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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

Behnam Liaghat, MSc,[a] Anja Ussing, MSc,[b,c] Birgitte Holm Petersen, MSc,[b] Henning Keinke Andersen, PhD,[b] Kristoffer Weisskirchner Barfod, PhD,[d] Martin Bach Jensen, PhD,[e] Morten Hoegh, PhD,[f] Simon Tarp, PhD,[b] Birgit Juul-Kristensen, PhD,[a] Stig Brorson, PhD[g,h]

From the [a]Department of Sports Science and Clinical Biomechanics, Research Unit for Musculoskeletal Function and Physiotherapy, University of Southern Denmark, Odense; [b]Danish Health Authority, Copenhagen; [c]The Parker Institute, Copenhagen University Hospital, Bispebjerg and Frederiksberg; [d]Department of Orthopedic Surgery, Clinical Orthopedic Research Hvidovre, Copenhagen University Hospital Hvidovre, Hvidovre; [e]Center for General Practice, Aalborg University, Aalborg; [f]Center for Neuroplasticity and Pain (CNAP), SMI, Aalborg University, Aalborg; [g]Department of Orthopaedic Surgery, Zealand University Hospital, Køge; and [h]Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark.

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.

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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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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 review[19] 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 Collaboration[20] 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 nontraumatic 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 study[23] 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. Nonrandomized 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 posttraumatic 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://gradepro.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 al[22] 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 German[43] 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 study[37] and ranged from 43-60.8 years in the rest. Nine studies

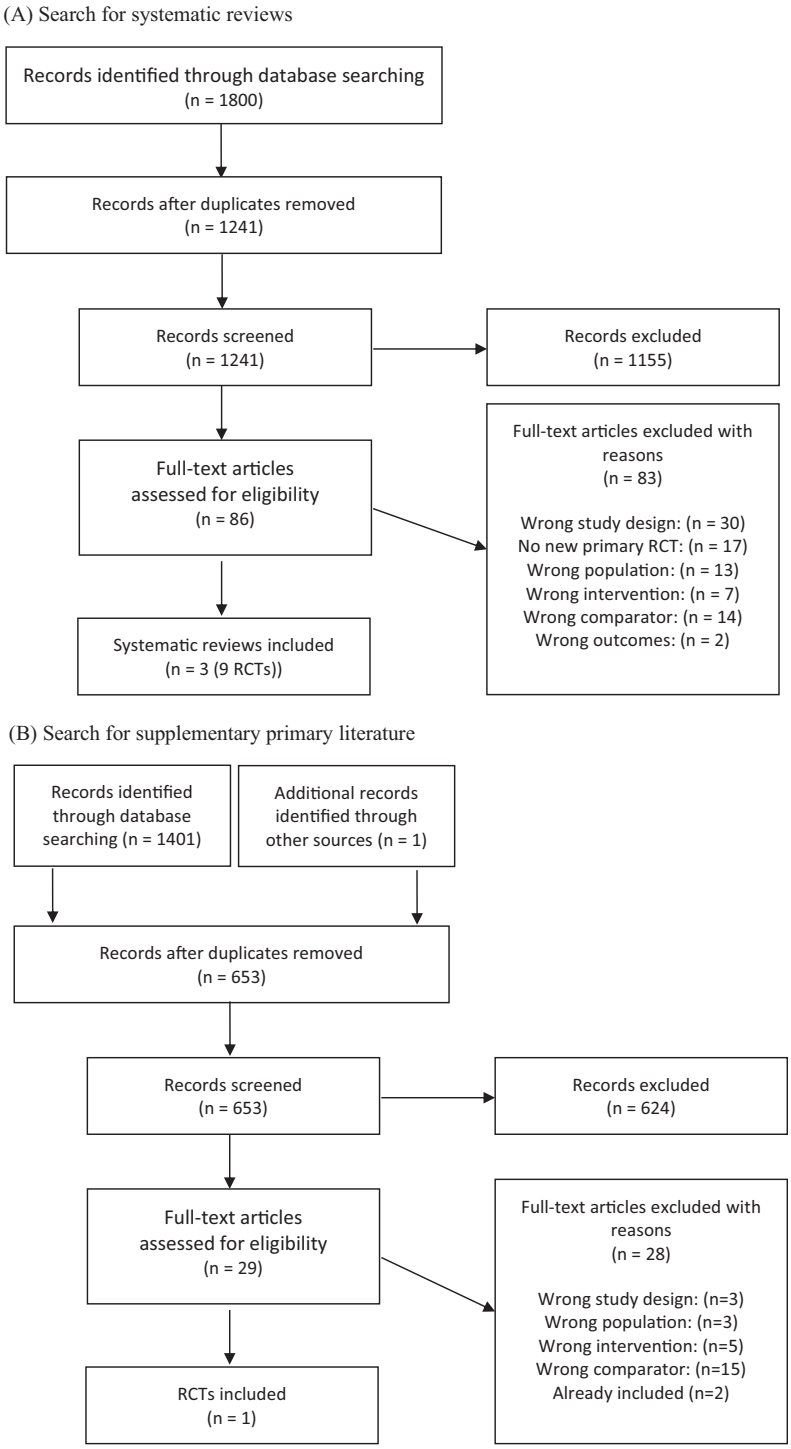

Fig 1 Flowchart showing the process of selecting (A) systematic reviews and (B) primary studies. The number of included studies and reasons for exclusion are provided.

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

Author, Country	Participants (n); Age (y), Mean ± SD, Female, n (%)	Inclusion Criteria	Intervention	Comparison	Outcomes
Bennell et al[34] Australia	n=20, Intervention 59.3±10.1 Control 60.8±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±NA Control 48±NA Arthroscopic surgery 48±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±1.74 Control 22.57±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

(*continued on next page*)

Table 1 (*Continued*)

Author, Country	Participants (n); Age (y), Mean ± 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±10.0 Control 48.2±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±11.6 Control 54.8±9.4, 46 (77)	A positive Neer test and Hawkin 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±1.8 Control 49.2±1.8 Asymptomatic control 49.4±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±7.35 Control 55.76±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

(*continued on next page*)

Table 1 (*Continued*)

Author, Country	Participants (n); Age (y), Mean ± SD, Female, n (%)	Inclusion Criteria	Intervention	Comparison	Outcomes
	Shock wave 53.66±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 study[43] with supraspinatus tendinosis. Nine studies[23,34-36,38-43] included adults from the general population, and 1 study[37] 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 ultrasonography[34]). 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 study[41] 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 al[37] 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 al[34] 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 study[41] 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 study[34] 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 study[44] 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

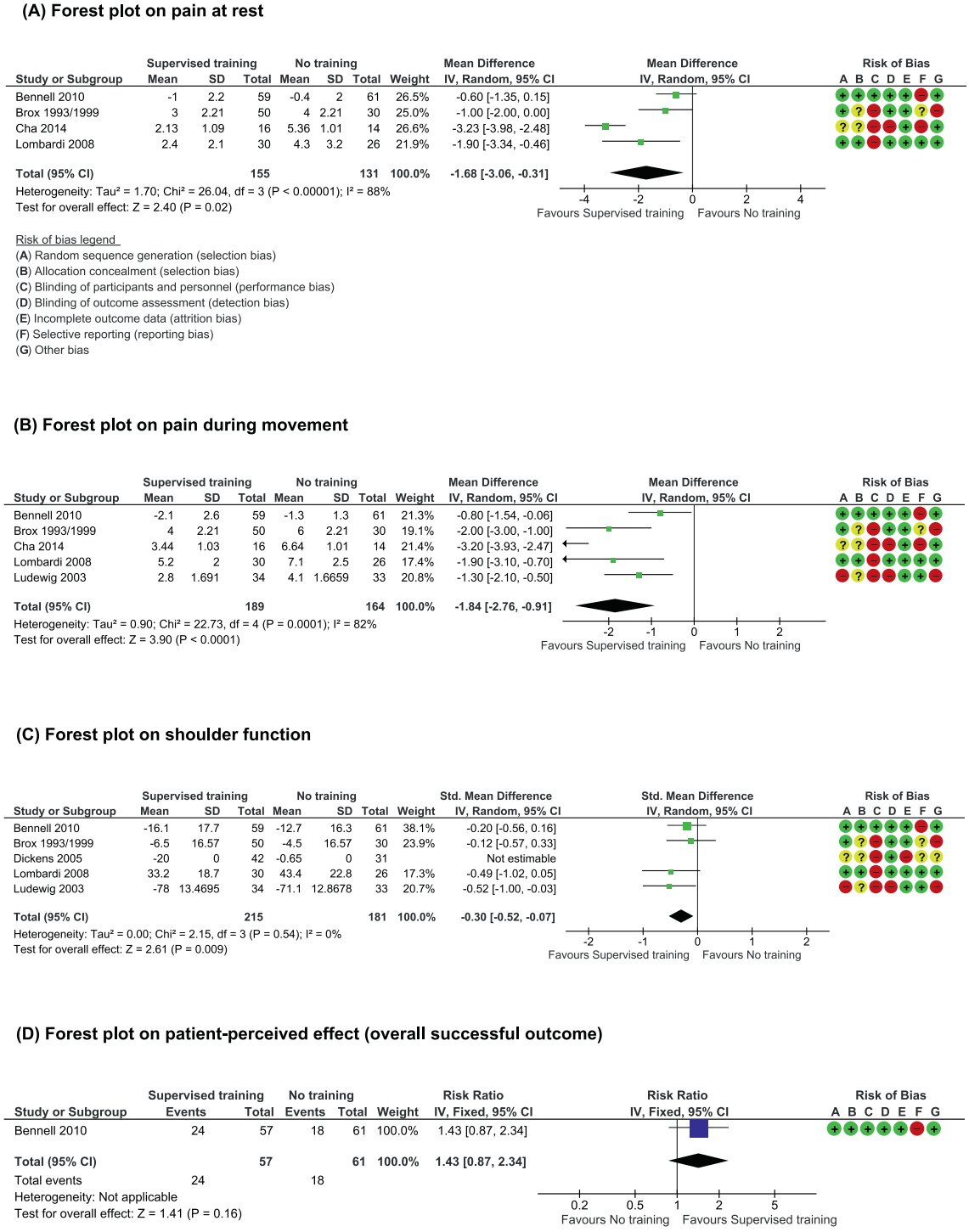

Fig 2 Forest plots of the comparison between supervised training and no training on (A) pain at rest, (B) pain during movement, (C) function, and (D) patient-perceived effect (overall successful outcome). Risk of bias: green (+) indicates low risk of bias, yellow (?) indicates unclear risk of bias, and 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 MIDs of 0.5-3.0 and the Constant score MIDs 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 low[33] to high.[46,47] The reasons for these discrepancies are likely based on methodological choices. Steuri et al[33] 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 al[22]), which we based on insufficient or no "blinding" and/or wide CIs on the critical outcomes. Our effect estimates are

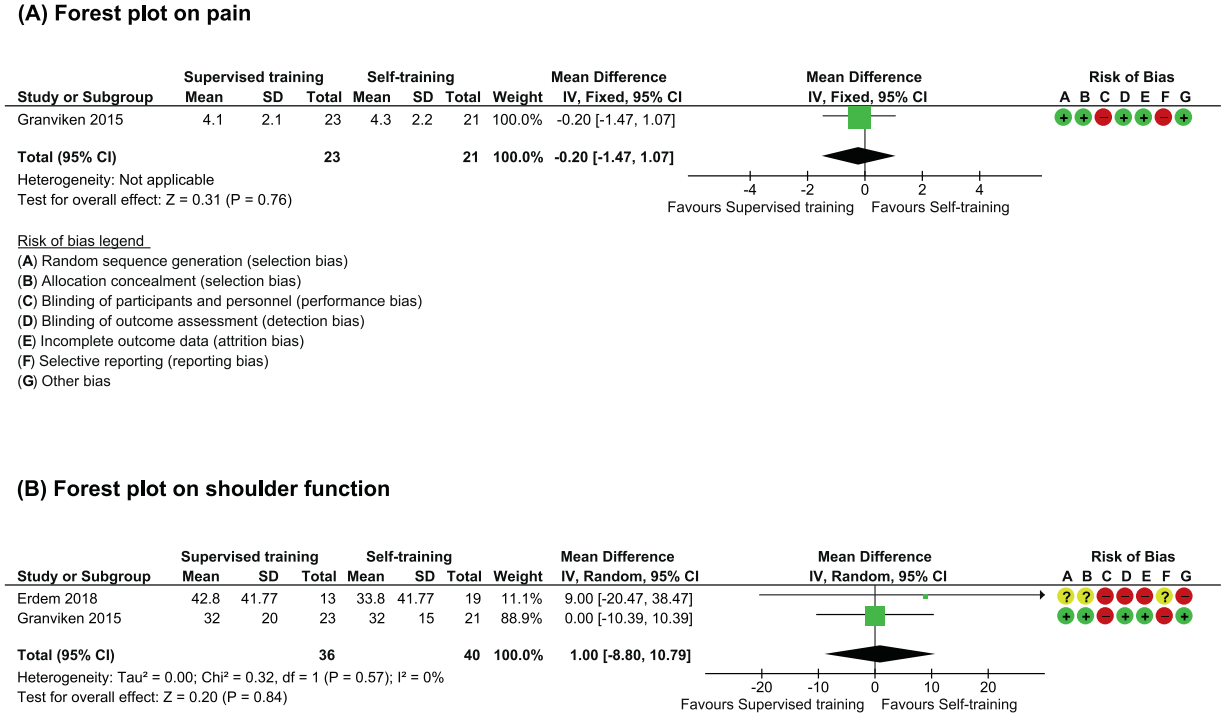

Fig 3 Forest plots of the comparison between supervised training and self-training on (A) pain and (B) function. Risk of bias: green (+) indicates low risk of bias, yellow (?) indicates unclear risk of bias, and red (−) indicates high risk of bias.

slightly lower than reported by Steuri et al,[33] which seems to be based on our inclusion of 2 additional studies[34-36] reporting the lowest improvements in favor of training. Abdulla et al[47] 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 review[48] 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 studies[34] (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 dosage[56] and scapular focused interventions[57] may be preferable. Mild transient pain during therapeutic training is considered a normal response to training[58] and need not be a barrier to successful outcomes[59]; 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

Corresponding author

Behnam Liaghat, MSc, University of Southern Denmark, Campusvej 55, 5230 Odense, Denmark. *E-mail address:* bliaghat@health.sdu.dk.

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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 analys*)).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 andVersions(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

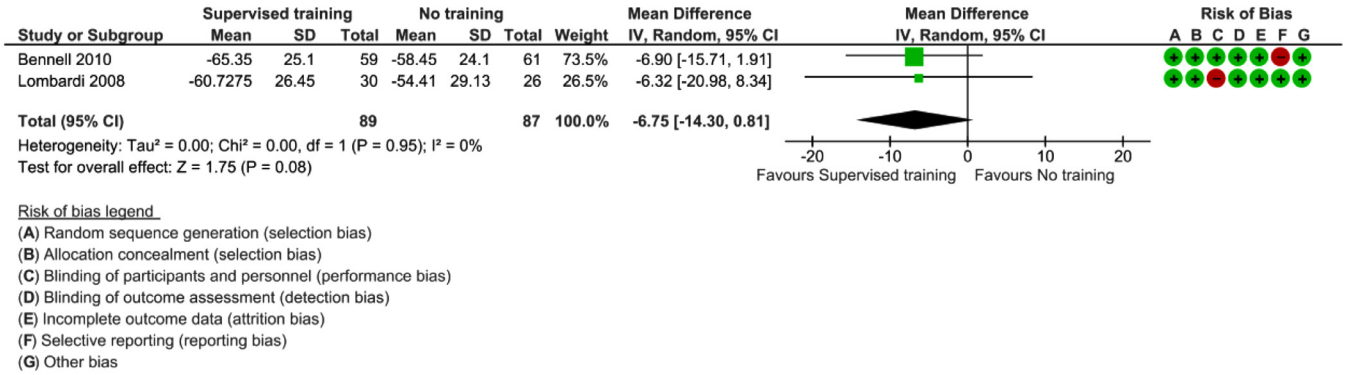
Results of the AMSTAR (A MeaSurement Tool to Assess systematic Reviews) Quality Appraisal

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 provided?	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

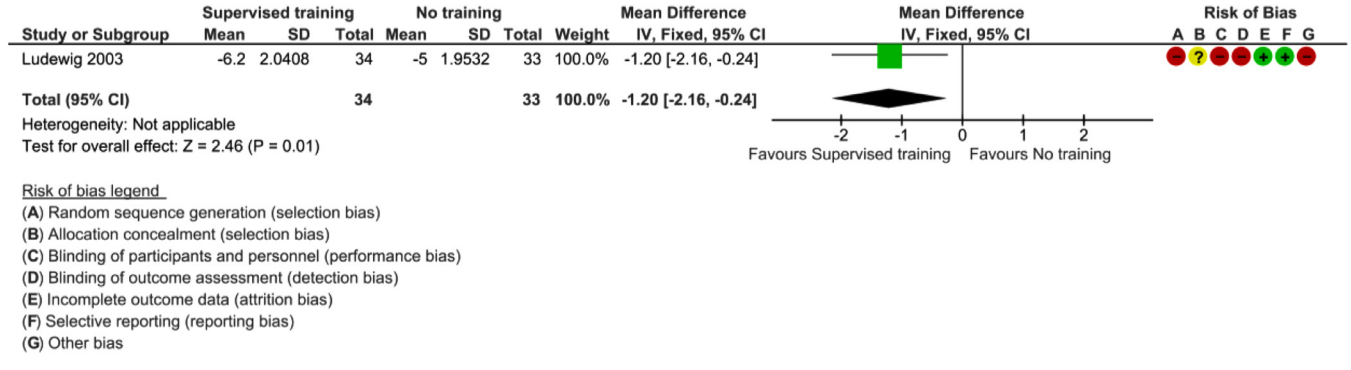
Supplementary appendix 2.B

Forest plots for important outcomes from the 10 included studies[2-12]. Risk of bias: green (+) indicates low risk of bias, yellow (?) indicates unclear risk of bias, and red (-) indicates high risk of bias.

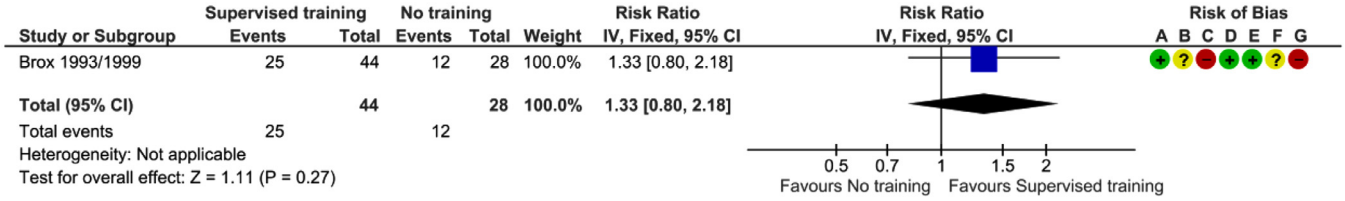
Supervised training compared with no training, outcome: quality of life.



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

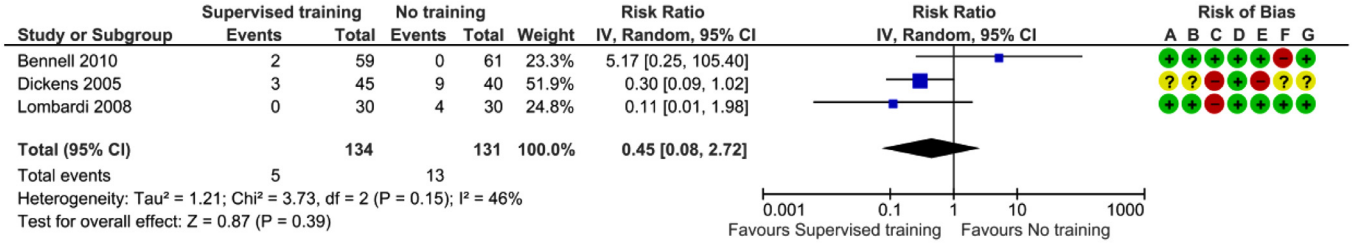


Supervised training compared with no training, outcome: return to work (number at work).



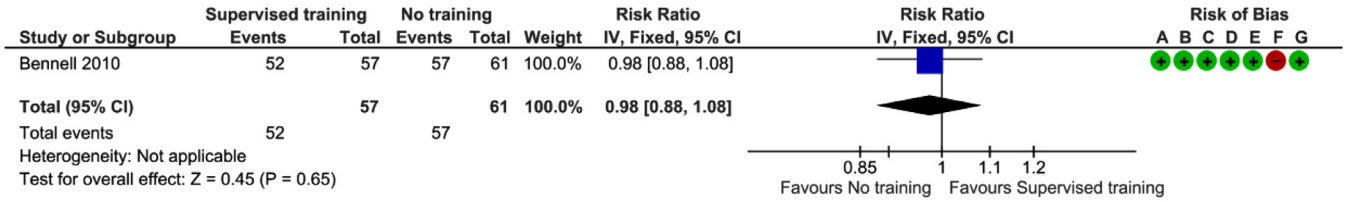
Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective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

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



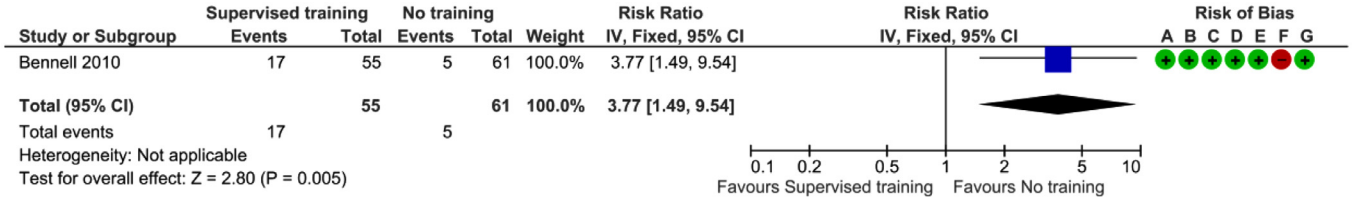
Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective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

Supervised training compared with no training, outcome: adherence.



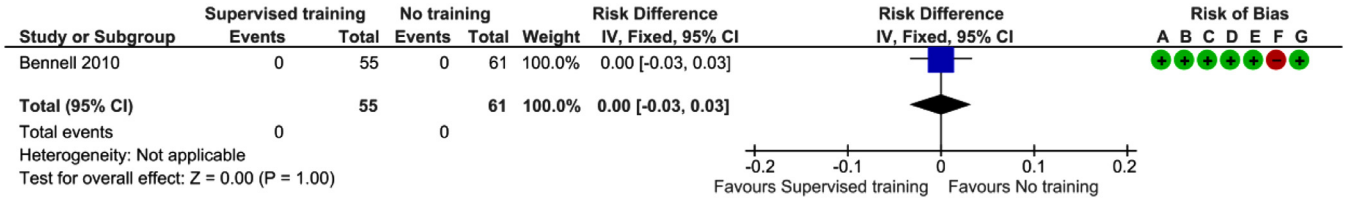
Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective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

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



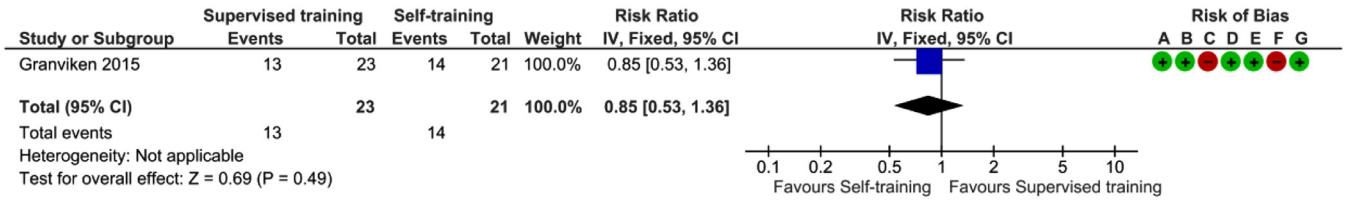
Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective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

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



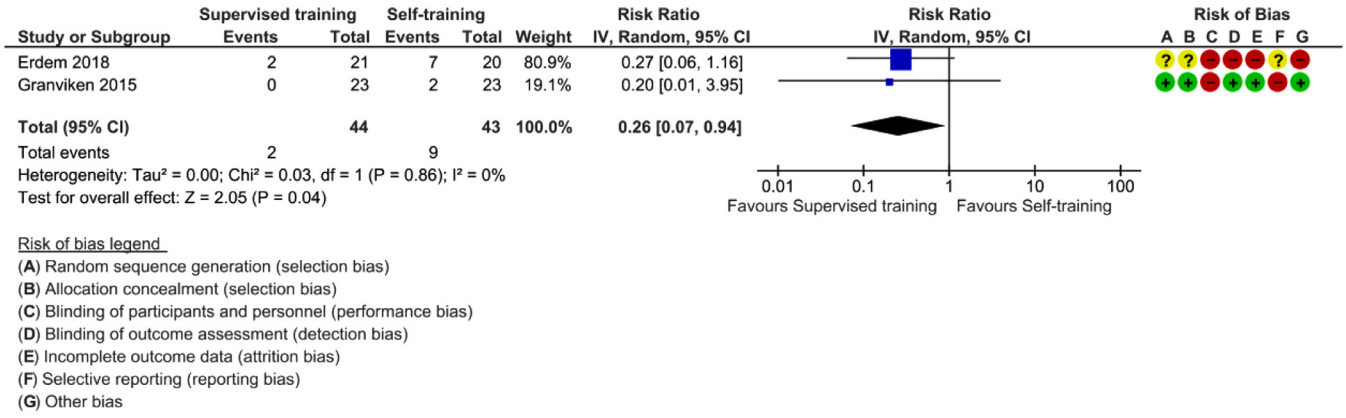
Risk of bias legend
(**A**) Random sequence generation (selection bias)
(**B**) Allocation concealment (selection bias)
(**C**) Blinding of participants and personnel (performance bias)
(**D**) Blinding of outcome assessment (detection bias)
(**E**) Incomplete outcome data (attrition bias)
(**F**) Selective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

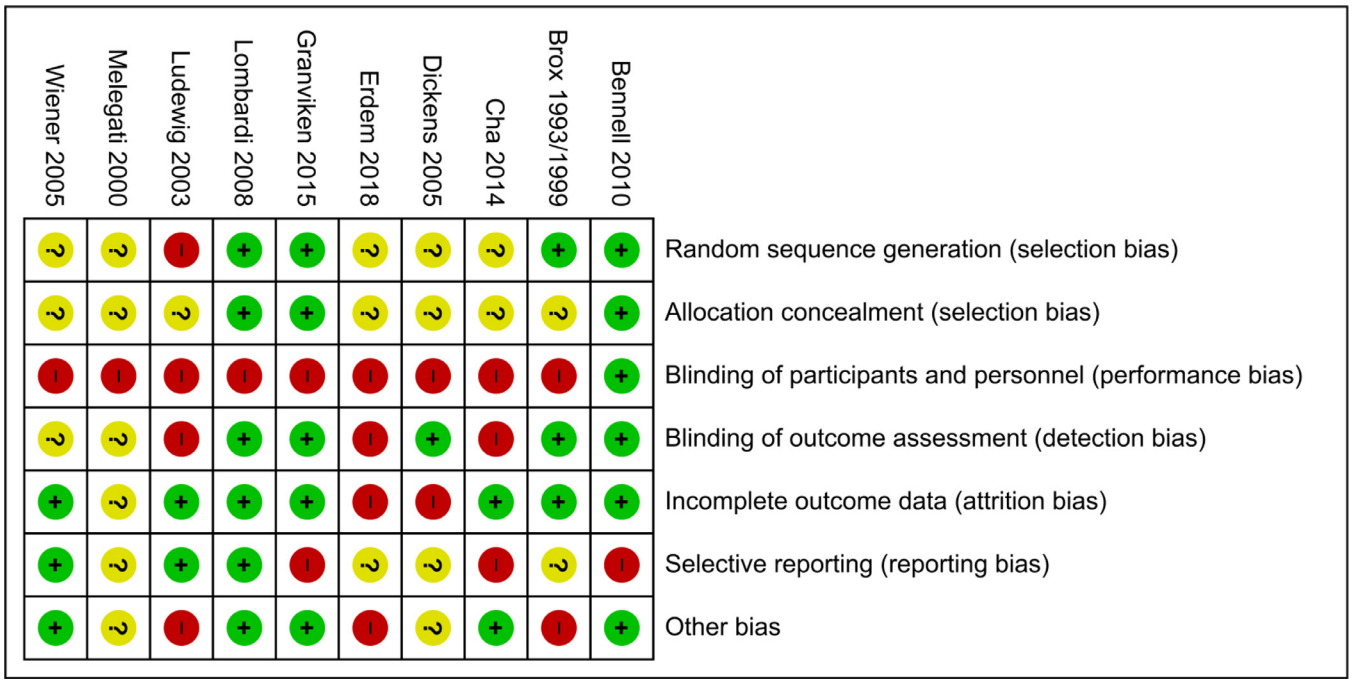
Supervised training compared with self-training, outcome: dropout all causes.



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.



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