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Clinical outcomes of exercise in the management of subacromial impingement syndrome: a systematic review

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Objective: To assess the clinical outcomes of types of exercise in the management of subacromial impingement syndrome.

Design: Systematic review of randomized controlled trials.

Methods: Studies were identified from databases searched to May 2009: MEDLINE, EMBASE, CINAHL, Sports Discus, PEDro, AMED, Cochrane Library, National Research Register, Index Chiropractic Literature. Two reviewers selected studies meeting inclusion criteria. The methodological quality of the included studies was independently assessed by two reviewers using the PEDro quality assessment tool.

Results: Eight studies with sample sizes ranging from 14 to 125 were included in the systematic review and appraised for content. Four papers achieved a score of 6 or above indicating good quality, with the remaining four achieving 4 or lower, indicating poor quality. Synthesis showed only limited evidence to support the use of exercise in the treatment of subacromial impingement syndrome.

Conclusion: There is a need for further well-defined clinical trials on specific exercise interventions for the treatment of shoulder dysfunction including subacromial impingement syndrome.

Introduction

Subacromial impingement syndrome occurs in the subacromial space when the subacromial bursa or the rotator cuff muscles become trapped between the humeral head and the acromion or coracoacromial ligament. This occurs due to pathomechanics, inflammation or bony protrusions into the subacromial space. It exists as an association of various comorbidities around the shoulder, each exhibiting different clinical signs and symptoms. Subacromial impingement syndrome causes pain and limited movement, resulting in altered movement patterns and functional limitation. The condition is classified as primary or secondary impingement.

A study by Linsell et al. identified the prevalence and incidence of adults consulting for shoulder conditions in a UK primary care setting. A prevalence of 2.36% and incidence of 1.47% was identified, peaking at 50 years and showing a linear increase with age. Fifty per cent had only one consultation, but 13.6% had consultations in the third year of the study. However there are no accurate estimates of the incidence or prevalence of subacromial impingement syndrome.
Subacromial impingement syndrome can be managed surgically or conservatively, although in the majority of cases conservative management precedes surgery. In recently published studies exercise programmes are generally described within the overall conservative management of subacromial impingement syndrome. Exercise generally has a positive effect in rehabilitation and retraining of muscle imbalance is a key factor in retraining normal muscle patterns. Exercise is used in the rehabilitation of subacromial impingement syndrome, but it is not clear what type or duration of exercise is indicated. Some studies also combine exercise with other conservative procedures within treatment protocols, which makes it impossible to evaluate the effect of exercise in isolation.

The aim of this review is to focus on the effectiveness of exercise intervention in the management of subacromial impingement syndrome. Previous reviews have considered a variety of surgical and conservative interventions, but results have been inconclusive, partly due to imprecise descriptions of exercise programmes. A systematic review by Michener et al. identified only limited evidence to support beneficial effects of exercise in subacromial impingement syndrome. The authors suggested that future research should focus on specific therapeutic methods to assist in developing the evidence base of treatment for subacromial impingement syndrome. A later systematic review by Trampas and Kitsios concluded that there is moderate evidence to support the use of therapeutic exercise. This review supports further exploration of exercise for subacromial impingement syndrome and a need to focus on specific types of exercise is an important factor. Exercise may be able to retrain postural control and improve muscle balance and have a greater impact on resolving problems and limiting recurrence.

Methods

The following electronic databases were searched: MEDLINE, EMBASE, CINAHL, Sports Discus, PEDro, AMED, Cochrane Library, National Research Register, and Index Chiropractic Literature. (Example of search in Appendix.) No language or date restrictions were applied and databases were searched up to September 2007. The search was subsequently updated to May 2009. Citation lists from all included studies were searched. Selection criteria are identified in Table 1.

Two reviewers (SK and PW) assessed papers for inclusion using the title, or the abstract if it was not clear from the title whether the paper met the criteria for selection. Full copies of remaining potentially relevant studies were obtained for detailed examination. Data extraction was independently carried out by two reviewers (SK and PW) using standardized headings: authors, study design, population (age, condition, setting, sample size), intervention, control, outcome measures, results, follow-up and comments. The data were tabulated by PW who also checked discrepancies within the data extraction. Discrepancies were resolved by discussion of the original paper between reviewers.

Quality was assessed using the PEDro scale. The PEDro scale is based on the Delphi list developed by Verhagen based on expert consensus. The PEDro Scale is more flexible for use in therapeutic trials including activity where blinding of participants and therapists is not feasible. Quality assessment was carried out independently by two reviewers (SK and PW). Discrepancies were resolved by discussion between reviewers. If agreement could not have been reached a third reviewer would have been recruited.

Studies were compared in relation to design, population, interventions used, control group characteristics and outcomes. It was found during the review that populations and interventions were heterogeneous, therefore it was not possible to pool results for meta-analysis. Because of limitations in the data a best-evidence synthesis analysis was undertaken.

Results

Figure 1 identifies results of all database searches. In total eight randomized controlled trials met the inclusion criteria. The randomized controlled trial
by Brox et al.\textsuperscript{12,13} was reported in two separate publications; the first evaluated participants at three- and six-month time-points and the second paper evaluated the same population at a two and a half year follow-up, but looked at different outcomes. Data for both articles are included in the analysis. A summary of the study characteristics is shown in Table 2.

The number of participants in studies ranged from 14 to 125, but as no studies identified sample size calculations, it is unlikely that studies had sufficient power to provide conclusive evidence. All of the studies were conducted using adults, but only three studies identified the proportion of male and female participants. Brox et al.\textsuperscript{12,13} and Conroy and Hayes\textsuperscript{14} excluded participants who had previous corticosteroid injections. Three studies\textsuperscript{12,13,15,16} also included participants who had previously taken steroidal or non-steroidal anti-inflammatory drugs. All studies used clinical tests to identify subacromial impingement, in addition four studies\textsuperscript{12,13,15–17} confirmed subacromial impingement syndrome using the subacromial anaesthetic injection test. All studies except Conroy and Hayes\textsuperscript{14} and Citaker et al.\textsuperscript{18} recruited participants who had received previous physiotherapy. There was a large variation in duration of symptoms across the studies and in half the studies duration was not identified.\textsuperscript{14,18–20} None of the studies provided specific details of exercise intervention and there was variability in the type of exercise and level of supervision. Most studies included combinations of interventions with exercise being combined with mobilizations, hot or cold therapy, education or surgery.

The study by Brox et al.\textsuperscript{12,13} had two comparators: placebo and surgery with exercise. Walther et al.\textsuperscript{16} also used a passive comparator intervention with no exercise component. Lombardi et al.\textsuperscript{19} used waiting list patients as a comparator group. The remaining four studies all had exercise as an element in the comparator. Haahr et al.\textsuperscript{15} and Rahme et al.\textsuperscript{17} included surgery in the comparator, Citaker et al.\textsuperscript{18} added either proprioceptive neuromuscular facilitation or manual mobilization to exercise and Conroy and Hayes\textsuperscript{14} added manual mobilization to the intervention group. In Senbursa et al.\textsuperscript{20} manual therapy was added to the comparator group. In Citaker et al.\textsuperscript{18} manual mobilization was added to the comparator and proprioceptive neuromuscular facilitation was included in the intervention, but no detail was given on the specific activities undertaken. In the studies by Haahr et al.\textsuperscript{15} and Rahme et al.\textsuperscript{17} arthroscopic decompression was compared with supervised exercise programmes. It should be noted that arthroscopic decompression was identified for the study by Haahr et al.,\textsuperscript{15} while open decompression was the intervention for the study by Rahme et al.,\textsuperscript{17} with a programme of supervised exercises according to Böhmer being undertaken by the control group. Although these two studies are comparing decompression, the less invasive arthroscopic surgery, which has been increasingly used as surgical techniques have

**Table 1** Selection criteria

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
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<tbody>
<tr>
<td>1. Population Adults between the ages of 18 and 66 years. Diagnosis of non-acute</td>
<td>1. Population Studies of participants suffering a history of non-specific shoulder</td>
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<tr>
<td>(minimum of three months duration) subacromial impingement syndrome, classified by</td>
<td>pain, rotator cuff injury or associated cervical spine involvement were excluded</td>
</tr>
<tr>
<td>Neer (1983) as Stages I and II</td>
<td>2. Intervention Studies where no clear exercise intervention could be identified</td>
</tr>
<tr>
<td>2. Intervention Exercise/exercise combined with other conservative management</td>
<td>3. Comparator Studies with no comparator</td>
</tr>
<tr>
<td>3. Comparator Non-exercise intervention or combinations of exercise with different surgical or conservative treatments</td>
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<tr>
<td>4. Outcome measures Any relevant clinical outcomes</td>
<td>5. Outcome measures Only subjective acceptability of the intervention reported</td>
</tr>
<tr>
<td>5. Study design Randomized controlled trials</td>
<td>6. Study design Studies where subjects were not randomly allocated were excluded from the review</td>
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improved, is likely to result in enhanced recovery compared with open decompression.

All included studies evaluated pain as a primary outcome measure together with other outcomes including range of movement and functional scales. Significant improvements from baseline measurements were reported for interventions and controls except for the placebo group in
<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Population (age &amp; condition)/setting/sample size</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Outcome measures</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Brox, Staff, Ljunggren and Brevik (1993). Brox, Gjengedal, Uppheim, Bohmer, Brevik and Ljunggren (1999) (Follow up study on original cohort at 2 1/2 years)</td>
<td>RCT</td>
<td>N = 125 SIS for minimum of 3 months Age: 18–66</td>
<td>Supervised exercise - for 3–6 months. Exercise for both groups: strengthening, normalisation movement patterns and home exercises</td>
<td>Comparator 1. Placebo (detuned laser). Twice a week for 6 weeks Comparator 2 Arthroscopic surgery, followed by supervised exercise for 3–6 months</td>
<td>Pain: Self report on activity, at rest, and at night during previous week. Neer shoulder score: verbal rating 10–100. Muscle strength: isometric abduction (45°), time pts could hold 2 kg weights Hopkins symptom checklist: distress Disability: ability to carry a shopping bag and reach to a wall cupboard. Percentage of participants on shoulder related absence from work Blind assessment at 3 and 6 months. Assessment at 2 1/2 years not blinded. After 6 months 50% of placebo group and 22% exercise group had surgery.</td>
<td>Using intention to treat analysis significant differences between both interventions and placebo at 6 months for Neer score and pain. For treatment received analysis at 2 1/2 years no significant difference between intervention groups.</td>
<td>Comparison at 2 1/2 years following change in treatment questionable with intention to treat. Analgesics and anti-inflammatory drugs were allowed. Much reduced contact time for placebo group.</td>
</tr>
<tr>
<td>2 Lombardi, Guarnieri, Fleury, Da Silva and Natour (2008)</td>
<td>RCT</td>
<td>N = 60 SIS – Neer and Hawkins test SIS duration not specified. Age: Experimental group mean 56.3 Control group mean 54.3</td>
<td>Progressive resistance training for flexion, extension, medial and lateral rotation. 2 times per week for 8 weeks</td>
<td>Patients on waiting list. Treatment delayed 2 months</td>
<td>Pain: VAS Function: Disabilities of the arm and shoulder questionnaire (DASH). Quality of life: SF – 36 Active range of movement: Shoulder flexion, extension and rotation. NSAIDs noted Assessment at baseline and 2 months</td>
<td>Using intention to treat analysis between groups significant improvement in intervention group for: pain, function (DASH), range of abduction and extension, and quality of life (SF – 36). Intervention group exhibited significant improvement in the same variables when comparing outcomes at baseline and 2 months.</td>
<td>Fewer analgesics taken by intervention group. Follow up limited to 2 months.</td>
</tr>
<tr>
<td>3 Walther, Werner, Stahlschmidt, Woelfel and Gohlke. (2004)</td>
<td>RCT</td>
<td>N = 60 SIS- Neer 1 &amp; 11. SIS duration not specified. Age: Group 1 40–66 yrs Group 2 37–66 yrs Group 3 25–61 yrs</td>
<td>Group 1: Self-training, stabilising exercises, stretching, theraband 5 times per week for 10–15 minutes. Group 2: Physiotherapy - 10 sessions, stabilising, exercises, stretching, drug prescriptions from GP.</td>
<td>Functional brace worn during day and night if possible</td>
<td>Pain: VAS Constant Murley Score: pain, pain free range of motion, muscle power and activities of daily living. NSAIDs noted in the therapy diary. Assessment at baseline, 6 and 12 weeks.</td>
<td>All 3 groups showed a significant reduction of pain at night, during rest periods and activity and in the Constant-Murley Score at 6 and 12 weeks, but no significant difference between groups. Inability to work ranged from 1 day to 4 months with no significant difference between groups.</td>
<td>No indication of specific GP prescriptions.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Population (age &amp; setting)/sample size</td>
<td>Intervention</td>
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<td>RCTs with exercise included in comparator</td>
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<tr>
<td>4 Citaker, Taskiran, Akdur, Arabaci and Ekkici (2005)</td>
<td>RCT</td>
<td>N = 40 Age: median 52.8 PNF group, 55.5 mobilisation group. SIS duration not specified</td>
<td>PNF Hot-packs Theraband strengthening exercise 20 sessions of treatment Home exercise</td>
<td>Manual mobilisation Hot-packs Theraband strengthening exercise 20 sessions of treatment Home Exercise</td>
<td>Pain: VAS Active range of movement: 5 movements measured University of California at Los Angeles criteria: pain, function and satisfaction. Assessment pre and post intervention</td>
<td>VAS pain scores – significant improvement in both, but no difference between groups. Increase in range of 5 movements was significant in both groups for patients with stage II and stage III impingement. UCLA values for function and pain were sig for Stage II patients.</td>
<td>Not clear what timescale for assessments. Specific movements measured not identified.</td>
</tr>
<tr>
<td>5 Conroy and Hayes (1998)</td>
<td>RCT</td>
<td>N = 14 Male female = 8:6 Age: Intervention mean 55, comparator mean 50.7 SIS duration not specified</td>
<td>Manual mobilisation Stretching Strengthening exercise Hot packs Education 1 1/2 hours 3 times per week for 3 weeks</td>
<td>As group 1 minus joint mobilisation</td>
<td>Pain: VAS intensity over 24 hrs and during sub-acromial compression test Active range of movement: Shoulder flexion, abduction, rotation and elevation. Function: 3 overhead activities graded on a 3 point scale Assessment pre and post treatment</td>
<td>Within Group: both groups improved on movement and function pre to post test. Intervention group less 24 hour and sub-acromial testing pain Between Groups: No difference in movement or function, but intervention group had significantly less pain over a 24 hr period and on the sub-acromial compression test post treatment.</td>
<td>Small sample for parametric statistical analysis</td>
</tr>
<tr>
<td>6 Haahr, Østergaard Dalsgaard, Norup, Frost, Lausen, Holm and Anderson (2004)</td>
<td>RCT</td>
<td>N = 90 Age: 18–55 yrs SIS 6–36 months</td>
<td>Strengthening exercises Stabilising exercises Exercise preceded by heat/cold/soft tissue treatment 19 one hour sessions</td>
<td>Arthroscopic decompression Stitches out at 10 days, instructed in a regimen of active exercises.</td>
<td>Constant score: 4 subscores of pain (VAS), range of movement, function and isometric muscle strength (Max. 100 = normal). Assessment at baseline, 3, 6 and 12 months.</td>
<td>Both groups improved from baseline at follow up assessment but not significant. No significant difference between groups for total or subgroup analysis of constant scores.</td>
<td>Physiotherapists not blinded to treatment for assessment. 6 patients from the exercise group were operated on within the 12 months of the study.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>N</td>
<td>Age</td>
<td>SIS Duration</td>
<td>Interventions</td>
<td>Outcomes</td>
<td>Findings</td>
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<td>Rahme, Soel-Bertoft, Westerberg, Lundber, Sorensen and Hilding (1998)</td>
<td>RCT</td>
<td>42</td>
<td>Mean 42</td>
<td>Greater than 1 year</td>
<td>Physiotherapy: Active and strengthening exercises</td>
<td>Pain at rest (VAS) and pain rated with ‘pour out of pot’ manoeuvre</td>
<td>Reduction of pain in groups A and B at 6 months, but no significant difference between groups. At 12 months reduction in pain in groups A and B and using intention to treat analysis (with group C identified as failures for physiotherapy) significant difference between groups, identifying greater pain decrease following surgery.</td>
</tr>
<tr>
<td>Senbursa, Baltaci and Atay (2007)</td>
<td>RCT</td>
<td>30</td>
<td>30-55</td>
<td>Neer I &amp; 2</td>
<td>Home exercises including theraband, 10–15 minutes daily mobilising, strengthening and stretching for rotator cuff, rhomboids and serratus anterior.</td>
<td>Active range of movement Function – Neer questionnaire Muscle strength – flexors, abduction, internal and external rotation.</td>
<td>No significant difference between groups for pain or Neer score. Both groups improved from baseline at follow up assessment for all outcomes. For the manual therapy group there was a significant difference.</td>
</tr>
</tbody>
</table>
Brox et al.\textsuperscript{12,13} and the comparator group in Lombardi et al.\textsuperscript{19}

In Brox et al\textsuperscript{12,13} the exercise intervention produced significant improvement compared with placebo control in relation to reduced pain, improved function and range of movement. In the longer term follow-up after two and a half years no significant differences were found between the three groups. However this may be because randomization was diluted, as at six months patients were offered a surgical intervention if previous treatment had not been effective. Variability in compliance with exercise over the extended time period was also a factor that could have influenced outcomes.

All studies randomly allocated subjects to groups, but only Haahr et al.\textsuperscript{15} and Lombardi et al.\textsuperscript{19} concealed allocation. All comparison groups except Rahme et al.\textsuperscript{17} were similar at baseline. There was no blinding of subjects or therapists in any studies, but this would not have been possible given the nature of the interventions used. Blinding of outcome assessors was done in five studies. Measurement of key outcomes for 85\% subjects allocated were available in five studies. Intention-to-treat analysis was only completed in four studies.

The two reviewers reached agreement on quality scores for all studies. PEDro scores for each study are included in Table 2, indicating that 4 of the 8 studies included were of poor quality. Overall, evidence to support the use of exercise in subacromial impingement syndrome is unclear as insufficient sample sizes, inconsistent results and poor methodological quality were evident in the included studies.

**Discussion**

This review has explored the effectiveness of specific exercise interventions in the management of subacromial impingement syndrome. Following evaluation of the studies it can only be suggested that exercise is effective in relieving pain and improving function in subacromial impingement syndrome. The research strategy was comprehensive but the review was constrained by the limited number of good-quality studies available. Although only randomized controlled trials were included, methodological quality was generally poor, with no sample size calculations, lack of detail on interventions and lack of blinding of outcome assessment. As a result of these limitations no firm conclusions can be made.

Outcome measures for pain, range of movement and function were used appropriately and reliability and validity had been considered. But the measures used may not have been sufficiently sensitive to identify clinically important differences in this population.

Because of the inclusion of exercise in the comparator for five of the studies, in these it was not possible to isolate the effect of exercise. This means that exercise groups can be shown to demonstrate improvement over time but the potential for other factors to have influenced results cannot be determined. Variation in timing of exercise intervention and combination with other interventions including anti-inflammatory injections and physiotherapy makes evaluation difficult. For future studies specific exercise regimens used in isolation need to be evaluated.

Conservative interventions included in studies within this review addressed symptoms of subacromial impingement syndrome, but the effect on underlying biomechanical problems may have been limited. Muscle strengthening and postural control around the shoulder region were identified, but exercise interventions were non-specific in relation to muscle balance and activation timing. As a consequence mechanical problems would be likely to continue and relief from symptoms would only be short term. If movement dysfunction causing subacromial impingement syndrome can be influenced by re-education of muscle balance and normalization of activation timing, longer term improvements may be expected. Increased control of movement could reduce or limit impingement during activity and potentially provide more effective and sustained relief of symptoms.

Future research in relation to exercise rehabilitation for subacromial impingement syndrome should focus on sufficiently powered randomized controlled trials. Trials should specify elements of muscle balance and movement pattern corrections;
to re-educate muscle activity to alleviate symptoms of impingement. To allow the evaluation of exercise it is essential that precise control groups are identified in which non-exercise or different specific types of exercises are identified to allow an evaluation of their effectiveness to be undertaken. Because of the difficulty of accurately diagnosing subacromial impingement syndrome the populations identified in the randomized controlled trials selected are likely to include a wide range of conditions. Consideration should therefore be given to the development of a categorization system to identify subgroups of patients with shoulder problems. This could include the use of patterns of pain and dysfunction, to allow identification of subgroups, so that more targeted exercise interventions could be developed to address specific alterations in movement patterns and muscle balance. In future studies both short- and long-term outcomes for focused exercise interventions should be considered, along with an economic evaluation, to provide evidence to support clinical practice guidelines for the management of subacromial impingement syndrome.

The review has shown exercise to be effective to some degree in the management of subacromial impingement syndrome. Support for exercise can only be tentatively accepted because of methodological flaws in the included studies. Also variability of exercise prescription in relation to type of exercise, repetitions, supervision and length of programmes, together with lack of specificity in identification of categories of symptoms make interpretation of findings difficult.

Acknowledgements
Advice on searching databases from Sue Bayliss (Information Specialist), School of Health and Population Sciences, University of Birmingham.

Author contributions
Study initiated by SK, designed by SK, CM and PW. SK and PW completed the search, selection and quality assessment for the review. Draft of article prepared by SK and PW and critically revised by SK, CM and PW. CW had a supervisory role.

References


**Appendix – Computer database search strategy for MEDLINE Database: Ovid**

**MEDLINE(R) Search Strategy:**

1 subacromial impingement syndrome.mp. or exp Shoulder Impingement Syndrome/ (699)

2 shoulder impingement.mp. (776)

3 rotator cuff.mp. or exp Rotator Cuff/ (3909)

4 supraspinatus.mp. (1169)

5 subacromial bursitis.mp. (60)

6 subacromial bursa$.mp. (151)

7 shoulder complex.mp. (82)

8 shoulder girdle.mp. (945)

9 scapula$.mp. or exp Scapula/ (7107)

10 scapulothoracic.mp. (191)

11 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 (11824)

12 physiotherapy.mp. (6091)

13 physical therapy.mp. (22609)

14 conservative management.mp. (5654)

15 rehabilitation.mp. or exp Rehabilitation/ (144706)

16 exercise.mp. or exp Exercise/ (149029)

17 muscle strength$.mp. or exp Muscle Strength/ (10566)

18 stretch$.mp. (33426)

19 muscle balance.mp. (141)

20 muscle reeducation.mp. (16)

21 muscle re-education.mp. (24)

22 mobili$.mp. (119319)

23 taping.mp. (515)

24 or/12–23 (446614)

25 11 and 24 (1549)

26 randomized controlled trial.pt. (240104)

27 controlled clinical trial.pt. (75709)

28 randomized controlled trials.sh. (50256)

29 random allocation.sh. (58676)

30 double blind method.sh. (92691)

31 single blind method.sh. (11221)

32 or/26–31 (406936)

33 (animals not human).sh. (4176946)

34 32 not 33 (372333)

35 clinical trial.pt. (439467)

36 exp clinical trials/ (194905)

37 (clin$ adj25 trial$s).ti,ab. (134032)
Exercise for subacromial impingement syndrome

38 ((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).ti,ab. (92104)
39 placebo$.ti,ab. (104208)
40 random$.ti,ab. (381459)
41 placebos.sh. (26423)
42 research design.sh. (48719)
43 or/35–42 (863611)
44 43 not 33 (757661)
45 44 not 34 (403342)
46 comparative study.sh. (0)
47 exp evaluation studies/ (609902)
48 follow up studies.sh. (343901)
49 prospective studies.sh. (226320)
50 (control$ or prospectiv$ or volunteer$). ti,ab. (1823660)
51 or/46–50 (2628452)
52 51 not 33 (1937741)
53 51 not (34 or 45) (2153337)
54 34 or 45 or 53 (2929012)
55 54 and 25 (607)
56 34 or 45 (775675)
57 25 and 56 (199)
58 from 57 keep 1–199 (199)