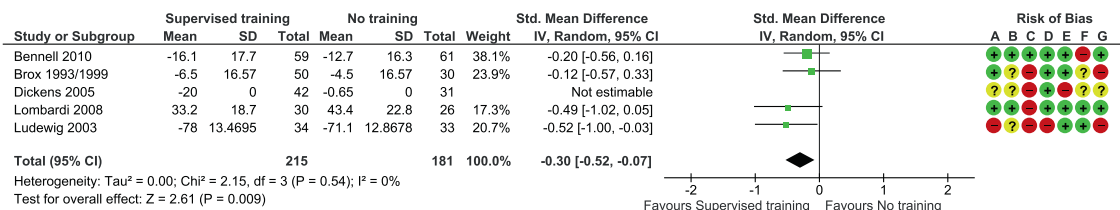
Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

(B) Forest plot on pain during movement



(C) Forest plot on shoulder function



(D) Forest plot on patient-perceived effect (overall successful outcome)

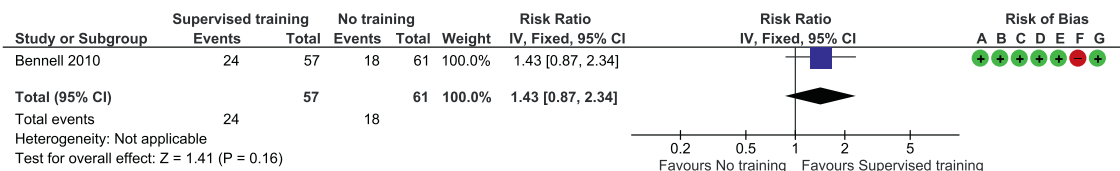


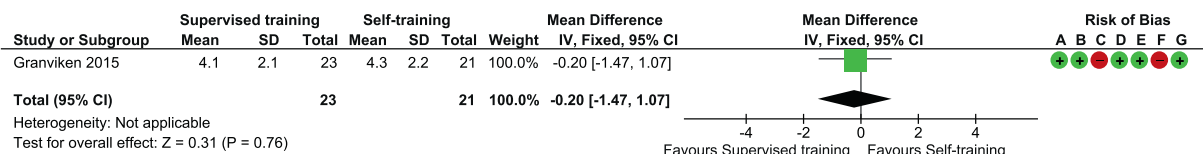
Fig 2 Forest plots of the comparison between supervised training and no training on (A) pain at rest, (B) pain during movement, (C) function, and (D) patient-perceived effect (overall successful outcome). Risk of bias: green (+) indicates low risk of bias, yellow (?) indicates unclear risk of bias, and red (-) indicates high risk of bias.

participants' disease/conditions, sample size, anchors and analytical methods, and the range of reported MID is wide for some of the outcome measures (eg, visual analog scale MID of 0.5-3.0 and the Constant score MID of 8-36).⁴⁵

Our findings on the critical outcomes pain and function are in line with previous reviews,^{22,33,46,47} although those reviews reported different evidence levels from very low³³ to high.^{46,47}

The reasons for these discrepancies are likely based on methodological choices. Steuri et al³³ included most of the studies^{37,40,41,43} from our review and concluded very low certainty evidence for the benefits of training using GRADE. In contrast, we could only find consensus on downgrading the evidence to "low" (similar to Page et al²²), which we based on insufficient or no "blinding" and/or wide CIs on the critical outcomes. Our effect estimates are

(A) Forest plot on pain



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

(B) Forest plot on shoulder function

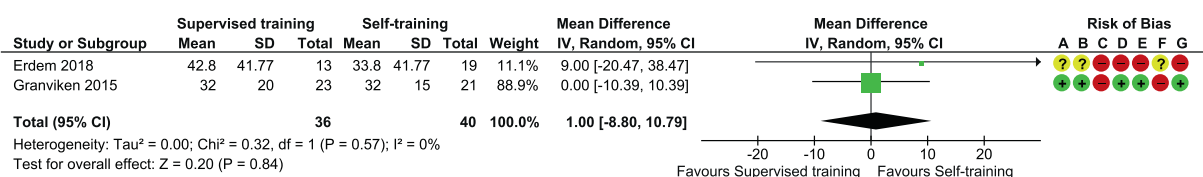


Fig 3 Forest plots of the comparison between supervised training and self-training on (A) pain and (B) function. Risk of bias: green (+) indicates low risk of bias, yellow (?) indicates unclear risk of bias, and red (-) indicates high risk of bias.

slightly lower than reported by Steuri et al,³³ which seems to be based on our inclusion of 2 additional studies³⁴⁻³⁶ reporting the lowest improvements in favor of training. Abdulla et al⁴⁷ found high-certainty evidence using a different appraisal tool (Scottish Intercollegiate Guidelines Network criteria) as well as selected studies with adequate internal validity (ie, low risk of bias), including RCTs, cohort studies, or case-control studies, and excluded training in combination with other interventions in their qualitative evidence synthesis. Haik et al,⁴⁶ who included RCTs and quasi-RCTs in English, Spanish, and Portuguese, reported high evidence because of what they perceived as large effect estimates, using 3 of the studies included in this article together with an additional pilot study excluded here because of the study design. A more recent review⁴⁸ did not evaluate the overall certainty of evidence, which may result in overlooking important sources of bias and may neglect their effect on study results.

These findings indicate that although the evidence levels are different across reviews with different grading methods and outcomes selected, the main message is the same: exercise is a relevant and important treatment option for this population.⁴⁹ However, we conclude that the current evidence supports a weak recommendation for training because of the absence of high-certainty evidence and improvements below the predefined MIDs.¹⁷ More transparent protocols with detailed information about the interventions are needed to ensure higher treatment fidelity.

The lack of difference between supervised training and self-training on pain and function is in line with a recent meta-analysis.³² However, the previous review used less strict criteria for study inclusion compared with the current study, and it reflected results from studies that were designed to compare different training interventions rather than just therapist guidance and attention (ie, supervision). The current review adds to the existing body of

evidence with a more focused conclusion about the role of supervision. Our results suggest that structured self-training is a relevant alternative to supervised training. However, it has been suggested that supervised training may be more useful for patients with large baseline symptoms (eg, above 49/100 on the Shoulder Pain and Disability Index),³⁹ and it may allow the clinician to consistently guide into relevant exercises, motivate and encourage the patient to adhere to the training intervention, and support the patient during potential symptom flares. Finally, our review did not discourage the use of supervised training; it suggests that supervision is a relevant variation of exercise therapy, which may be beneficial to some but not all patients with shoulder pain. These factors should be considered when planning the amount of supervision before initiating a training intervention.

In a clinical setting, training will usually be combined with other interventions. Training combined with manual therapy is the most clinically used intervention,⁵⁰ but evidence does not support additional benefits of combining manual therapy and training. One of the included studies³⁴ (low risk of bias) indicated no clinically important differences between manual therapy plus training compared with placebo with respect to pain, function, and other health-related outcomes. These findings are in line with other studies.^{38,48,51} However, short-term pain relief from manual therapy can create a window to initiate more active training interventions, and as such manual therapy may provide a clinical pathway to initiate the training.^{19,49} Patient education is a well-documented intervention, which seems to be more effective when used in combination with training, physical activity, and/or manual therapy.⁵² Evidence for the benefits of pain education has mostly been documented on low back pain, but the benefits of adding an educational intervention to treat musculoskeletal pain is considered best practice.⁵³

Table 2 Summary of findings for supervised training compared with no training

| Outcomes | Anticipated Absolute Effects* (95% CI) | | Relative Effect (95% CI) | No. of Participants (Studies) | Certainty of the Evidence (GRADE) | Comments |
|---|--|---|--------------------------|-------------------------------|-----------------------------------|---|
| | Risk With No Training | Risk With Supervised Training | | | | |
| Pain at rest | Mean pain at rest was 4 | MD 1.68 lower (3.06 lower to 0.31 lower) | - | 286 (4 RCTs) | ⊕⊕⊗⊗ Low ^{†,‡} | Supervised training may reduce pain at rest compared with no training. |
| Pain on movement | Mean pain on movement was 6 | MD 1.84 lower (2.76 lower to 0.91 lower) | - | 353 (5 RCTs) | ⊕⊕⊗⊗ Low ^{†,‡} | Supervised training may reduce pain on movement compared with no training. |
| Function | - | SMD 0.3 lower (0.07 lower to 0.52 lower) | - | 396 (5 RCTs) | ⊕⊕⊗⊗ Low ^{†,§} | Supervised training may result in little to no difference in function compared with no training. |
| Quality of life | Mean quality of life was 58.45 | MD 6.75 higher (0.81 lower to 14.3 higher) | - | 176 (2 RCTs) | ⊕⊕⊗⊗ Low ^{†,§} | Supervised training may result in little to no difference in quality of life compared with no training. |
| Patient-perceived effect (overall successful outcome) | 295/1000 | 422/1000 (257-690) | RR 1.43 (0.87-2.34) | 118 (1 RCT) | ⊕⊕⊗⊗ Low ^{†,} | Supervised training may increase patient-perceived effect (overall successful outcome) compared with no training. |
| Return to work (no. at work) | 429/1000 | 570/1000 (343-934) | RR 1.33 (0.80-2.18) | 72 (1 RCT) | ⊕⊕⊕⊗ Moderate ^{†,} | Supervised training probably increases return to work (no. at work) compared with no training. |
| Dropout all causes | 99/1000 | 45/1000 (8-270) | RR 0.45 (0.08-2.72) | 265 (3 RCTs) | ⊕⊕⊕⊗ Moderate [†] | Supervised training probably reduces dropout all causes compared with no training. |
| Adherence | 934/1000 | 916/1000 (822-1000) | RR 0.98 (0.88-1.08) | 118 (1 RCT) | ⊕⊕⊕⊗ Moderate ^{†,} | There is probably a high level of adherence to supervised training. |
| Adverse events | 82/1000 | 309/1000 (122-782) | RR 3.77 (1.49-9.54) | 116 (1 RCT) | ⊕⊕⊕⊗ Moderate ^{†,} | Supervised training probably increases adverse events compared with no training. |
| Serious adverse events | 0/1000 | 0/1000 (0-0) | Not estimable | 116 (1 RCT) | ⊕⊕⊕⊗ Moderate ^{,¶} | Supervised training probably results in little to no difference in serious adverse events compared with no training. There are probably no serious adverse events of supervised training. |

NOTE. 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.

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

† Lack of blinding and self-reported outcome.

‡ Wide confidence intervals.

§ Lack of blinding.

|| Only 1 study.

¶ No events.

Table 3 Summary of findings for supervised training compared with self-training

| Outcomes | Anticipated Absolute Effects* (95% CI) | | Relative Effect (95% CI) | No. of Participants (Studies) | Certainty of the Evidence (GRADE) | Comments |
|------------------------------|--|--|--------------------------|-------------------------------|-----------------------------------|--|
| | Risk With Self-training | Risk With Supervised Training | | | | |
| Pain | Mean pain was 4.3 | MD 0.2 lower (1.47 lower to 1.07 higher) | - | 44 (1 RCT) | ⊕⊕⊕⊕ Low [†] | Supervised training may result in little to no difference in pain compared with self-training. |
| Function | Mean function was 32 | MD 1 higher (8.8 lower to 10.79 higher) | - | 76 (2 RCTs) | ⊕⊕⊕⊕ Low ^{†,‡} | Supervised training may result in little to no difference in function compared with self-training. |
| Return to work (no. at work) | 667/1,000 | 567/1,000 (353-907) | RR 0.85 (0.53-1.36) | 44 (1 RCT) | ⊕⊕⊕⊕ Low ^{†,‡} | Supervised training may reduce return to work (no. at work) slightly compared with self-training. |
| Dropout all causes | 209/1,000 | 54/1,000 (15-197) | RR 0.26 (0.07-0.94) | 87 (2 RCTs) | ⊕⊕⊕⊕ Moderate [‡] | Supervised training probably reduces dropout all causes slightly compared with self-training. |

NOTE. 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.

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

† Lack of blinding and self-reported outcome.

‡ Wide confidence intervals.

§ Lack of blinding.

|| Only 1 study.

¶ No events.

Implications for clinicians and research

One of the first decisions most primary practitioners face is whether the patient presenting clinical symptoms of SAPS should be recommended formally structured training over no training and whether providing supervision should be prescribed. On a group level, supervised training and self-training are likely to benefit the majority of patients with SAPS, with several additional benefits of the supervised training (eg, guiding in relevant exercises, motivation and encouragement, support in symptom flares). As in other studies, individuals could also benefit from no treatment or need a referral to secondary care (eg, orthopedic surgeons) because the pathogenesis and natural course of SAPS are still unclear. Clinicians should always try to embrace the expectations and needs of the patients when designing the intervention, considering baseline symptoms, patient preferences, training experience, and whether the patient can adhere to the intervention with or without supervision. Based on limited data, self-training may be considered for those patients who prefer that (eg, because of time constraints or financial barriers) because the beneficial effects on pain and function may be the same as for supervised training, provided satisfactory adherence to the prescribed training. However, patients seem more likely to follow the training program if they are supervised rather than completing a self-administered program.⁵⁴ There is a paucity of knowledge about the ideal dosage and type of exercise,^{4,19,55} but high training dosage⁵⁶ and scapular focused interventions⁵⁷ may be preferable. Mild transient pain during therapeutic training is considered a normal response to training⁵⁸ and need not be a barrier to successful outcomes⁵⁹; however, it is important to inform the patient about the risk of mild transient pain before initiating the training intervention. Future studies should compare supervised training with self-training using transparent and well-described training protocols. These should aim at understanding the optimal parameters of training as well as combining training-based interventions with patient education to better defining the optimal treatment of SAPS.

Study limitations

Important limitations are highlighted here. First, for supervised training, we included 2 studies that combined training with manual therapy, making it difficult to determine whether a potential effect was caused by training or manual therapy. However, none of the included studies that used the combined treatment^{34,37} showed significantly larger effect sizes than training alone. Next, using our strict inclusion criteria, only 2 small studies comparing supervised training with self-training were available. Other limitations related to our inclusion of studies are that we accepted the studies' own definition of SAPS, accepted differences in follow-up time periods without data about long-term (eg, 12 months) effects, and included a broad definition of no training. Finally, the conclusions are drawn based on low certainty of evidence for the critical outcomes pain, function, and patient-perceived effect and low-moderate certainty of evidence for the important outcomes. Therefore, it is possible that future studies can change the current effect estimates.

Conclusions

Supervised training might be superior to no training and equally effective as self-training on critical and important outcomes after 3 months in patients with SAPS lasting for more than 1 month.

However, only improvements in pain were above the predefined MID. Supervised training showed potential benefits regarding quality of life, return to work, dropout, and training adherence compared with no training, albeit more patients reported mild transient pain and muscle soreness after training. Based on low-moderate certainty of evidence, these findings support a weak recommendation for the use of supervised training in patients with SAPS.

Suppliers

- a. Covidence systematic review software; Veritas Health Innovation.
- b. Review Manager 5.3 software; The Nordic Cochrane Centre, The Cochrane Collaboration.

Keywords

Exercise therapy; Meta-analysis; Rehabilitation; Shoulder impingement syndrome; Shoulder joint; Shoulder pain

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Search matrix for systematic reviews

Last updated 29 January 2020.

Medline (130120)

Database(s): **Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R)** 1946 to January 10, 2020

Search Strategy:

| # | Searches | Results |
|----|--|---------|
| 1 | Shoulder Impingement Syndrome/ or subacromial pain syndrome*.mp. | 1776 |
| 2 | SAPS.mp. | 3062 |
| 3 | Shoulder Joint/ or shoulder joint*.mp. | 20976 |
| 4 | Shoulder Pain/ or shoulder pain*.mp. | 8810 |
| 5 | shoulder impingement*.mp. | 2009 |
| 6 | Rotator Cuff/ or rotator cuff*.mp. | 12683 |
| 7 | rotator cuff disease*.mp. | 500 |
| 8 | Rotator Cuff Injuries/ or rotator cuff tear*.mp. | 7397 |
| 9 | non traumatic shoulder pain*.mp. | 11 |
| 10 | Supraspinatus* or supra-spinatus*.mp. | 3518 |
| 11 | physiotherap*.mp. | 25344 |
| 12 | exp Physical Therapy Modalities/ or Physical Therapy Modalitie*.mp. | 148937 |
| 13 | physical therap*.mp. | 53514 |
| 14 | Physical Therapy Modality.mp. | 20 |
| 15 | Physical Therapy speciality.mp. | 9 |
| 16 | Physical Therapy Specialty/ | 2780 |
| 17 | (physiotherapy or physiotherapies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] | 18816 |
| 18 | rehabilitation*.mp. or Rehabilitation/ | 310645 |
| 19 | exp Exercise Therapy/ | 48734 |
| 20 | exercise*.mp. or *Exercise/ or Exercise Therapy/ or exp Exercise Test/ | 368482 |
| 21 | exp Resistance Training/ or resistance training*.mp. | 12433 |
| 22 | strength training*.mp. | 5003 |
| 23 | stability training*.mp. | 109 |
| 24 | aquatic exercise*.mp. | 348 |
| 25 | (aqua therapy or aqua therapies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] | 10 |
| 26 | ((systematic or method* or rapid or integrative or umbrella) adj3 (review* or overview* or study or studies or search* or approach*)) or meta analy* or meta-analy* or metaanaly*).ti,ab,kw,kf. | 787914 |
| 27 | (pooled adj1 (data or analy*)).ti,ab. | 17429 |
| 28 | (pubmed or medline or embase or cochrane or "web of science" or psycinfo or psychinfo or scopus).ti,ab. | 221172 |
| 29 | Cochrane.jw. | 14884 |
| 30 | 26 or 27 or 28 or 29 | 871030 |
| 31 | or/1-10 | 38865 |
| 32 | or/11-25 | 736846 |
| 33 | 30 and 31 and 32 | 623 |
| 34 | limit 33 to yr="2009 - 2020" | 518 |

Embase (130120)Database(s): **Embase** 1996 to 2020 Week 02

Search Strategy:

| # | Searches | Results |
|----|---|---------|
| 1 | Shoulder Impingement Syndrome/ or subacromial pain syndrome*.mp. | 2793 |
| 2 | SAPS.mp. | 5550 |
| 3 | Shoulder Joint/ or shoulder joint*.mp. | 26868 |
| 4 | Shoulder Pain/ or shoulder pain*.mp. | 16651 |
| 5 | shoulder impingement*.mp. | 2875 |
| 6 | Rotator Cuff/ or rotator cuff*.mp. | 14934 |
| 7 | rotator cuff disease*.mp. | 550 |
| 8 | Rotator Cuff Injuries/ or rotator cuff tear*.mp. | 6723 |
| 9 | non traumatic shoulder pain*.mp. | 11 |
| 10 | Supraspinatus* or supra-spinatus*.mp. | 4205 |
| 11 | physiotherap*.mp. | 94475 |
| 12 | exp Physical Therapy Modalities/ or Physical Therapy Modalitie*.mp. | 73468 |
| 13 | physical therap*.mp. | 30687 |
| 14 | Physical Therapy Modality.mp. | 38 |
| 15 | Physical Therapy speciality.mp. | 24 |
| 16 | Physical Therapy Specialty/ | 71532 |
| 17 | (physiotherapy or physiotherapies).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] | 80463 |
| 18 | rehabilitation*.mp. or Rehabilitation/ | 280771 |
| 19 | exp Exercise Therapy/ | 65751 |
| 20 | exercise*.mp. or *Exercise/ or Exercise Therapy/ or exp Exercise Test/ | 425659 |
| 21 | exp Resistance Training/ or resistance training*.mp. | 19688 |
| 22 | strength training*.mp. | 6268 |
| 23 | stability training*.mp. | 166 |
| 24 | aquatic exercise*.mp. | 676 |
| 25 | (aqua therapy or aqua therapies).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word] | 19 |
| 26 | ((systematic or method* or rapid or integrative or umbrella) adj3 (review* or overview* or study or studies or search* or approach*)) or meta analy* or meta-analy* or metaanaly*).ti,ab,kw. | 1023785 |
| 27 | (pooled adj1 (data or analys*)).ti,ab. | 26340 |
| 28 | (pubmed or medline or embase or cochrane or "web of science" or psycinfo or psychinfo or scopus).ti,ab. | 270387 |
| 29 | Cochrane.jx. | 21254 |
| 30 | 26 or 27 or 28 or 29 | 1131992 |
| 31 | or/1-10 | 57447 |
| 32 | or/11-25 | 729520 |
| 33 | 30 and 31 and 32 | 1081 |
| 34 | limit 33 to yr="2009 - 2020" | 920 |

PEDro (130120)

Searched for

Subacromial impingement and pain and exercise, and systematic review from 2009 and onwards and

Shoulder and pain and exercise and systematic review from 2009 and onwards.

In total 37 references.

Cinahl (140120)

| # | Query | Results |
|--|--|---------|
| S20 | S6 AND S14 AND S18 | |
| Limiters - Published Date: 20090101-20201231 | 325 | |
| S19 | S6 AND S14 AND S18 | 408 |
| S18 | S15 OR S16 OR S17 | 322,418 |
| S17 | (pooled N1 (data or analys*)) | 8,161 |
| S16 | ((systematic or method* or rapid or integrative) N3 (review* or overview* or study or studies or search* or approach*)) or meta analy* or meta-analy* or metaanaly*) | 311,799 |
| S15 | PT (Systematic Review or Meta Analysis) | 86,800 |
| S14 | S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 | 283,376 |
| S13 | "stability training*" | 97 |
| S12 | "exercise therap*" OR (MH "Therapeutic Exercise+") OR (MH "Aquatic Exercises") | 48,989 |
| S11 | (MH "Resistance Training") OR "resistance training*" | 6,773 |
| S10 | (MH "Muscle Strengthening+") OR "strength training*" | 19,996 |
| S9 | physical therap* | 60,713 |
| S8 | (MH "Physical Therapy+") OR "physiotherapy" | 136,096 |
| S7 | (MH "Exercise+") OR "exercise" | 180,076 |
| S6 | S1 OR S2 OR S3 OR S4 OR S5 | 14,677 |
| S5 | (MH "Rotator Cuff Injuries") OR (MH "Rotator Cuff+") OR "rotator cuff" | 5,916 |
| S4 | (MH "Shoulder Impingement Syndrome") OR "schoulder impingement" | 1,235 |
| S3 | shoulder impingement* | 1,323 |
| S2 | (MH "Shoulder Pain") OR "shoulder pain" OR (MH "Shoulder Injuries+") | 11,646 |
| S1 | shoulder pain* | 5,123 |

Search matrix for full-text articles

Medline (090320)

Database(s): Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and

Versions(R) 1946 to March 06, 2020

Search Strategy:

| # | Searches | Results |
|----|---|---------|
| 1 | Shoulder Impingement Syndrome/ or subacromial pain syndrome*.mp. | 1790 |
| 2 | SAPS.mp. | 3093 |
| 3 | Shoulder Joint/ or shoulder joint*.mp. | 21169 |
| 4 | Shoulder Pain/ or shoulder pain*.mp. | 8915 |
| 5 | shoulder impingement*.mp. | 2029 |
| 6 | Rotator Cuff/ or rotator cuff*.mp. | 12872 |
| 7 | rotator cuff disease*.mp. | 506 |
| 8 | Rotator Cuff Injuries/ or rotator cuff tear*.mp. | 7529 |
| 9 | non traumatic shoulder pain*.mp. | 11 |
| 10 | supra-spinatus*.mp. | 21 |
| 11 | physiotherap*.mp. | 25698 |
| 12 | exp Physical Therapy Modalities/ or Physical Therapy Modalitie*.mp. | 150099 |
| 13 | physical therap*.mp. | 54005 |

(continued on next page)

(Continued)

| # | Searches | Results |
|----|--|---------|
| 14 | Physical Therapy Modality.mp. | 21 |
| 15 | Physical Therapy speciality.mp. | 9 |
| 16 | Physical Therapy Specialty/ | 2795 |
| 17 | (physiotherapy or physiotherapies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] | 19077 |
| 18 | rehabilitation*.mp. or Rehabilitation/ | 313167 |
| 19 | exp Exercise Therapy/ | 49266 |
| 20 | exercise*.mp. or *Exercise/ or Exercise Therapy/ or exp Exercise Test/ | 372201 |
| 21 | exp Resistance Training/ or resistance training*.mp. | 126414 |
| 22 | strength training*.mp. | 5069 |
| 23 | stability training*.mp. | 111 |
| 24 | aquatic exercise*.mp. | 357 |
| 25 | (aqua therapy or aqua therapies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] | 10 |
| 26 | or/1-10 | 38619 |
| 27 | or/11-25 | 743393 |
| 28 | ((random* or cluster-random* or control?ed or crossover or cross-over or blind* or mask*) adj3 (trial*1 or study or studies or analy*) or rct).ti,ab,kw,kf. | 653422 |
| 29 | (placebo* or single-blind* or double-blind* or triple-blind*).ti,ab,kw. | 278930 |
| 30 | ((single or double or triple) adj2 (blind* or mask*)).ti,ab,kw. | 170856 |
| 31 | 28 or 29 or 30 | 747233 |
| 32 | 26 and 27 and | 31 1148 |
| 33 | limit 32 to yr="2015 - 2020" | 510 |

Embase (090320)

Database(s): Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R)
1946 to March 06, 2020

Search Strategy:

| # | Searches | Results |
|----|--|---------|
| 1 | Shoulder Impingement Syndrome/ or subacromial pain syndrome*.mp. | 1790 |
| 2 | SAPS.mp. | 3093 |
| 3 | Shoulder Joint/ or shoulder joint*.mp. | 21169 |
| 4 | Shoulder Pain/ or shoulder pain*.mp. | 8915 |
| 5 | shoulder impingement*.mp. | 2029 |
| 6 | Rotator Cuff/ or rotator cuff*.mp. | 12872 |
| 7 | rotator cuff disease*.mp. | 506 |
| 8 | Rotator Cuff Injuries/ or rotator cuff tear*.mp. | 7529 |
| 9 | non traumatic shoulder pain*.mp. | 115 |
| 10 | supra-spinatus*.mp. | 21 |
| 11 | physiotherap*.mp. | 25698 |
| 12 | exp Physical Therapy Modalities/ or Physical Therapy Modalitie*.mp. | 150099 |
| 13 | physical therap*.mp. | 54005 |
| 14 | Physical Therapy Modality.mp. | 21 |
| 15 | Physical Therapy speciality.mp. | 9 |
| 16 | Physical Therapy Specialty/ | 2795 |
| 17 | (physiotherapy or physiotherapies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] | 19077 |

(continued on next page)

(Continued)

| # | Searches | Results |
|----|--|---------|
| 18 | rehabilitation*.mp. or Rehabilitation/ | 313167 |
| 19 | exp Exercise Therapy/ | 49266 |
| 20 | exercise*.mp. or *Exercise/ or Exercise Therapy/ or exp Exercise Test/ | 372201 |
| 21 | exp Resistance Training/ or resistance training*.mp. | 12641 |
| 22 | strength training*.mp. | 5069 |
| 23 | stability training*.mp. | 111 |
| 24 | aquatic exercise*.mp. | 357 |
| 25 | (aqua therapy or aqua therapies).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms] | 10 |
| 26 | or/1-10 | 38619 |
| 27 | or/11-25 | 743393 |
| 28 | ((random* or cluster-random* or control?ed or crossover or cross-over or blind* or mask*) adj3 (trial*1 or study or studies or analy*)) or rct).ti,ab,kw. | 651340 |
| 29 | (placebo* or single-blind* or double-blind* or triple-blind*).ti,ab,kw. | 278930 |
| 30 | ((single or double or triple) adj2 (blind* or mask*)).ti,ab,kw. | 170856 |
| 31 | 28 or 29 or 30 | 745414 |
| 32 | 26 and 27 and 31 | 1145 |
| 33 | (books or chapter or conference abstract or "conference review" or editorial or letter).pt. | 1584358 |
| 34 | 32 not 33 | 1137 |
| 35 | limit 34 to yr="2015 - 2020" | 502 |

PEDro (060320)

Searched for:

Subacromial impingement and pain and exercise, and clinical trial from 2015 and onwards. and

Shoulder and pain and exercise and clinical trial from 2015 and onwards.

In total 23 references

Cinahl (090320)

| | | |
|-----|--|---------|
| S17 | S13 AND S14 AND S15, Limiters - Published Date: 20150101-20201231 | 366 |
| S16 | S13 AND S14 AND S15 | 829 |
| S15 | S11 OR S12 | 463,430 |
| S14 | S6 OR S7 OR S8 OR S9 OR S10 | 276,505 |
| S13 | S1 OR S2 OR S4 OR S5 | 14,875 |
| S12 | (placebo* or single-blind* or double-blind* or triple-blind* or ((single or double or triple) N1 (blind* or mask*))) | 100,563 |
| S11 | ((random* or cluster-random* or control#ed or crossover or cross-over or blind* or mask*) N3 (trial* or study or studies or analy*)) or rct) | 453,872 |
| S10 | stability training* | 99 |
| S9 | (MH "Therapeutic Exercise+") OR "exercise therap*" OR (MH "Aquatic Exercises") | 49,608 |
| S8 | (MH "Muscle Strengthening+") OR "strength training*" OR (MH "Resistance Training") | 20,257 |
| S7 | "physiotherap*" OR (MH "Physical Therapy+") | 140,423 |
| S6 | (MH "Exercise+") OR (MH "Resistance Training") OR "exercise*" | 192,126 |
| S5 | (MH "Rotator Cuff+") OR (MH "Rotator Cuff Injuries") OR "rotator cuff*" | 6,012 |
| S4 | (MH "Shoulder Impingement Syndrome") OR (MH "Shoulder Injuries+") | 8,362 |
| S3 | (MH "Shoulder Pain") | 3,652 |
| S2 | shoulder impingement* | 1,332 |
| S1 | shoulder pain* | 5,1797 |

Supplementary appendix 2.A

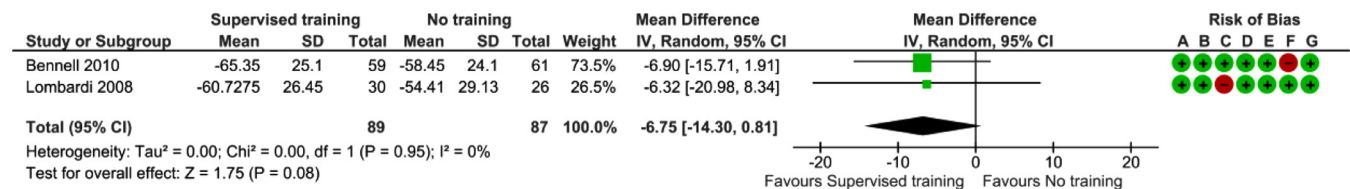
Results of the AMSTAR (A MeaSurement Tool to Assess systematic Reviews) Quality Appraisal

| Study, year | 1. Was an 'a priori' design provided? | 2. Was there duplicate study selection and data extraction? | 3. Was a comprehensive literature search performed? | 4. Was the status of publication (i.e. grey literature) used as an inclusion criterion? | 5. Was a list of studies (included and excluded) provided? | 6. Were the characteristics of the included studies assessed and documented? | 7. Was the scientific quality of the included studies assessed and documented? | 8. Was the scientific quality of the included studies used appropriately in formulating conclusions? | 9. Were the methods used to combine the findings of studies appropriate? | 10. Was the likelihood of publication bias assessed? | 11. Was the conflict of interest included? | Total |
|-------------------------|---------------------------------------|---|---|---|--|--|--|--|--|--|--|-------|
| Page, 2016 ¹ | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | 11/11 |

Supplementary appendix 2.B

Forest plots for important outcomes from the 10 included studies²⁻¹². Risk of bias: green (+) indicates low risk of bias, yellow (?) indicates unclear risk of bias, and red (-) indicates high risk of bias.

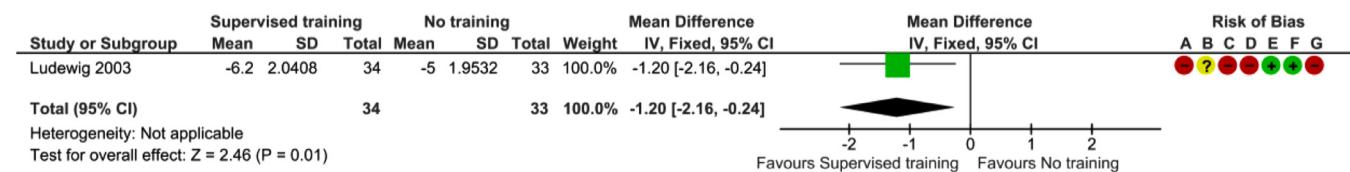
Supervised training compared with no training, outcome: quality of life.



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

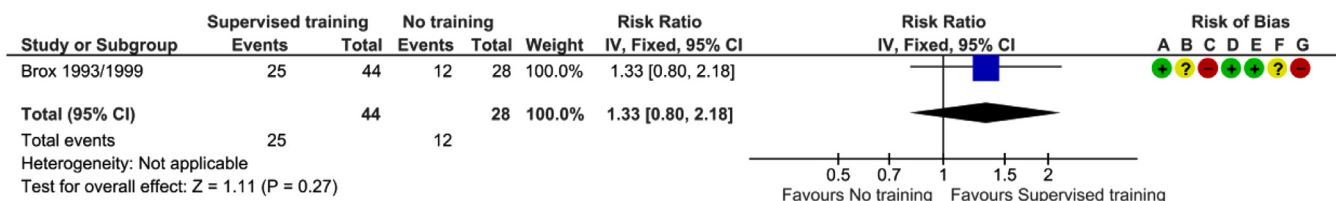
Supervised training compared with no training, outcome: patient-perceived effect (patient satisfaction).



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

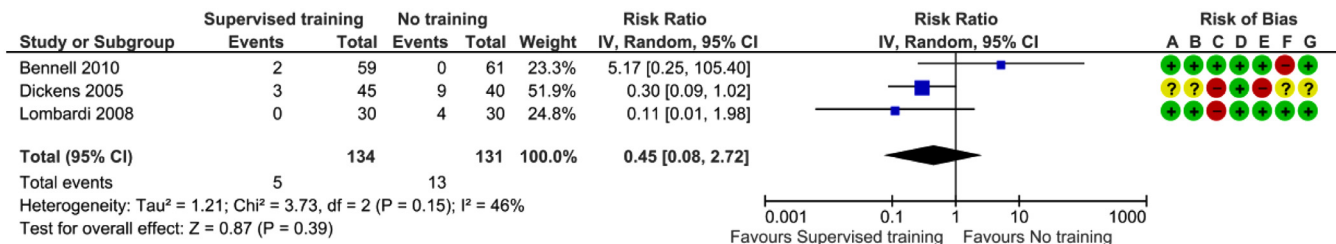
Supervised training compared with no training, outcome: return to work (number at work).



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

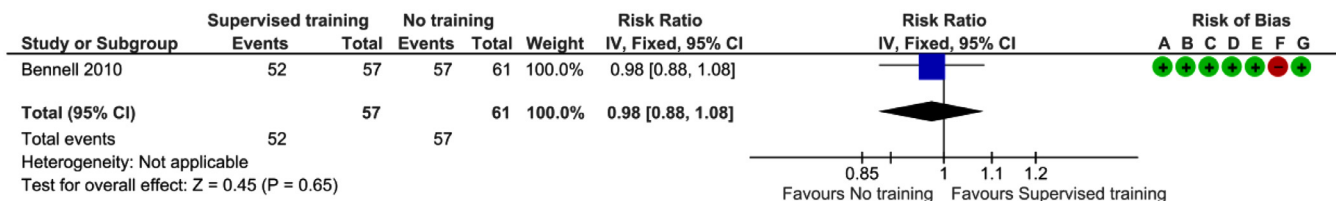
Supervised training compared with no training, outcome: drop-out all causes.



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

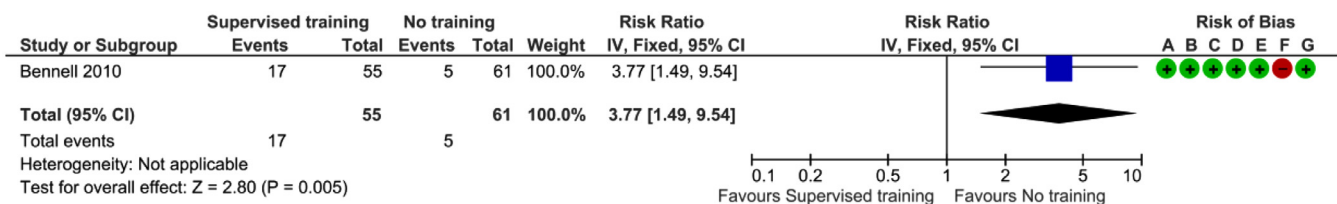
Supervised training compared with no training, outcome: adherence.



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

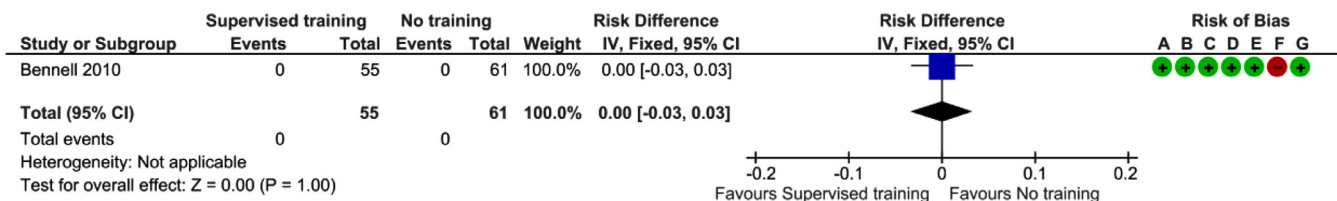
Supervised training compared with no training, outcome: adverse events.



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

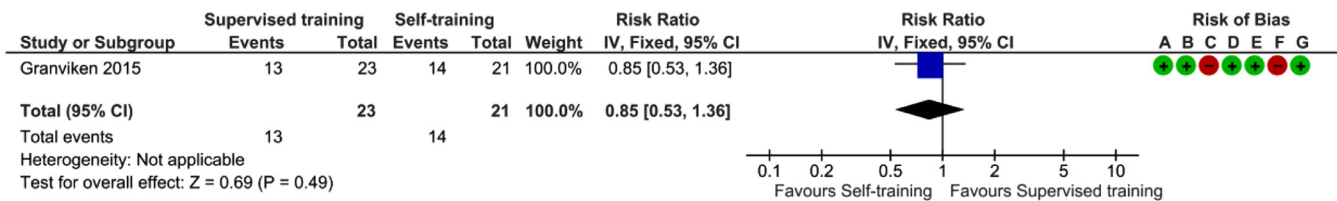
Supervised training compared with no training, outcome: serious adverse events.



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

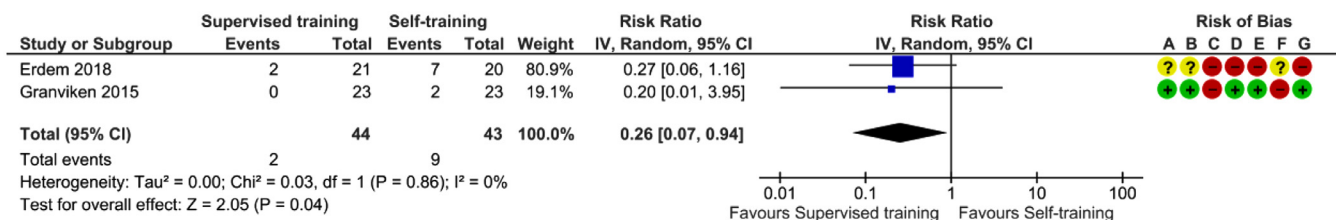
Supervised training compared with self-training, outcome: return to work (number at work).



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

Supervised training compared with self-training, outcome: dropout all causes.



Risk of bias legend

- (A) Random sequence generation (selection bias)
- (B) Allocation concealment (selection bias)
- (C) Blinding of participants and personnel (performance bias)
- (D) Blinding of outcome assessment (detection bias)
- (E) Incomplete outcome data (attrition bias)
- (F) Selective reporting (reporting bias)
- (G) Other bias

Supplementary appendix 2.C

Risk of bias as assessed by the Cochrane risk of bias tool. A plus (+) indicates low risk of bias; a question mark (?) indicates unclear risk of bias, and a minus (-) indicates high risk of bias. The specific type of bias is presented in the right row, and the individual studies in the top column.

| Study | Bennell 2010 | Brox 1993/1999 | Cha 2014 | Dickens 2005 | Erdem 2018 | Granviken 2015 | Lombardi 2008 | Ludewig 2003 | Melegati 2000 | Wiener 2005 | Bias Type |
|-------|--------------|----------------|----------|--------------|------------|----------------|---------------|--------------|---------------|-------------|---|
| | + | + | ? | ? | ? | + | + | - | ? | ? | Random sequence generation (selection bias) |
| | + | ? | ? | ? | ? | + | + | ? | ? | ? | Allocation concealment (selection bias) |
| | + | - | - | - | - | - | - | - | - | - | Blinding of participants and personnel (performance bias) |
| | + | + | - | + | - | + | + | - | ? | ? | Blinding of outcome assessment (detection bias) |
| | + | + | + | - | - | + | + | + | ? | + | Incomplete outcome data (attrition bias) |
| | - | ? | - | ? | ? | - | + | + | ? | + | Selective reporting (reporting bias) |
| | + | - | + | ? | - | + | + | - | ? | + | Other bias |

References

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