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Physiotherapy interventions for ankylosing spondylitis (Review)

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[Intervention Review]

Physiotherapy interventions for ankylosing spondylitis

Hanne Dagfinrud¹, Kåre Birger Hagen², Tore K Kvien³

¹Section for Health Science, University of Oslo, Oslo, Norway. ²National Resource Centre for Rehabilitation in Rheumatology, Diakonhjemmet Hospital, 0319 Oslo, Norway. ³Department of Rheumatology, Diakonhjemmet Hospital, Oslo, Norway

Contact address: Hanne Dagfinrud, Section for Health Science, University of Oslo, P.O.box 1153, Blindern, Gydas vei 8, Oslo, 0316, Norway. h.s.dagfinrud@medisin.uio.no.

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ABSTRACT

Background

Ankylosing spondylitis (AS) is a chronic, inflammatory rheumatic disease. Physiotherapy is considered an important part of the overall management of AS.

Objectives

To summarise the available scientific evidence on the effectiveness of physiotherapy interventions in the management of AS.

Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, AMED, CINAHL and PEDro up to January 2007 for all relevant publications, without any language restrictions. We checked the reference lists of relevant articles and contacted the authors of included articles.

Selection criteria

We included randomised and quasi-randomised studies with AS patients and where at least one of the comparison groups received physiotherapy. The main outcomes of interest were pain, stiffness, spinal mobility, physical function and patient global assessment.

Data collection and analysis

Two reviewers independently selected trials for inclusion, extracted data and assessed trial quality. Investigators were contacted to obtain missing information.

Main results

Eleven trials with a total of 763 participants were included in this updated review.

Four trials compared individualised home exercise programs or a supervised exercise program with no intervention and reported low quality evidence for effects in spinal mobility (Relative percentage differences (RPDs) from 5-50%) and physical function (four points on a 33-point scale).

Three trials compared supervised group physiotherapy with an individualised home-exercise program and reported moderate quality evidence for small differences in spinal mobility (RPDs 7.5-18%) and patient global assessment (1.46 cm) in favour of supervised group exercises.

In one study, a three-week inpatient spa-exercise therapy followed by 37 weeks of weekly outpatient group physiotherapy (without spa) was compared with weekly outpatient group physiotherapy alone; there was moderate quality evidence for effects in pain (18%), physical function (24%) and patient global assessment (27%) in favour of the combined spa-exercise therapy. One study compared daily outpatient balneotherapy and an exercise program with only exercise program, and another study compared balneotherapy with fresh water therapy.

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None of these studies showed significant between-group differences. One study compared an experimental exercise program with a conventional program; statistically significant change scores were reported on nearly all spinal mobility measures and physical function in favour of the experimental program.

Authors' conclusions

The results of this review suggest that an individual home-based or supervised exercise program is better than no intervention; that supervised group physiotherapy is better than home exercises; and that combined inpatient spa-exercise therapy followed by group physiotherapy is better than group physiotherapy alone.

PLAIN LANGUAGE SUMMARY

Physiotherapy for ankylosing spondylitis

How well does physical therapy work for treating ankylosing spondylitis and how safe is it?

To answer this question, scientists working with the Cochrane Musculoskeletal Group found and analyzed 11 studies testing over 700 people who had ankylosing spondylitis (AS). Studies compared people who did exercises at home, went to group exercise programs, went to spa or balneotherapy, performed different exercise programs or had no therapy at all. These studies provide the best evidence we have today.

What is ankylosing spondylitis and how can physical therapy help?

AS is a type of arthritis most typically affecting the joints and ligaments of the spine, and results in varying degree of pain, stiffness and disability. Physiotherapy is an important treatment to maintain or improve movement in the spine, improve fitness and decrease pain.

How well does physical therapy work?

Four studies compared individual or supervised exercises to no therapy at all. They found that both individual and supervised exercise programs improve spinal movement more than no therapy. The exercise programs were done for two to six months.

Three studies compared home exercises to supervised group exercises. They found that group exercises improve movement in the spine and overall well-being, but did not improve self-reported physical function more than home exercises. Exercises were done for three weeks to nine months, and included strengthening, aerobic exercises, hydrotherapy, sports activities and stretching.

One study compared two groups who both did weekly group exercises for 10 months, but one of the groups also went to a spa resort for three weeks of physiotherapy. Spa therapy plus weekly group exercises improves pain and overall well-being more than just weekly group exercises. One study compared balneotherapy and daily exercises with only daily exercises, and another study compared balneotherapy with fresh water therapy. Both these studies showed improvements after treatment for several outcomes, but no significant differences between the groups were found. One study compared a four-month experimental exercise program with a conventional program. Both groups improved, but the experimental exercise group improved more on spinal mobility and physical function than the conventional exercise group.

Did physical therapy harm patients?

Harms to the patients were not reported in the studies.

What is the bottom line?

Physiotherapy or exercises are helpful to people with ankylosing spondylitis.

There is "silver" level evidence (www.cochranemsk.org) that exercise programs, home-based or supervised, are better than no exercises and improve movement and physical function. Group exercises are better than home exercises, and improve movement and overall well-being. Adding a few weeks of exercising at a spa resort to weekly group exercises is better than just weekly group exercises. Balneotherapy in addition to exercise program did not show additional effect, nor did balneotherapy compared to fresh water therapy. An experimental exercise program showed more improvement on mobility and physical function than conventional exercises, but differences between groups were not statistically significant. We still need more information about the different types of physiotherapy and exercise, and how long, how intensive and how often physiotherapy should be done for the most improvement.

BACKGROUND

Ankylosing spondylitis (AS) is a chronic, progressive, inflammatory disorder mainly affecting the axial skeleton with aseptic inflammation of synovial tissue, spinal ligaments, intervertebral discs and facet joints. It is characterised clinically by pain and stiffness of the back and the sacroiliac joints, and is frequently also associated with peripheral arthritis, enthesitis and acute anterior uveitis ([Khan 2002](#); [Sieper 2002](#)). The aetiology of AS is unknown. The estimated prevalence in European Caucasian populations is 0.1 to 1.2% and the male to female ratio is about 2-3:1 ([Dougados 1995](#); [Gran 1993](#); [Robbins 2001](#); [Sieper 2006](#)). AS leads to variable degrees of pain, reduced spinal mobility and limitations in physical functioning. Physiotherapy is, therefore, considered important to maintain or improve spinal mobility and fitness and to reduce pain, and is included in the recently published evidence based recommendations for management of AS ([Zochling 2006](#)).

OBJECTIVES

The purpose of this review was to assess the effectiveness of various physiotherapy interventions (active and passive modalities) in the management of patients with AS.

The following main comparisons were made:

1. physiotherapy versus other interventions (including no intervention);
2. comparison of different modalities or applications of physiotherapy.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised or quasi-randomised controlled studies examining the effectiveness of physiotherapy in AS.

Types of participants

Males and females with the diagnosis of AS according to the classification system described in the modified New York criteria ([Van der Linden 1984](#)). We excluded trials if the diagnostic criteria were unsure or not met.

Types of interventions

We included studies if the intervention included any physiotherapy modality considered relevant in the management of AS. If co-interventions were included, they had to be similar in the comparator groups. The relevant physiotherapy modalities in the management of AS include: supervised and unsupervised exercises, training, manual therapy, massage, hydrotherapy, electrotherapy, acupuncture, patient information and educational programs.

Types of outcome measures

The study group for Assessment in AS (ASAS) has suggested a core set of outcome measures in physiotherapy ([Van der Heijde 1999](#)). Studies which have any of these outcome measures were included in the review.

- Pain
- Stiffness

- Spinal mobility
- Physical function
- Patient global assessment
- Other relevant outcome measures

Search methods for identification of studies

We identified relevant studies by searching the Cochrane Central Register of Controlled Trials (CENTRAL), MEDLINE, EMBASE, AMED, CINAHL and PEDro up to January 2007.

We used the search strategies recommended in the Cochrane Reviewers' Handbook 4.2.6 ([Higgins 2006](#)). The reference lists of retrieved studies were scanned to identify additional relevant trials, and authors of relevant studies were contacted for additional information.

Data collection and analysis

Two of the reviewers (HD and KBH) independently selected trials included in the review, using a standard pre-developed form that was pilot-tested.

Methodological quality

HD and KBH also independently assessed the methodological quality of the included studies. Disagreement was easily resolved by discussion. We assessed internal validity using criteria according to the Cochrane Reviewers' Handbook ([Higgins 2006](#)). We used the following five criteria in assessment:

1. concealment of allocation;
2. co-intervention;
3. intention-to-treat analysis and losses to follow up;
4. outcome assessment;
5. blinding of patients.

These five criteria were rated as "MET", "UNCLEAR" or "NOT MET". Blinding of providers is clearly not possible, so the criteria focus upon blinding of assessors and patients.

Operationalisation of the five methodological quality criteria

1. Concealment of allocation

Met: use of a centralised (e.g. group assignment by a central office unaware of participant characteristics); on-site computer system combined with group assignments in a locked unreadable computer file that could be accessed only after entering of an enrolled participant; sequentially numbered, sealed, opaque envelopes; i.e. the randomisation was independent of provider and investigator.

Unclear: concealment approach not reported and could not be verified by contacting the investigators.

Not met: included alternation, case record numbers, dates of birth, day of week, and any allocation procedure that was entirely transparent before assignment such as open list of random numbers of assignments.

2. Co-intervention

Met: interventions other than those compared were avoided or used similarly across comparison groups.

Unclear: co-interventions not reported and could not be verified by contacting investigators.

Not met: dissimilar use of interventions other than physiotherapy.

3. Intention-to-treat analysis and losses to follow up

Met: intention-to-treat analysis performed AND losses to follow up less than 20% and equally distributed between comparison groups.
Unclear: intention-to-treat analysis or losses to follow up not reported and could not be verified by contacting the authors.
Not met: exclusion not reported and could not be verified by contacting the investigators AND losses to follow up greater than 20%.

4. Outcome assessment

Met: assessors unaware of the assigned treatment when collecting outcome measures.
Unclear: blinding of assessor not reported, and could not be verified by contacting the investigators.
Not met: assessor aware of the assigned treatment when collecting outcome measures.

5. Blinding of patients

Met: patients unaware of the assigned treatment.
Unclear: blinding of patients not reported.
Not met: patients aware of the assigned treatment or blinding of patient not possible.

An overall assessment of internal validity was based on a summary of these five criteria: low risk of bias meant that four out of five criteria were met; moderate risk of bias meant that three criteria were met; and high risk of bias meant that fewer than three criteria were met.

Data extraction and analyses

Two reviewers (KBH and HD) independently extracted data by using a pilot-tested data extraction form. Disagreement was resolved by discussion. If the article did not provide sufficient information for methodological assessment or necessary data for statistical analyses letters were sent to investigators to collect missing data. We sent six letters, and four of the authors replied to our request. Two provided additional information regarding methodological quality and two provided additional data for statistical analyses.

Analyses

For the first main comparison of physiotherapy interventions versus other interventions or no intervention the pre-planned analyses were:

trials comparing (individual) home-based or supervised exercise program with no intervention.

For the second main comparison of different modalities or applications of physiotherapy the pre-planned stratified analyses were:

- trials comparing home exercise regimes with supervised, inpatient or outpatient group physiotherapy (including hydrotherapy);
- trials comparing inpatient spa-exercise therapy with supervised, weekly group physiotherapy;
- trials comparing balneotherapy and exercises with exercises alone;
- trials comparing balneotherapy with fresh water therapy;
- trials comparing an experimental muscle chain exercise program with a conventional exercise program.

The various outcome measures are presented separately (see Graphs 01.01 to 07.02). Since all outcomes were continuous

variables, results are expressed, if possible, as weighted mean differences (WMD) with corresponding 95 percent confidence intervals (CI) (Deeks J 2004).

Due to insufficient data reporting, overall effects could be calculated only for two outcomes in one comparison. Both outcomes were measured with identical instruments across studies and WMDs were calculated. Both random-effect and fixed-effect models were employed. For the other comparisons and outcomes only data from single studies provided data for statistical analyses. For studies not providing sufficient data, we undertook qualitative analyses. In one trial (Van Tubergen 2001) two interventions were considered clinically similar and were, therefore, combined for analytical purposes.

Clinical relevance

In order to improve the clinical relevance of the review, we calculated absolute benefit and relative percentage differences (RPD). Absolute benefit was calculated as the improvement in the treatment group less the improvement in the control group using the original units. RPD was calculated as the absolute benefit divided by the baseline mean in the control group. According to the Philadelphia Panel, an improvement at 15% relative to a control group was considered clinically relevant (presented in 'Additional tables').

Quality of evidence

Finally, we assessed the quality of evidence according to a recently developed systematic and explicit method (Grade Working Group). In order to indicate the extent to which one can be confident that an estimate of effect is correct, judgments about the quality of evidence were made for each comparison and outcome. These judgments considered study design (RCT, quasi-RCT or observational study), study quality (detailed study design and execution), consistency of results (similarity of estimates of effect across studies) and directness (the extent to which people, interventions and outcome measures are similar to those of interest). The following definitions in grading the quality of evidence for each outcome were used.

High: further research is very unlikely to change our confidence in the estimate of effect.

Moderate: further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low: further research is very likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Very low: any estimate of effect is very uncertain.

In addition, there are some considerations that can lower or raise the quality of evidence which were not employed in this review (Grade Working Group).

Grading of evidence

The grading system used is recommended by the Cochrane Musculoskeletal Review Group (Tugwell 2004):

Platinum level

The Platinum ranking is given to evidence that meets the following criteria as reported:

a published systematic review that has at least two individual controlled trials, each satisfying the following:

"Sample sizes of at least 50 per group. If they do not find a statistically significant difference, they are adequately powered for a 20% relative difference in the relevant outcome.

"Blinding of patients and assessors for outcomes.

"Handling of withdrawals >80% follow up (imputations based on methods such as Last Observation Carried Forward (LOCF) acceptable).

"Concealment of treatment allocation.

Gold level

The Gold ranking is given to evidence if at least one randomised clinical trial meets all of the following criteria for the major outcome(s) as reported:

"Sample sizes of at least 50 per group. If they do not find a statistically significant difference, they are adequately powered for a 20% relative difference in the relevant outcome.

"Blinding of patients and assessors for outcomes.

"Handling of withdrawals > 80% follow up (imputations based on methods such as Last Observation Carried Forward (LOCF) acceptable).

"Concealment of treatment allocation.

Silver level

The Silver ranking is given to evidence if randomised trial does not meet the above criteria. Silver ranking would also include evidence from at least one study of non-randomised cohorts who did and did not receive the therapy or evidence from at least one high quality case-control study. A randomised trial with a 'head-to-head' comparison of agents is considered Silver level ranking unless a reference is provided to a comparison of one of the agents to placebo showing at least a 20% relative difference.

Bronze level

The bronze ranking is given to evidence if there is at least one high quality case series without controls (including simple before/after studies in which the patient acts as their own control) or if it is derived from expert opinion based on clinical experience without reference to any of the foregoing (for example, argument from physiology, bench research or first principles).

RESULTS

Description of studies

Included studies

We considered 52 studies for inclusion in this review. We excluded 36 due to either study design, participants, intervention, outcome measures or insufficient data reporting (see 'Characteristics of excluded studies'). Two conference abstracts ([Ahmad 2000](#); [Pickering 2000](#)) were considered as potentially eligible, but full reports were not available (see 'Studies awaiting assessment'). Fourteen published trials were RCTs and investigated the effect of physiotherapy in the management of patients with AS ([Altan 2006](#); [Analay 2003](#); [Codish 2005](#); [D'Las Peñas 2005](#); [D'Las Peñas b2005](#); [Helliwell 1996](#); [Hidding 1993](#); [Hidding 1994](#); [Ince 2006](#); [Kraag 1990](#); [Kraag 1994](#); [Lim 2005](#); [Sweeney 2002](#); [Van Tubergen 2001](#)). However, two of these were cross-over or follow-up studies that did not provide independent results and were consequently excluded from the review ([Hidding 1994](#); [Kraag 1994](#)). Eleven trials were included in the review. In addition, we have included results from one follow-up study ([D'Las Peñas b2005](#)). The studies were undertaken in Canada ([Kraag 1990](#)), the Netherlands ([Hidding A 1993](#)), United Kingdom ([Helliwell 1996](#); [Sweeney 2002](#)), Austria,

Germany and Netherlands ([Van Tubergen 2001](#)), Turkey ([Altan 2006](#); [Analay 2003](#); [Ince 2006](#)), Republic of Korea ([Lim 2005](#)), Israel ([Codish 2005](#)) and Spain ([D'Las Peñas 2005](#)).

Participants

[Kraag 1990](#) included 53 patients; 79% were men. The patients were stratified according to age: 18 to 35 years, and 36 years and over. The exclusion criteria were patients with reduced hip flexion and patients receiving contravening treatment.

[Hidding 1993](#) included 144 patients, aged between 17 and 69 years; 76% were men. Patients were excluded if they were unable to engage in physiotherapy for any reason.

[Helliwell 1996](#) conducted a study of 44 patients; 89% were men. Mean age in the inpatient, outpatient and home exercise groups were 39, 43 and 42 years respectively. The participants were stratified into two levels of disease severity. Patients were excluded if they had severe peripheral joint involvement which made them unable to exercise.

[Van Tubergen 2001](#) included a total of 120 patients in their trial. Mean ages in the two spa-exercise groups were 48 and 49 years, and in the control group, 48 years. In the two spa-exercise groups, the proportion of men was 67% and 70% respectively, while the control group included 85% men. The exclusion criteria were unwillingness to participate in weekly group physical therapy, pregnancy, claustrophobia, severe co-morbidity and patients having AS for more than 20 years.

In the study of [Sweeney 2002](#), 155 patients between 16 and 65 years participated, 68% men in the intervention group and 66% men in the control group. Exclusion criteria were not described.

[Analay 2003](#) conducted a study of 45 patients aged between 18 and 55 years. Mean age was 38 years in the intervention group and 34 years in the control group. The proportion of men was 87% in the intervention group and 82% in the control group. The participants fulfilled the AMOR criteria for spondylarthropathies, which were considered equal to the New York criteria ([Amor 1991](#)). Patients were excluded if they had systemic organ involvement, hip or knee deformities, had been treated by a physiotherapist within the last three months, were practising regular exercises or were receiving disease-modifying anti-rheumatic drugs (DMARDs). Three studies were published in 2005. [Codish 2005](#) conducted a study with 28 participants (93% men); the inclusion criteria were fulfilling NY criteria and back pain last three months prior to enrollment. Patients were excluded if they had concomitant psoriasis, other seronegative SpA, malignancies, equilibrium disturbances, mental disorders or active non-inflammatory spinal disease.

A study from Spain ([D'Las Peñas 2005](#)) included 40 AS patients fulfilling NY criteria, 78% men, mean age 45.5 years. Patients were excluded if they were in functional class level IV, had comorbidity or osteoporosis.

In the Republic of Korea, a study including 50 participants, 78% men and mean age 28 years, was carried out ([Lim 2005](#)). The patients were included if they had been out of regular exercising previous six months, had no complications, no changes in current medication and were classified in the functional class II for AS.

Two studies were carried out in Turkey in 2006. [Ince 2006](#) included 30 participants, mean age 35 years and 60% men. Inclusion and

exclusion criteria not described, but the included patients fulfilled the NY criteria, and Altan 2006 included 54 patients, details not reported.

Comparisons and interventions

Four studies compared physiotherapy interventions with no intervention (Ince 2006; Kraag 1990; Lim 2005; Sweeney 2002), and seven studies compared different modalities or applications of physiotherapy (Altan 2006; Analay 2003; Codish 2005; D'Las Peñas 2005; Helliwell 1996; Hidding 1993; Van Tubergen 2001).

Exercises were the main experimental treatment in all trials, although other physiotherapy modalities were reported as 'occasionally used' (Helliwell 1996; Kraag 1990).

Kraag 1990 compared a four-month home exercise and educational program (supervised, one-to-one design) with no intervention. The educational program was not described but the treatment objectives were disease education, pain control and improved posture and function.

The group exercise program in the study of Hidding 1993 consisted of one hour physical training, one hour sporting activity and one hour hydrotherapy. The intervention period was nine months, and the intervention was compared to an individualised home exercise program.

The participants in the study of Helliwell 1996 were randomised into three groups: firstly an inpatient group receiving a three-week program, including one hour group exercise five days a week and, in addition, hydrotherapy three times per week; secondly, an outpatient hydrotherapy and home exercise group; and finally, a group doing individualised home exercises. The analyses in this review did not include the outpatient hydrotherapy group. Thus, the three weeks inpatient intervention program was compared to the individualised home exercise intervention.

Van Tubergen 2001 investigated the efficacy of combined spa-exercise therapy in addition to standard treatment with drugs and weekly group physiotherapy. The spa-exercise interventions were provided in two groups, one group treated in a spa resort in Austria and one in The Netherlands. These two groups were considered clinically similar and were combined for analytical purposes in this review. The three week spa-exercise therapy consisted of group physical exercises, walking, correction therapy (lying supine), hydrotherapy, sports and sauna. A control group stayed home and followed weekly group physiotherapy sessions. After the intervention period, all patients from the three groups engaged in weekly group physiotherapy sessions for another 37-week follow-up period.

Sweeney 2002 compared the effect of a six-month home-based exercise intervention package with a non-intervention control group. The intervention consisted of an exercise/information video, exercise progress chart, patient education booklet and exercise reminder stickers.

In the study of Analay 2003, a group of patients was included in a six-week intensive, supervised physiotherapy program. The exercise program included stretching, mobilization and strengthening exercises, aerobic exercises and postural and respiratory exercises; this intervention was compared to an individualised home exercise program.

All interventions in all studies were delivered by physiotherapists.

Codish 2005 compared two groups exposed to the climate carried out a study at the Dead Sea area; one was combined with balneotherapy and the other with access to fresh water pool.

In the study of D'Las Peñas 2005, two different exercise programs were compared, an "experimental" program versus a "conventional" program, both applied for 60 minutes once a week, 15 sessions over four months. The experimental program addressed the postural affection of AS, focusing on the shortened muscle chains according to the Global Posture Reeducation method.

Lim 2005 compared the effect of an individual 30-minute exercise program per day for eight weeks with a group of wait-list controls, and Ince 2006 compared a group doing a multimodal supervised exercise program 50 minutes three days per week for three months with a no-intervention group.

Outcomes

In eight studies, pain was measured with a VAS-scale (0 to 10 cm), and in one study (Sweeney 2002) with a self-efficacy scale (1 to 10 cm). Helliwell 1996 combined the scores of pain and stiffness to produce one assessment (two VAS scales added giving a maximum score of 200); Hidding 1993 measured stiffness on a separate VAS scale (0 to 10 cm). Altan 2006, Analay 2003, Kraag 1990, and Van Tubergen 2001 reported the duration of morning stiffness in minutes; the other studies did not measure stiffness.

Spinal mobility was measured in eight studies. Altan 2006, Analay 2003, Kraag 1990 and Lim 2005 measured the patient's distance from fingertip to floor (FFD) in maximal flexed position (in cm). Hidding 1993 assessed the thoracolumbar flexion and extension using the 10 cm segment method (Miller) while Altan 2006, Analay 2003, Helliwell 1996, Ince 2006 and Kraag 1990 used the Modified Schober's test (cm). The chest expansion was measured in cm by Altan 2006, Analay 2003 and Helliwell 1996, and cervical rotation was reported in degrees by Helliwell 1996 and Hidding 1993. Tragus or occiput to wall and chin-to-chest distance were included in the studies of Altan 2006, Analay 2003 and Ince 2006.

Physical functioning and health status were assessed by the Health Assessment Questionnaire for the Spondylarthropathies (HAQ-S: 0 to 3, 3 worst score) and the Functional Index (FI: 0 to 2, 2 worst score) in the study of Hidding 1993. Altan 2006, D'Las Peñas 2005, Lim 2005, Sweeney 2002 and Van Tubergen 2001 measured self-reported physical functioning by the Bath Ankylosing Spondylitis Functioning Index (BASFI: VAS scales 0 to 10 cm, 10 worst score). The other studies did not include physical function.

Patient global assessment was reported by Altan 2006, Hidding 1993, Sweeney 2002 and Van Tubergen 2001.

Points of assessment varied in the studies. In Helliwell 1996, assessment points were two times prior to intervention, immediately after completing treatment, and two, four and six months after cessation of treatment. Hidding 1993 evaluated the participants at baseline and subsequently every third month up to nine months. Kraag 1990 evaluated the patients at baseline and after the four-month intervention period; Sweeney 2002 at baseline and after the six-month intervention period; and Analay 2003 at baseline, after the six-week intervention period and at

three months. In the study of [Van Tubergen 2001](#), the points of assessment were baseline (two weeks before spa-exercise therapy) and at one, four, seven and ten months after the start of the spa-exercise therapy. [Altan 2006](#) evaluated after the three-week intervention period and after three months, [Ince 2006](#) only after three months, and [Codish 2005](#) after treatment and at four and 12 weeks. [Lim 2005](#) measured the participants after the eight-week exercise period and [D'Las Peñas 2005](#) published results from after treatment, six and twelve months.

Risk of bias in included studies

Four of the included studies met the **concealment of allocation criteria** ([Analay 2003](#); [D'Las Peñas 2005](#); [Hidding 1993](#); [Van Tubergen 2001](#)). In the other studies, the randomization procedure did not meet the quality criteria or the description of the procedure was not clear.

Co-interventions in the trials were adequately reported by [Altan 2006](#), [D'Las Peñas 2005](#), [Hidding 1993](#), [Kraag 1990](#) and [Van Tubergen 2001](#). These studies met the criterion for avoiding performance bias, the other studies did not report if co-interventions were avoided or comparable in the groups.

Exclusions or losses to follow up were less than 20% in seven studies ([Altan 2006](#); [Analay 2003](#); [Codish 2005](#); [D'Las Peñas 2005](#); [Hidding 1993](#); [Kraag 1990](#); [Van Tubergen 2001](#)). In the other studies, losses to follow up were either too large or insufficiently reported.

In eight of the studies, the **assessor was unaware of the assigned treatment** when collecting outcome measures ([Altan 2006](#); [Analay 2003](#); [D'Las Peñas 2005](#); [Hidding 1993](#); [Ince 2006](#); [Kraag 1990](#); [Lim 2005](#); [Van Tubergen 2001](#)). The others did not meet the criterion for avoiding detection bias or were rated as unclear on this criterion. **Blinding of patients** was not met in any studies.

The overall assessment of the methodological quality of the trials in this review was as follows: Three studies ([D'Las Peñas 2005](#); [Hidding 1993](#); [Van Tubergen 2001](#)) met four of five criteria of internal validity and were rated to have low risk of bias. Three studies ([Altan 2006](#); [Analay 2003](#); [Kraag 1990](#)) met three criteria and were assessed to have moderate risk of bias. Five studies met fewer than three criteria, and were assessed to have high risk of bias ([Codish 2005](#); [Helliwell 1996](#); [Ince 2006](#); [Lim 2005](#); [Sweeney 2002](#)) (see table 'Characteristics of included studies').

Baseline comparability

Even if [Helliwell 1996](#) stratified the participants into two disease severity groups before randomisation, the treatment groups varied in proportion of patients in each severity group, resulting in different baseline values. In the study of [Hidding 1993](#), there were no relevant differences between the study groups at baseline. In the study of [Kraag 1990](#), the initial measurements of the groups were comparable except for one variable; the control group reported significantly more rib cage pain and stiffness than the experimental group. In the study of [Sweeney 2002](#), the groups were comparable at baseline. [Analay 2003](#) found the groups comparable at baseline in all parameters except for Modified Schober. In [Van Tubergen 2001](#), relatively more men than women were allocated to the control group than to the intervention groups; remaining characteristics were balanced among the groups.

In the study of [Altan 2006](#), the control group reported significantly longer lasting morning stiffness, whereas the other parameters were comparable at baseline. The authors reported no significant differences in the baseline values in the study of [Codish 2005](#), [D'Las Peñas 2005](#), [Ince 2006](#) and [Lim 2005](#). However, although statistically comparable baseline values were reported, there was considerable imbalance for some measures.

Effects of interventions

Eleven trials with a total of 763 participants were included in this updated review, as compared to six trials and 561 participants in the previous version. Four studies compared physiotherapy interventions with no intervention (Main comparison 1) ([Ince 2006](#); [Kraag 1990](#); [Lim 2005](#); [Sweeney 2002](#)). Seven studies compared different modalities or applications of physiotherapy (Main comparison 2) ([Altan 2006](#); [Analay 2003](#); [Codish 2005](#); [D'Las Peñas 2005](#); [Helliwell 1996](#); [Hidding 1993](#); [Van Tubergen 2001](#)).

Main comparison 1 - physiotherapy versus other treatment (including no treatment)

Three trials comparing home exercise and educational programs with no intervention were included ([Kraag 1990](#); [Lim 2005](#); [Sweeney 2002](#)). One of the studies was assessed to have moderate risk of bias ([Kraag 1990](#)) and two to have high risk of bias ([Lim 2005](#); [Sweeney 2002](#)). One trial, with high risk of bias, examined the effects of a 12-week, multimodal exercise program compared to no intervention ([Ince 2006](#)).

Pain

In the study of [Kraag 1990](#), no significant differences between the groups were found in pain reduction from baseline to four months. In the study of [Sweeney 2002](#), a small but significant difference was found in favour of the intervention group (Weighted Mean Difference (WMD) 0.56; 95% CI 0.2 to 0.9). The relative percentage difference (RPD) was 2% ([Table 1](#)). Exact point estimates are not reported in the study of [Lim 2005](#), but a significant difference in favour of the exercise group was reported for VAS pain ($p < 0.0001$). [Ince 2006](#) did not measure pain. Based on these results, we conclude that there is low quality of evidence for a small pain reduction in favour of the individual exercise programs compared to no intervention.

Stiffness

Stiffness was not measured in the studies. However, stiffness is included in the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) score and no group differences were found on the BASDAI in the study of [Sweeney 2002](#).

Spinal mobility

In the study of [Kraag 1990](#), spinal mobility was measured as fingertip-to-floor distance (FFD). After the four-month intervention period, the intervention group had improved significantly compared to the control group ($p < 0.001$). The RPD was estimated at 37% in favour of the intervention group ([Table 2](#)), while no significant difference was found in the Schober test. [Ince 2006](#) reported a significant difference in favour of the exercise group in Schober test (WMD (CI) 1.35 (0.14, 2.56), RPD was 5% ([Table 3](#)). The WMD (CI) for FFD in this study was not significant (3.39 (-14.6, 7.8)), RPD 17% ([Table 3](#)). [Lim 2005](#) reported significantly more improvement on FFD for the exercise group compared to the control group ($p < 0.001$) (insufficient data reporting for recalculation of effects). Further, [Ince 2006](#) reported a significant

difference in favour of exercises for chest expansion (WMD(CI)1.46 (0.29,2.63), RPD 49.7% (Table 3). Significant differences in favour of exercises were also reported for occiput to wall distance (OWD) (WMD(CI) 2.56 (4.9, 0.2) and chin to chest distance (CCD) (WMD (CI) 1.88 (3.1, 0.7), RPD 21% and 32% respectively (Table 3). Sweeney 2002 did not measure spinal mobility. We conclude that there is moderate quality evidence for a positive effect of individual exercise programs, home-based or supervised, on some measures of spinal mobility, when compared to a no-intervention group.

Physical function

Physical function score was significantly better in the experimental group than in the no-intervention group in the study of Kraag 1990 ($p < 0.001$). Average difference after treatment was about four points on a 33-point scale (modified Toronto Activities of Daily Living Questionnaire). Sweeney 2002 reported no significant group difference after six months for self-reported physical function (BASFI), $p = 0.08$, and Ince 2006 did not measure physical function. Lim 2005 reported significantly larger improvement in physical function (BASFI) in the exercise group than in the control group ($p < 0.001$). In conclusion, there is moderate quality evidence for a treatment effect on self-reported physical function when compared to no intervention.

Patient global assessment was not measured in the studies of Ince 2006, Kraag 1990 and Lim 2005. Sweeney 2002 reported no group differences in the Bath AS patient global score (BAS-G). Thus, there is low quality of evidence for no difference between the groups on patient global assessment.

Main comparison 2 - different modalities or applications of physiotherapy

The following subcomparisons were made:

2a) Three trials comparing supervised group physiotherapy (including hydrotherapy) with home exercise regimes were included in this comparison. One trial was assessed to have low risk of bias (Hidding 1993), one to have moderate risk (Analay 2003), and one to have high risk of bias (Helliwell 1996).

2b) One trial (low risk of bias) comparing the effectiveness of spa therapy with weekly group physiotherapy was included (Van Tubergen 2001).

2c) One trial (moderate risk of bias) comparing the effectiveness of balneotherapy and exercises with exercises alone was included (Altan 2006).

2d) One trial (high risk of bias) comparing the effectiveness balneotherapy with fresh water therapy (Codish 2005) was included.

2e) One trial (low risk of bias) comparing an experimental muscle chain exercise program with a conventional program was included (D'Las Peñas 2005).

2a) Supervised group physiotherapy (including hydrotherapy) versus home exercise regimes

Pain

Hidding 1993 found no significant differences in pain between the groups. Analay 2003 measured pain at rest and during activity

and found no significant differences between the groups after treatment or after three months.

Helliwell 1996 combined pain and stiffness in one variable and found a significant difference immediately after treatment (WMD -3.90 cm (95% CI -7.7 to -0.06), RPD 48% (Table 4). However, six months after the intervention there were no significant differences between the three treatment groups regarding pain and stiffness. Thus, it is reasonable to state that there is moderate quality evidence for no difference in pain intensity between the groups.

Stiffness

No significant differences in stiffness were found between the groups after nine months in the study of Hidding 1993. In the study of Analay 2003, duration of morning stiffness in minutes was measured. The authors reported statistically significant improvement after treatment and at three months follow up. However, between-group analyses showed no significant differences at the two measurement points (WMD -16.13; 95% CI -45.22 to 12.96 and -11.50; 95% CI -32.84 to 9.84, respectively). The quality of evidence for no group difference is considered to be moderate.

Spinal mobility

Hidding 1993 found a statistically significant difference for thoracolumbar mobility in favour of the additional group physiotherapy after the nine-month intervention period (WMD(CI) 0.4 cm (0.1,0.7), RPD 7.5% in favour of the supervised group physiotherapy. This group also performed slightly better on the other spinal mobility outcomes, but the results were not statistically significant. Chest expansion and Schober test were measured after treatment in two studies (Analay 2003; Helliwell 1996) and pooled analyses showed no significant differences between the groups for these two measures. A significant difference in Schober test was found between the groups at three months in the study of Analay 2003 with an absolute benefit of 0.6 cm and RPD 18% (Table 5). Furthermore, no difference in cervical rotation between the supervised group program and the home exercise group, after treatment or six months after treatment, was found in the study of Helliwell 1996. In the study of Analay 2003, no difference between the groups was found on FFD or tragus to wall distance (TWD). In conclusion, the quality of evidence for small beneficial effects on some measures of spinal mobility in favour of group physiotherapy is considered to be moderate.

Physical function

Hidding 1993 and Analay 2003 found no significant differences in self-reported physical function measured at nine and three months respectively. The quality of evidence for no group differences is moderate.

Patient global assessment

The supervised group reported significantly better scores on the patient global assessment in the study of Hidding 1993. Mean change difference between the two groups after the nine-month intervention period was 1.46 cm (CI 95% 1.05 to 1.87); RPD was not calculated due to insufficient reporting of baseline data. Patient global assessment was not measured in the studies of Analay 2003 and Helliwell 1996. The quality of evidence for a difference in favour of group physiotherapy is considered to be moderate.

2 b) Spa therapy and group physiotherapy versus group physiotherapy alone

One study with low risk of bias was included (Van Tubergen 2001). The two spa-exercise groups were considered clinically similar and thus they were combined to perform one group (intervention group: IG) which was compared to weekly group physiotherapy alone (control group: CG). The authors expressed the primary outcomes (BASFI, BAS-G, pain intensity and morning stiffness) as a pooled index of change (PIC). Both the pooled index and the individual variables were reported.

Pain

Significant effects of the spa-exercise intervention were found regarding pain. At one month WMD was -1.07 (CI 95% -2.02 to -0.12), and at four months WMD was -1.09 (CI 95% -2.04 to -0.14). Absolute benefit at one and four months was 0.9 cm and RPD 18% in favour of the spa-exercise group (Table 6). After seven months, the authors still reported a significant difference between the IG and the CG on a pooled index (PIC). However, no significant differences in pain were found at seven or 10 months when regarded as an individual variable. It may be reasonable to conclude that there is moderate quality evidence for a clinically relevant effect of the spa-exercise intervention on pain.

Stiffness

Stiffness was measured as duration of morning stiffness, in minutes. Significant differences between the spa-exercise groups and the control group were not found. Thus, the quality of evidence for no group differences is moderate.

Spinal mobility

Spinal mobility was not measured in this study.

Physical function

Physical function was measured with BASFI and included in the pooled index of change. Evaluated as a separate variable there was no statistically significant difference between the groups, but the RPD was 24% and 17% at one and four months respectively (Table 7). The quality of evidence for no group differences is moderate.

Patient global assessment

Significant positive effects of the spa-exercise interventions were found for patient global assessment at one month (WMD -0.93; 95% CI -1.78 to -0.09), four months (WMD -0.93; 95% CI -1.84 to -0.02) and seven months (WMD -1.00; CI -2.02 to 0.02). The absolute benefit was 1.3 cm, 1.4 cm and 1.4 cm respectively; the RPD, in favour of the spa-exercise groups, was 27% at one month and 29% at four and seven months (Table 8). At 10 months, no differences between the groups were found. There is moderate quality evidence for a clinically relevant effect in favour of an additional combined spa-exercises course.

2c) Balneotherapy and exercises versus exercises alone

One study with moderate risk of bias was included (Altan 2006).

Pain

No group differences were found for day or night pain, and RPDs of less than 10% were found in all assessment points (Table 9). We concluded that there is low quality evidence for no group differences in pain.

Stiffness

Altan 2006 reported morning stiffness on a 0-3 point scale. No significant group differences were found after treatment or at 24 weeks, thus there is low quality evidence for no group differences regarding morning stiffness.

Spinal mobility

Schober test, FFD, OWD and chest expansion were measured and no significant group differences were found. Thus, we conclude that there is low quality evidence for no effect on spinal mobility.

Physical function

After treatment, the WMD for BASFI was 0.11(ns). The RPDs after treatment and at 24 weeks were 53% and 58%. However, considerable differences in baseline scores might have inflated the RPDs (Table 10). Conclusively, there is low quality evidence for no effect on BASFI.

Patient global assessment

Small, not significant WMDs were found for patients' global evaluation after treatment and at 24 weeks. However, the RPD was 21% after treatment, indicating a possible clinical relevant after treatment effect on this variable (Table 11). Conclusively, low quality evidence for no effect.

2d) Balneotherapy versus fresh water therapy

One study with high risk of bias (Codish 2005) was included.

Pain

No significant group differences on pain were reported at any assessment point, thus there is low quality evidence for no effect

Stiffness

Morning stiffness in minutes was reported as a baseline characteristic, but no after treatment results were reported. BASDAI was also included, but did not show group differences, thus there is low quality evidence for no effect.

Spinal mobility

Codish 2005 reported limitation of movement on a VAS scale. No significant WMDs were found, but RPDs 22% (after treatment) and 18% (four and 12 weeks) were calculated (Table 12). We conclude that there is low quality evidence for no group differences regarding mobility.

Physical function and **Patient global assessment** were not reported

2e) An experimental exercise program versus a conventional program

One study with low risk of bias (D'Las Peñas 2005) was included.

Pain

D'Las Peñas 2005 did not include a separate pain measure; BASDAI was used, but no group differences were found at any assessment point.

Stiffness was not measured

Spinal mobility

The elements of BASMI (Schober test, lumbar side flexion, intermalleolar distance, cervical rotation, TWD) were measured, and no significant group differences were found after treatment or at one year follow up. Some clinical relevant differences were calculated (Table 13), and a comparison of the prepost scores between the two groups shows that the experimental group improved significantly more than the control group in all spinal mobility measures except TWD. We conclude that there is moderate quality evidence for group differences in favour of the experimental exercise group.

Physical function

There was no significant WMD for BASFI at any assessment point. However, an intergroup comparison between the improvement (prepost change scores) showed that the experimental group improved significantly more, and we conclude that there is moderate quality evidence for beneficial effect on BASFI in favour of the experimental exercise program compared to the conventional program.

Patient global assessment was not measured.

DISCUSSION

Eleven studies met the inclusion criteria of this review, with a total of 763 patients with AS. Three of the studies were assessed to have low risk of bias, three studies were assessed to have moderate, and five to have high risk of bias. We can conclude from this review that patients with AS have some beneficial effects from individualised home exercise programs compared to no intervention. Furthermore, supervised group physiotherapy programs are slightly better than individualised home exercise regimes, and a three-week combined spa-exercise intervention is better than weekly group physiotherapy alone. An experimental chain muscle exercise program showed larger improvement than a conventional exercise program. For the remaining studies comparing different modalities/programs or applications of physiotherapy, improvements were found for all programs from baseline to after treatment, but no between-group differences were reported.

Most of the studies in this review included more than 70% men. Since AS seems to affect men and women differently (Dagfinrud 2005; Lee 2007), it is important to underline that the applicability of the results to women may be limited. Further, the exclusion criteria in the studies included use of DMARDs, patients with peripheral joint involvement, severe co-morbidity and diagnosis of AS more than 20 years ago. Thus, the applicability to severely affected AS patients may also be limited.

The main goal of the trials in this review was to study the effectiveness of physiotherapy in the management of AS. However, interventions are often poorly described, different types of exercises and training doses are used and the expected physiological responses to the exercise programs are not defined. Consequently, the optimal exercise program for patients with AS can still not be determined. Another problem related to the external validity is the use of unavailable interventions, such as treatment programs in spa resorts or at the Dead Sea area. Although spa-exercise interventions have shown favourable cost-effectiveness and cost-utility ratios compared to self-exercising and group exercising (Van Tubergen 2002), spa resorts and Dead Sea

climate are not easily available in many parts of the world and the generalisability of the results may therefore be limited.

In order to improve the clinical relevance of the review, relative percentage differences (RPD) were calculated when possible. According to the Philadelphia Panel, an improvement of 15% relative to a control group can be considered as clinically relevant (Philadelphia Panel). For several outcomes, clinically relevant differences were found, even if they were not statistically significant. However, the calculation of RPD is based on the difference between the change scores in the two groups, but the variation (standard deviation) of the scores is not taken into consideration, and the RPD must therefore be interpreted with caution, especially in underpowered studies. Further, small sample sizes often result in baseline incomparability, which also complicate correct estimation of benefit.

We employed a systematic and explicit method to indicate the extent to which one can be confident that the effect estimates were correct (Grade Working Group); assessments of the quality of evidence were done for each comparison and outcome. By considering study design, study quality, similarity of estimates of effect across studies and directness (the extent to which people, interventions and outcome measures are similar to those of interest) we found that the quality of evidence for the comparisons in this review was either moderate or low. Thus, further research is recommended to confirm these effect estimates.

Some of the trials compared therapeutic exercises applied in group settings to exercises performed individually. Thus, the comparisons may provide information on the effect of the group setting rather than the effect of the specific content of the exercise programs. The fact that the patients who participated in groups improved more than the patients who did exercises on their own may be ascribed to the contribution of non-physical factors, such as mutual encouragement, increased motivation and exchange of experiences with fellow sufferers. These are important factors for the total well-being, but do not give evidence to decide the most appropriate and effective exercise program.

Although the RCT is considered to be the best design, the random allocation of patients may lead to reduced effectiveness of the interventions in physiotherapy studies. Physiotherapy interventions are often time consuming and compliance is dependent on motivated patients. Helliwell 1996 addressed this problem, considering that the great number of drop-outs in their study may have been due to lack of motivation and a time-consuming treatment program which the patients had not chosen. Further, when using intention-to-treat analyses, the non-compliers may influence the treatment effects negatively. Due to these challenges, researchers tend to compare active and quite similar interventions in order to avoid poor recruitment or non-compliance. In this review, comparing different modalities or applications of exercise programs resulted in improvement for both groups, but between-group differences could not be proved. Comparing two active and similar interventions diminish the contrast between them, thus, the 11 included RCTs with more than 700 patients give a disproportionately small amount of new knowledge on the effectiveness of physiotherapy interventions for AS.

The effects of exercises are determined by mode, frequency, intensity, duration and, not least, adherence to the program

(Herbert 2005). In order to contribute with new knowledge, future trials should report more thoroughly on these issues.

The recently published evidence-based recommendations for the management of AS conclude that optimal management requires a combination of non-pharmacological and pharmacological treatments, and that the non-pharmacological treatment should include patient education and regular exercise (Zochling 2006). This statements are reinforced in a study of experts' beliefs, where physiotherapy is considered to be indicated for early AS (by 88% of the experts) and for AS of longer duration (by 94% of the experts), implying that physiotherapy should be prescribed to AS patients (Mihai 2005). Thus, even if the evidence base for exercises as shown in the present review is relatively weak, there seems to be agreement among clinicians and experts that exercises is a cornerstone in the management of AS.

AUTHORS' CONCLUSIONS

Implications for practice

The results of this review give low quality evidence for beneficial effects of exercise program compared to no intervention, and moderate evidence for benefits of supervised group physiotherapy compared to individualised home programs. A combined spa-exercise and group physiotherapy program was more effective than only group physiotherapy in the management of AS, and an experimental muscle chain exercise program might be better than conventional exercises. However, it must be emphasised that small numbers of participants, heterogeneous interventions and outcome measures, together with deficient reporting of data in these studies do not provide strong evidence.

No randomised trials investigating relevant physiotherapy interventions other than exercise programs were found through this systematic search strategy. To improve practice and decision making, it is important to conduct trials examining different modes, frequency, intensity, duration and adherence of the exercise programs. Further, trials investigating other commonly used physiotherapy approaches such as different hands-on techniques and specific education and information programs are still lacking. Accordingly, we still do not know which particular treatment protocol to be recommended in the management of AS.

Implications for research

More trials are needed in this field. Other commonly used physiotherapy interventions (e.g. different hands-on techniques such as manual therapy, electrotherapy, information and education programs) should be investigated. New trials should compare different treatment and exercise programs and aspire to provide an accurate description of the content, dose, application and adherence to the interventions.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies [ordered by study ID]

Altan 2006

Methods	Concealment of allocation: UNCLEAR Co-intervention: MET Exclusions or losses to follow up: MET Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in Turkey, included 54 participants, age and gender not reported
Interventions	Group 1: outpatient balneotherapy, 30 min once a day for 3 weeks + exercise program 30 min pr day Group 2: 30 min exercise program pr day
Outcomes	Daily and night pain, morning stiffness, patients global, physician global, BASDAI, BASFI, DFI, tragus-wall, chest expansion, mod Schober, finger-tip-fibula distance, NHP Points of assessment: after treatment and 24 weeks
Notes	
Risk of bias	
Bias	Authors' judgement Support for judgement

Physiotherapy interventions for ankylosing spondylitis (Review)

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Altan 2006 (Continued)

Allocation concealment? Unclear risk B - Unclear

Analay 2003

Methods	Concealment of allocation: MET Co-intervention: UNCLEAR Exclusions or losses to follow up: MET Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in Turkey, included 45 participants, aged between 18 and 55 years, 84% men. Inclusion criteria: AMOR criteria, able to participate in exercise group Exclusion criteria: systemic organic involvement, hip and knee deformities, treated by physiotherapy last three months or practising regular exercises, receiving DMARDS
Interventions	Group 1: Intensive exercise program, 6 weeks, 3 days pr week, supervised. Group 2: The control group was encouraged to practice an individualised home exercise program 3 days pr week for 6 weeks. They were called by phone every week.
Outcomes	Pain at rest and during activity (VAS), duration of morning stiffness. Anthopometric measures: chest expansion, tragus-to-wall-distance, Schober's test, finger-tip-to-floor-distance, intermalleolar distance Physical condition: Aastrand test Psychosocial measure: Beck Depression Scale Points of assessment: baseline, after treatment and 3 months after treatment
Notes	The exercise program included stretching, mobilization and strengthening exercises, aerobic exercises and postural and respiratory exercises

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Codish 2005

Methods	Concealment of allocation: UNCLEAR Co-intervention: UNCLEAR Exclusions or losses to follow-up: MET Outcome assessment: UNCLEAR Blinding of patients: NOT MET
Participants	The study was carried out at the Dead Sea area, included 28 participants, 93% men. Inclusion criteria: fulfilling NY criteria, back pain last months prior to enrollment Exclusion criteria: concomitant psoriasis, other seroneg. SpA, malignacies, equilibrium disturbances, mental disorders, active noninflammatory spinal disease
Interventions	Group 1: balneotherapy + exposure to climatic conditions, 6 days pr week, 2 weeks

Codish 2005 (Continued)

Group 2: fresh water pool + exposure to climatic conditions

Outcomes	Well-being, BASDAI, pain VAS, limitation of movement VAS. Points of assessment: prior to arrival at Dead Sea, last day at Dead Sea, 1 and 3 months after end of treatment.	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

D'Las Peñas 2005

Methods	Concealment of allocation: MET Co-intervention: MET Exclusions or losses to follow-up: UNCLEAR Outcome assessment: MET Blinding of patients: NOT MET	
Participants	The study was carried out in Spain, included 40 participants, 78% men, mean age 45.5 years. Inclusion criteria: NY criteria Exclusion criteria: functional class level IV, comorbidity, osteoporosis	
Interventions	Group 1: "experimental" muscle chain exercise program, 60 min/once a week/15 sessions/4 months Group 2: "conventional" program, same procedure as group 1	
Outcomes	BASMI, BASFI, BASDAI Points of assessment: baseline (pretreatment) and at end of 15 sessions (posttreatment)	
Notes		
<i>Risk of bias</i>		
Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Helliwell 1996

Methods	Concealment of allocation: NOT MET Co-intervention: UNCLEAR Exclusions or losses to follow-up: NOT MET Outcome assessment: NOT MET Blinding of patients: NOT MET	
Participants	The study was carried out in the UK, included 44 participants with a mean age 38.9 years, 89% men. Inclusion criteria: Fulfilling the New York criteria	

Helliwell 1996 (Continued)

Exclusion criteria:
participated in inpatient program within last year, peripheral joint involvement, unable to exercise.

Participants were divided into two disease severity groups (A and B, group B including patients with most severe disease) on the basis of anthropometric measures

Interventions	Group 1: inpatient, supervised group physiotherapy: 1 hour, 5 days pr week, 3 weeks + hydrotherapy 3 times pr week Group 2: outpatient hydrotherapy and home-exercise: 2 times pr week , 6 weeks Group 3: Home exercises: 6 weeks home exercise regime
Outcomes	1. Anthropometric measures: cervical rotation, chest expansion, Schober test 2. Subjective scores: Pain and stiffness (combined, VAS) Points of assessment: two times prior to treatment, after treatment, 2, 4 and 6 months after treatment
Notes	Group 1: + occasionally massage and interference, included nine patients in severity group A and six patients in group B. Group 2: hydrotherapy + home exercise program, included 12 patients in severity group A and 3 in group B Group 3: included 9 patients in severity group A and 5 in group B

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	High risk	C - Inadequate

Hidding 1993

Methods	Concealment of allocation: MET Co-intervention: MET Exclusions or losses to follow-up: MET Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in the Netherlands, included 144 participants, aged between 17 and 69 years, 76% men. Inclusion criteria: Fulfilling the New York criteria + one or more of the following features: Pain, stiffness or functional limitation last 3 months. Exclusion criteria: Hip replacement, BP > 100mmHg at rest, pregnancy
Interventions	Group 1: Home-exercise program, the participants were encouraged to exercise for 30 minutes daily for 9 months. Group 2: The home exercise program + supervised group once a week, 9 months.
Outcomes	1: Spinal mobility: Thoraco-lumbar flexion (Miller method), cervical rotation 2: Physical fitness: Max work capacity, bicycle ergometer 3: Functioning or health status: Sickness Impact Profile, Health Assessment Questionnaire for Spondy-larthropathies, Functional Index 4: Patient global assessment of wellbeing (VAS) Points of assessments: baseline and subsequently every 3 months up to 9 months

Hidding 1993 (Continued)

Notes	The exercise program focus on hip joints, peripheral joints and the entire spinal column. The group exercise program consisted of: 1hour physical training, 1 hour sporting activity, 1 hour hydrotherapy
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Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Ince 2006

Methods	Concealment of allocation: UNCLEAR Co-intervention: UNCLEAR Exclusions or losses to follow-up: UNCLEAR Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in Turkey, included 30 participants, mean age 35 years, 60% men. Inclusion criteria: not described. Participants fulfills NY criteria Exclusion criteria: not described
Interventions	Group 1: multimodal supervised exercise program, 50 min/3days pr week/3 months. Group 2: no intervention
Outcomes	Chest expansion, chin-to-chest distance, mod. Schober, occ-to-wall distance. Inclinator: gross hip flexion, gross lumbar and thoracic flexion. Vital capacity, work capacity. Points of assessments: baseline and after treatment (3 months)

Notes

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Kraag 1990

Methods	Concealment of allocation: UNCLEAR Co-intervention: MET Exclusions or losses to follow-up: MET Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in Canada, included 53 participants between 19-73 years, 79% men. The participants were divided into two age groups: 18-35 years (n = 27) and 36 or over (n = 26). Inclusion criteria: Fulfilling the New York criteria + stable clinical status and drug therapy, absence of corticosteroid therapy for at least 3 months and immunosuppressive therapy for at least 6 months

Physiotherapy interventions for ankylosing spondylitis (Review)

Kraag 1990 (Continued)

Exclusion criteria:
patients with more than 10% loss of hip flexion+ contravening treatment

Interventions	Group 1: Home program, disease information and exercises. Planned visits 8-16 during the intervention period of 4 months Group 2: no intervention
Outcomes	Main outcome: FFD Secondary outcomes: the Toronto Activities of Daily Living Questionnaire, occiput-wall-distance, Schober test, pain (VAS), morning stiffness and sleep pattern. Points of assessment: baseline and after intervention (4 months).
Notes	The treatment objectives were: disease education, pain control, improved posture and function.

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Lim 2005

Methods	Concealment of allocation: UNCLEAR Co-intervention: UNCLEAR Exclusions or losses to follow-up: MET Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in Republic of Korea, included 50 participants, mean age 28 years, 78% men. Inclusion criteria: outpatient without complications, lack of regular exercise previous 6 months, able to understand questionnaires, no changes in current medication, classified in the functional class II for AS Exclusion criteria: not described
Interventions	Group 1: exercise program, 30 min pr day/8 weeks Group 2: no intervention, wait-list controls
Outcomes	Joint mobility: FFD, cervical flexion, extension, shoulder flexion, hip abduction, knee flexion. BASFI, pain VAS, Beck Depression Inventory Points of assessments: baseline and after 8 weeks intervention
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Sweeney 2002

Methods	Concealment of allocation: UNCLEAR Co-intervention: UNCLEAR Exclusions or losses to follow-up: NOT MET Outcome assessment: UNCLEAR Blinding of patients: NOT MET
Participants	The study was carried out in the UK, included 155 participants aged between 16-65 years, 67% men. Inclusion criteria: members of the National AS Society or outpatients of the Royal National Hospital for Rheumatic Diseases Exclusion criteria: not described
Interventions	Group 1: home-based intervention, exercise and educational program delivered by mail, 30 min, 6 months Group 2: no intervention
Outcomes	Physical function (BASFI), disease activity (BASDAI), global well-being (BAS-G), exercise self efficacy (ESE), arthritis self efficacy (SES), quantity of AS exercise Points of assessment: baseline and after intervention (6 months)
Notes	The mailed package included: video, educational booklet, exercise progress wall chart and exercise reminder stickers

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Van Tubergen 2001

Methods	Concealment of allocation: MET Co-intervention: MET Exclusions or losses to follow up: MET Outcome assessment: MET Blinding of patients: NOT MET
Participants	The study was carried out in The Netherlands, Germany and Austria, included 120 participants (3 groups of 40). Group 1 included 67% men, mean (SD) age in the group was 48 (10), group 2 included 70% men, mean (SD) age 49 (9) and group 3 (control group) included 85% men, and the mean (SD) age in the group was 48 (10). Inclusion criteria: fulfilling the New York criteria, pain and stiffness or functional limitations for at least 3 months before entry and being able to stay away from home and work for 3 weeks Exclusion criteria: inability or unwillingness to participate in weekly group physical therapy, pregnancy, claustrophobia, severe comorbidity and/or AS for more than 20 years
Interventions	Group 1: Spa- exercise therapy Austria Group 2: Spa-exercise therapy Netherlands, 3 weeks Group 3: staying home receiving weekly physiotherapy and drug treatment as usual. Weekly group physiotherapy consisted of 1 hour exercises, 1 hour sports and 1 hour hydrotherapy. After the intervention period, all patients from the 3 groups engaged in weekly group physiotherapy sessions for another 37 weeks follow-up period

Van Tubergen 2001 (Continued)

Outcomes	Main outcomes: Physical function (BASFI), pain, duration of morning stiffness, aggregated in a pooled index (PIC) Secondary outcomes: disease activity (BASDAI), general health and functioning (HAQ-S), night pain, quality of life (ASQoL), intake of NSAIDs. Points of assessment: baseline (2 weeks before spa therapy) and 1, 4, 7 and 10 months after start of spa-exercise therapy
Notes	The standardised spa-exercise therapy consisted of group physical exercises, walking, correction therapy (lying supine), hydrotherapy, sports and sauna

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Abbreviations:

BASDAI: Bath Ankylosing Disease Activity Index

BASFI: Bath Ankylosing Functional Index

BASMI: Bath Ankylosing Meterology Index

BAS-G: Bath Ankylosing Patient Global Score

VAS: visual analogue scale

FFD: fingertip to floor distance

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Ammer 1997	A systematic review of physiotherapy spondylarthropathies. The criteria of study design not met.
Backlund, 1998	A five-year follow-up study on spinal mobility in AS patients, independent of interventions. The criteria of intervention and study design not met.
Bakker et al 1994	A study of cost effectiveness of supervised group physiotherapy. Based on data from an included RCT (Hidding 1993)
Band 1997	A pre-post study of an inpatient management program, the criteria of study design not met.
Bender 2005	A review of the use of water for medical treatment, study design and participants not met.
Bulstrode 1986	A controlled pre-post study of the effect of daily passive stretching of the hip-joint. The criteria of study design not met.
D'Las Peñas c2005	A middle term follow-up study. Control group data not reported.
Falkenbach 2003	A cross-sectional, retrospective study of exercise habits. The criteria of intervention and study design not met.
Fisher 1990	The objective was to establish the relation between restriction of chest expansion, lung function and work capacity. The criteria of intervention and study design not met.
Gall 1994	A review of effects of exercise in AS. The criteria of study design not met.
Hafstrom 2003	A pre-post study of physiotherapy in subtropic climate. The criteria of participants and study design not met.

Study	Reason for exclusion
Heikkila 2000	Based on data from Viitanen 1995. The criteria of study design not met.
Hidding 1994	A follow-up study of an included RCT (Hidding 1993)
Hidding 1995	A study of the effect of group physiotherapy. Pre-post design, the criteria of study design not met.
Hider 2002	A study of the effect of exercising on body image. The criteria of outcome measures and study design not met.
Horslev-Petersen 1985	A long-term study of the effect of exercises. The criteria of study design not met.
Kraag 1994	A follow-up study of an included RCT (Kraag 1990).
O'Driscoll 1978	A study of effect of an inpatient program on neck mobility. The criteria of study design not met.
Rasmussen 1989	A description of a training program and preliminary results. The criteria of study design not met.
Russell 1992	A pre-post study of physical training. The criteria of study design not met.
Santos 1998	A screening study to evaluate how much exercise AS patients perform on a regular basis. The criteria of intervention and study design not met.
Seckin 2000	A cross-sectional study of the relationship between pulmonary function and exercise tolerance. The criteria of study design and intervention not met.
Stenstrom 1997	A randomised controlled trial, comparing two methods of muscle training in patients with rheumatic diseases. The criteria of participants not met.
Sundstrom 2002	A cross-sectional study of exercise habits, the criteria of study design not met.
Tegelberg 1988	A study of effect of physical training on the stomatognathic system in patients with RA and AS. The criteria of outcome measures not met.
Tegelberg 1996	A follow up of Tegelberg 1988.
Tishler 1995	A pre-post pilot study of the effects of spa therapy. The criteria of study design not met.
Tomlinson 1986	Pre-post study of an inpatient physiotherapy course. The criteria of study design not met.
Uhrin 2000	A prospective, longitudinal study of exercising. The criteria of study design not met.
Van Tubergen 2002	An evaluation of cost effectiveness of a spa-exercise course, based on data from an included RCT (van Tubergen 2001).
Van Tubergen 2002 b	A review on evidence for benefits of physical therapy and spa therapy. The criteria of study design not met.
Viitanen 1992	A retrospective analysis of the efficacy of inpatient physiotherapy, the criteria of study design not met.
Viitanen 1995	A follow-up study of an inpatient physiotherapy program. The criteria of study design not met.
Viitanen 2001	A follow-up study of functional changes before and after an inpatient course. The criteria of study design not met.

Study	Reason for exclusion
Wordsworth 1983	A study of the effect of corticotrophin. Criteria of intervention and study design not met.
Yurtukan M	A comparison of balneotherapy and NSAIDs. The balneotherapy group "had baths for 20 min a day", no exercising added, criteria for intervention not met.

DATA AND ANALYSES

Comparison 1. Individualised home exercise program versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 SES pain (scale not reported) 6 months	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2 Physical function (BASFI), VAS (cm), 6 months	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3 Patient global (BAS-G), VAS (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
4 Self-reported disease activity (BAS-DAI), VAS (cm), 6 months	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only

Analysis 1.1. Comparison 1 Individualised home exercise program versus no intervention, Outcome 1 SES pain (scale not reported) 6 months.

Study or subgroup	Home exerc.		Control		Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
	N	Mean(SD)	N	Mean(SD)			
Sweeney 2002	75	6.8 (1.2)	80	6.2 (1.1)		0%	0.56[0.2,0.92]
					-4 -2 0 2 4		
					Favours control Favours home exerc.		

Analysis 1.2. Comparison 1 Individualised home exercise program versus no intervention, Outcome 2 Physical function (BASFI), VAS (cm), 6 months.

Study or subgroup	Treatment		Control		Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI
	N	Mean(SD)	N	Mean(SD)			
Sweeney 2002	75	3.1 (2.4)	80	3.4 (2.6)		0%	-0.3[-1.09,0.49]
					-4 -2 0 2 4		
					Favours home exerc Favours control		

Analysis 1.3. Comparison 1 Individualised home exercise program versus no intervention, Outcome 3 Patient global (BAS-G), VAS (cm).

Study or subgroup	Home exerc.		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Sweeney 2002	75	3.6 (2.6)	80	3.6 (2.8)		0%	0[-0.85,0.85]
					Favours home exerc.		Favours control

Analysis 1.4. Comparison 1 Individualised home exercise program versus no intervention, Outcome 4 Self-reported disease activity (BASDAI), VAS (cm), 6 months.

Study or subgroup	Home exercise		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Sweeney 2002	75	3.7 (2)	80	3.5 (2.2)		0%	0.2[-0.46,0.86]
					Favours home exer		Favours control

Comparison 2. Supervised exercises versus no intervention

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Chest expansion	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2 Finger-tip-to-floor distance	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3 Occiput to wall distance	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
4 Modified Schober test	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
5 Chin to chest distance	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only

Analysis 2.1. Comparison 2 Supervised exercises versus no intervention, Outcome 1 Chest expansion.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Ince 2006	15	3.2 (1.6)	15	1.8 (1.7)		0%	1.46[0.29,2.63]
					Favours control		Favours treatment

Analysis 2.2. Comparison 2 Supervised exercises versus no intervention, Outcome 2 Finger-tip-to-floor distance.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Ince 2006	15	14.7 (16.6)	15	18.1 (14.7)		0%	-3.39[-14.61,7.83]
					Favours treatment		Favours control

Analysis 2.3. Comparison 2 Supervised exercises versus no intervention, Outcome 3 Occiput to wall distance.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Ince 2006	15	4.2 (3.3)	15	6.8 (3.3)		0%	-2.56[-4.9,-0.22]
					Favours treatment -10 -5 0 5 10 Favours control		

Analysis 2.4. Comparison 2 Supervised exercises versus no intervention, Outcome 4 Modified Schober test.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Ince 2006	15	13.8 (1.6)	15	12.5 (1.8)		0%	1.35[0.14,2.56]
					Favours control -10 -5 0 5 10 Favours treatment		

Analysis 2.5. Comparison 2 Supervised exercises versus no intervention, Outcome 5 Chin to chest distance.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Ince 2006	15	2.5 (1.7)	15	4.4 (1.6)		0%	-1.88[-3.08,-0.68]
					Favours treatment -10 -5 0 5 10 Favours control		

Comparison 3. Group physiotherapy (inpatient) versus individualised home exercises

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain/stiffness, VAS (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 after treatment	1	29	Mean Difference (IV, Fixed, 95% CI)	-3.90 [-7.74, -0.06]
1.2 6 months	1	21	Mean Difference (IV, Fixed, 95% CI)	-3.50 [-9.70, 2.70]
2 Pain at rest, VAS (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 after treatment	1	45	Mean Difference (IV, Fixed, 95% CI)	0.20 [-1.57, 1.97]
2.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	0.20 [-1.45, 1.85]
3 Pain activity, VAS (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 after treatment	1	45	Mean Difference (IV, Fixed, 95% CI)	-0.10 [-1.89, 1.69]
3.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	-1.10 [-2.86, 0.66]
4 Morning stiffness (minutes)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 after treatment	1	45	Mean Difference (IV, Fixed, 95% CI)	-16.13 [-45.22, 12.96]
4.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	-11.5 [-32.84, 9.84]
5 Cervical rotation (degrees)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
5.1 after treatment	1	29	Mean Difference (IV, Fixed, 95% CI)	21.40 [-19.64, 62.44]
5.2 6 months	1	21	Mean Difference (IV, Fixed, 95% CI)	3.60 [-49.29, 56.49]
6 Chest expansion (cm)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
6.1 after treatment	2	74	Mean Difference (IV, Fixed, 95% CI)	0.59 [-0.34, 1.51]
6.2 6 months	1	21	Mean Difference (IV, Fixed, 95% CI)	-0.20 [0.00, 1.60]
7 Schober test (cm)	2		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
7.1 after treatment	2	74	Mean Difference (IV, Fixed, 95% CI)	0.40 [-0.78, 1.59]
7.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	2.0 [0.15, 3.85]
7.3 6 months	1	21	Mean Difference (IV, Fixed, 95% CI)	-0.20 [-1.79, 1.39]
8 Finger tip to floor distance (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
8.1 after treatment	1	45	Mean Difference (IV, Fixed, 95% CI)	-2.63 [-11.80, 6.54]
8.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	-1.85 [-11.09, 7.39]
9 Tragus to wall distance (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
9.1 after treatment	1	45	Mean Difference (IV, Fixed, 95% CI)	-0.79 [-3.34, 1.76]
9.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	-0.24 [-2.92, 2.44]
10 BASFI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 after treatment	1	45	Mean Difference (IV, Fixed, 95% CI)	-7.31 [-18.25, 3.63]
10.2 3 months	1	45	Mean Difference (IV, Fixed, 95% CI)	-4.13 [-14.17, 5.91]

Analysis 3.1. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 1 Pain/stiffness, VAS (cm).

Analysis 3.2. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 2 Pain at rest, VAS (cm).

Analysis 3.3. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 3 Pain activity, VAS (cm).

Analysis 3.4. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 4 Morning stiffness (minutes).

Analysis 3.5. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 5 Cervical rotation (degrees).

Analysis 3.6. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 6 Chest expansion (cm).

Analysis 3.7. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 7 Schober test (cm).

Analysis 3.8. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 8 Finger tip to floor distance (cm).

Analysis 3.9. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 9 Tragus to wall distance (cm).

Analysis 3.10. Comparison 3 Group physiotherapy (inpatient) versus individualised home exercises, Outcome 10 BASFI.

Comparison 4. Spa therapy in addition versus weekly group PT alone

Outcome or sub-group title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain, VAS (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 4 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-1.07 [-2.02, -0.12]
1.2 16 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-1.09 [-2.04, -0.14]
1.3 28 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.55 [-1.58, 0.48]
1.4 40 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.30 [-1.25, 0.65]
2 BASFI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 4 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.62 [-1.43, 0.19]
2.2 16 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.30 [-1.16, 0.56]
2.3 28 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.10 [-0.96, 0.76]
2.4 40 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	0.07 [-0.74, 0.88]
3 Patient global	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 4 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.93 [-1.78, -0.08]
3.2 16 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.93 [-1.84, -0.02]
3.3 28 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-1.00 [-2.02, 0.02]
3.4 40 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.04 [-1.02, 0.94]
4 BASDAI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
4.1 4 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.26 [-1.05, 0.53]
4.2 16 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	-0.59 [-1.40, 0.22]
4.3 28 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	0.14 [-0.59, 0.87]
4.4 40 weeks	1	120	Mean Difference (IV, Fixed, 95% CI)	0.03 [-0.73, 0.79]

Analysis 4.1. Comparison 4 Spa therapy in addition versus weekly group PT alone, Outcome 1 Pain, VAS (cm).

Analysis 4.2. Comparison 4 Spa therapy in addition versus weekly group PT alone, Outcome 2 BASFI.

Analysis 4.3. Comparison 4 Spa therapy in addition versus weekly group PT alone, Outcome 3 Patient global.

Analysis 4.4. Comparison 4 Spa therapy in addition versus weekly group PT alone, Outcome 4 BASDAI.

Comparison 5. Two different exercise programs

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Tragus to wall	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	0.80 [-1.68, 3.28]
1.2 6 months follow-up	0	0	Mean Difference (IV, Fixed, 95% CI)	0.0 [0.0, 0.0]
1.3 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	-0.20 [-2.19, 1.79]
2 Modified Schober	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	-0.30 [-1.05, 0.45]
2.2 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	-0.20 [-0.92, 0.52]
3 Cervical rotation (degrees)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	0.0 [-8.82, 8.82]
3.2 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	-3.0 [-10.54, 4.54]
4 Lumbar side flexion	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	0.10 [-1.48, 1.68]
4.2 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	0.0 [-1.49, 1.49]
5 Intermalleolar distance	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
5.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	2.30 [-3.78, 8.38]
5.2 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	2.0 [-3.40, 7.40]
6 BASFI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
6.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	-0.80 [-13.69, 12.09]
6.2 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	-1.30 [-13.48, 10.88]
7 BASDAI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
7.1 after treatment	1	40	Mean Difference (IV, Fixed, 95% CI)	-0.20 [-6.42, 6.02]
7.2 one year follow up	1	40	Mean Difference (IV, Fixed, 95% CI)	-1.20 [-7.30, 4.90]

Analysis 5.1. Comparison 5 Two different exercise programs, Outcome 1 Tragus to wall.

Analysis 5.2. Comparison 5 Two different exercise programs, Outcome 2 Modified Schober.

Analysis 5.3. Comparison 5 Two different exercise programs, Outcome 3 Cervical rotation (degrees).

Analysis 5.4. Comparison 5 Two different exercise programs, Outcome 4 Lumbar side flexion.

Study or subgroup	Treatment		Control		Mean Difference Fixed, 95% CI	Weight	Mean Difference Fixed, 95% CI			
	N	Mean(SD)	N	Mean(SD)						
Heterogeneity: Not applicable										
Test for overall effect: Not applicable										
Test for subgroup differences: Chi²=0.01, df=1 (P=0.93), I²=0%										
				Favours control	-10	-5	0	5	10	Favours treatment

Analysis 5.5. Comparison 5 Two different exercise programs, Outcome 5 Intermalleolar distance.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
5.5.1 after treatment							
D'Las Peñas 2005	20	90.8 (11.2)	20	88.5 (8.2)		100%	2.3[-3.78,8.38]
Subtotal ***	20		20			100%	2.3[-3.78,8.38]
Heterogeneity: Not applicable							
Test for overall effect: Z=0.74(P=0.46)							
5.5.2 one year follow up							
D'Las Peñas 2005	20	86.8 (10)	20	84.8 (7.2)		100%	2[-3.4,7.4]
Subtotal ***	20		20			100%	2[-3.4,7.4]
Heterogeneity: Not applicable							
Test for overall effect: Z=0.73(P=0.47)							
Test for subgroup differences: Chi²=0.01, df=1 (P=0.94), I²=0%							
					-10 -5 0 5 10		
					Favours control	Favours treatment	

Analysis 5.6. Comparison 5 Two different exercise programs, Outcome 6 BASFI.

Study or subgroup	Treatment		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
5.6.1 after treatment							
D'Las Peñas 2005	20	45.7 (20.6)	20	46.5 (21)		100%	-0.8[-13.69,12.09]
Subtotal ***	20		20			100%	-0.8[-13.69,12.09]
Heterogeneity: Tau²=0; Chi²=0, df=0(P<0.0001); I²=100%							
Test for overall effect: Z=0.12(P=0.9)							
5.6.2 one year follow up							
D'Las Peñas 2005	20	46.7 (19.9)	20	48 (19.4)		100%	-1.3[-13.48,10.88]
Subtotal ***	20		20			100%	-1.3[-13.48,10.88]
Heterogeneity: Tau²=0; Chi²=0, df=0(P<0.0001); I²=100%							
Test for overall effect: Z=0.21(P=0.83)							
Test for subgroup differences: Chi²=0, df=1 (P=0.96), I²=0%							
					-10 -5 0 5 10		
					Favours treatment	Favours control	

Analysis 5.7. Comparison 5 Two different exercise programs, Outcome 7 BASDAI.

Comparison 6. Balneotherapy and exercises versus exercises alone

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain day	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.04 [-0.79, 0.71]
1.2 24 week follow up	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.19 [-0.97, 0.59]
2 Pain night	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	0.03 [-0.82, 0.88]
2.2 24 week follow up	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.16 [-1.14, 0.82]
3 Morning stiffness (0-3)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
3.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.28 [-0.54, -0.02]
3.2 24 week follow up	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.15 [-0.36, 0.06]
4 Patient global evaluation of disease activity (1-5)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
4.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.27 [-0.65, 0.11]
4.2 24 week follow up	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.11 [-0.53, 0.31]
5 Schober test (cm)	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
5.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.05 [-0.83, 0.73]
5.2 24 weeks	1	54	Mean Difference (IV, Fixed, 95% CI)	0.21 [-0.65, 1.07]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
6 Fingertip-to-floor	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
6.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	1.03 [-0.91, 2.97]
6.2 24 weeks	1	54	Mean Difference (IV, Fixed, 95% CI)	0.19 [-1.52, 1.90]
7 Chest expansion	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
7.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.08 [-0.94, 0.78]
7.2 24 weeks	1	54	Mean Difference (IV, Fixed, 95% CI)	0.03 [-0.98, 1.04]
8 Occiput Wall distance	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
8.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.37 [-2.83, 2.09]
8.2 24 weeks	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.72 [-1.00, 1.56]
9 BASFI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
9.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.11 [-0.47, 0.25]
9.2 24 weeks	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.16 [-0.51, 0.19]
10 BASDAI	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
10.1 after treatment	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.67 [-1.14, -0.20]
10.2 24 weeks	1	54	Mean Difference (IV, Fixed, 95% CI)	-0.13 [-0.87, 0.61]

Analysis 6.1. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 1 Pain day.

Analysis 6.2. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 2 Pain night.

Analysis 6.3. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 3 Morning stiffness (0-3).

Analysis 6.4. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 4 Patient global evaluation of disease activity (1-5).

Analysis 6.5. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 5 Schober test (cm).

Analysis 6.6. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 6 Fingertip-to-floor.

Analysis 6.7. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 7 Chest expansion.

Analysis 6.8. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 8 Occiput Wall distance.

Analysis 6.9. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 9 BASFI.

Analysis 6.10. Comparison 6 Balneotherapy and exercises versus exercises alone, Outcome 10 BASDAI.

Comparison 7. Balneotherapy therapy versus fresh water pool

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Pain	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
1.1 after treatment	1	28	Mean Difference (IV, Fixed, 95% CI)	0.0 [-1.74, 1.74]
1.2 one month follow up	1	28	Mean Difference (IV, Fixed, 95% CI)	0.10 [-1.61, 1.81]
1.3 3 months follow up	1	28	Mean Difference (IV, Fixed, 95% CI)	0.20 [-1.73, 2.13]
2 Movement	1		Mean Difference (IV, Fixed, 95% CI)	Subtotals only
2.1 after treatment	1	28	Mean Difference (IV, Fixed, 95% CI)	0.80 [-0.87, 2.47]
2.2 one months follow up	1	28	Mean Difference (IV, Fixed, 95% CI)	0.5 [-0.95, 1.95]
2.3 3 months follow up	1	28	Mean Difference (IV, Fixed, 95% CI)	0.5 [-1.06, 2.06]

Analysis 7.1. Comparison 7 Balneotherapy therapy versus fresh water pool, Outcome 1 Pain.

Analysis 7.2. Comparison 7 Balneotherapy therapy versus fresh water pool, Outcome 2 Movement.

ADDITIONAL TABLES

Table 1. Home exercise vs no intervention: pain

Study	Assessment point	Treatment Group	Outcome (scale)	No of patients	Baseline mean	Follow-up mean	Absolute Benefit	Relative Difference	Level of evidence
Sweeney 2002	6 months	Home exercise prog.	Pain (not reported)	75	6.49	6.80	0.13	2.1% (?)	Silver
		Control		80	6.06	6.24			
Kraag 1990	4 months	Home exercise prog	Pain (0-100)	26	32.2	37.4	-10.4	26.9% (w) ns	Silver
		Control		27	38.7	33.5			
ns=non-significant									

Table 2. Home exercise vs no intervention: spinal mobility

Study	Assessment point	Treatment Group	Outcome (Scale)	No. of Patients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Difference	Level of evidence
Kraag 1994	4 months	Home exercise/educational program	FFD (cm)	26	23.6	15.3	10.3	37% (I) s	Silver
		Control group		27	27.5	29.5			
Kraag 1994	4 months	Home exercise/educational program	Schober (cm)	26	13.7	11.3	0.3	2.3% (I) ns	Silver
		Control group		27	13.3	10.6			
s=significant ns=non-significant									

Table 3. Supervised vs no intervention: spinal mobility

Study	Assess- ment point	Treatment group	Outcome (scale)	No of pa- tients	Baseline mean	Follow-up mean	Absolute benefit	Relative Dif- ference	Level of evidence
Ince 2006	3 months	Supervised exercise vs no intervention	Chest ex- pansion (cm)	15	2.40	3.23	0.93	49.7% (I) s	Silver
		Control		15	1.87	1.77			
Ince 2006	3 months	Supervised exercise vs no intervention	FFD (cm)	15	18.13	14.67	3.23	17% (I), ns	Silver
		Control		15	18.70	18.07			
Ince 2006	3 months	Supervised exercise vs no intervention	Occiput to wall (cm)	15	4.48	4.23	1.21	20.8% (I) s	Silver
		Control		15	5.83	6.79			
Ince 2006	3 months	Supervised exercise vs no intervention	Schober test (cm)	15	13.63	13.83	0.63	4.9% (I) s	Silver
		Control		15	12.91	12.48			
Ince 2006	3 months	Supervised exercise vs no intervention	Chin to chest (cm)	15	2.97	2.50	1.17	31.8% (I) s	Silver
		Control		15	3.68	4.38			
								s=significant ns=non-sig- nificant	

Table 4. Group PT vs individualised PT: pain and stiffness

Study	Assessment point	Treatment Group	Outcome (Scale)	No. of patients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Difference	Level of evidence
Helliwell 1996	after treatment	Supervised group physiotherapy	Pain and stiffness VAS (0-200)	15	81	41	39	48% (I), s	Silver
		Control group		14	81	80			
Helliwell 1996	6 months	Supervised group physiotherapy	Pain and stiffness VAS (0-200)	13	81	65	35	43% (I), ns	Silver
		Control group		8	81	100			

Table 4. Group PT vs individualised PT: pain and stiffness (Continued)

Hidding 1993	9 months	Supervised group physiotherapy	Pain (0-10)	67	3.4	3.6	0.5	12.5% (I), ns	Silver
		Control group		68	4.0	4.7			
Hidding 1993	9 months	Supervised group physiotherapy	Stiffness (0-10)	67	3.2	3.1	0.1	2.7% (W), ns	Silver
		Control group		68	3.7	3.5			
Analay 2003	after treat-ment	Supervised group physiotherapy	Pain rest	23	3.82	3.30	0.48	15.3% (I), ns	Silver
		Control group		22	3.13	3.09			
Analay 2003	3 months	Supervised group physiotherapy	Pain rest	23	3.82	3.43	0.44	14% (I), ns	Silver
		Control group		22	3.13	3.18			
Analay 2003	after treat-ment	Supervised group physiotherapy	Pain activity	23	4.47	4.21	0.2	4% (W), ns	Silver
		Control group		22	4.59	4.31			
Analay 2003	3 months	Supervised group physiotherapy	Pain activity	23	4.47	4.65	0.54	11.7% (W), ns	Silver
		Control group		22	4.59	5.31			
								s=significant ns=non-sig-nificanth	

Table 5. Group PT vs individualised PT: spinal mobility

Study	Assessment point	Treatment Group	Outcome (Scale)	No. of Patients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Difference	Level of evidence
Analay 2003	after treatment	Supervised group physiotherapy	Modified Schobers test (cm)	23	4.38	5.26	0.20	6% (I),ns	Silver
		Control group		22	3.28	3.96			
Analay 2003	3 months	Supervised group physiotherapy	Modified Schobers test (cm)	23	4.38	5.13	0.60	18% (I),s	Silver
		Control group		22	3.28	3.13			

Table 5. Group PT vs individualised PT: spinal mobility *(Continued)*

Analay 2003	after treatment	Supervised group physiotherapy	FFD (cm)	23	20.77	15.50	4.31	22.6% (I),ns	Silver
		Control group		22	19.09	18.13			
Analay 2003	3 months	Supervised group physiotherapy	FFD (cm)	23	20.77	17.13	3.53	18.5% (I),ns	Silver
		Control group		22	19.09	18.98			
Analay 2003	after treatment	Supervised group physiotherapy	Chest expansion (cm)	23	3.97	4.73	0.67	16.2% (I),ns	Silver
		Control group		22	4.13	4.22			
Analay 2003	3 months	Supervised group physiotherapy	Chest expansion (cm)	23	3.97	4.28	0.44	10.7% (I),ns	Silver
		Control group		22	4.13	4.00			
Analay 2003	after treatment	Supervised group physiotherapy	Tragus Wall Distance (cm)	23	16.97	14.02	2.31	14.9%(I),ns	Silver
		Control group		22	15.45	14.81			
Analay 2003	3 months	Supervised group physiotherapy	Tragus Wall Distance (cm)	23	16.97	14.71	1.76	11.4%(I),ns	Silver
		Control group		22	15.45	14.95			
Helliwell 1996	after treatment	Supervised group physiotherapy	Cervical rotation (degrees)	15	95.3	112.0	14.6	16.5%(I), ns	Silver
		Control group		14	88.5	90.6			
Helliwell 1996	6 months	Supervised group physiotherapy	Cervical rotation (degrees)	15	95.3	101.5	3.2	3.6%(W), ns	Silver
		Control group		14	88.5	97.9			
Helliwell 1996	after treatment	Supervised group physiotherapy	Chest expansion (cm)	15	54.5	63.0	3.0	6%(I), ns	Silver
		Control group		14	50.2	55.7			
Helliwell 1996	6 months	Supervised group physiotherapy	Chest expansion (cm)	15	54.5	68.5	7.1	14%(W), ns	Silver
		Control group		14	50.2	71.3			
Helliwell 1996	after treatment	Supervised group physiotherapy	Modified Schober test (cm)	15	34.2	39.0	2.3	6%(I), ns	Silver
		Control group		14	38.6	41.1			

Table 5. Group PT vs individualised PT: spinal mobility (Continued)

Helliwell 1996	6 months	Supervised group physiotherapy	Modified Schober test (cm)	15	34.2	38.9	2.7	7%(I), ns	Silver
		Control group		14	38.6	40.6			
Hidding 1993	9 months	Supervised group physiotherapy	Spinal flexion (cm)	67	5.3	6.2	0.4	7.5%(I), s	Silver
		Control group		68	5.3	5.8			
Hidding 1993	9 months	Supervised group physiotherapy	Chest expan- sion	67	3.7	4.3	0.2	5%(I), ns	Silver
		Control group		68	4.0	4.4			
Hidding 1993	9 months	Supervised group physiotherapy	Cerv. rotation	67	95	111	4.0	4.2%(I), ns	Silver
		Control group		68	96	108			
								s=signifi- cant ns=non- significant	

Table 6. Spa-therapy vs PT: pain

Study	Assess- ment point	Treatment Group	Outcome (Scale)	No. of Pa- tients	Baseline Mean	End-of- Study Mean	Absolute Benefit	Relative Differ- ence	Level of evidence
Van Tuber- gen 2001	4 weeks	Spa exercise therapy	Pain, VAS (0-10)	80	4.6	3.6	0.9	18% (I), s	Silver
		Control group		40	4.8	4.7			
Van Tuber- gen 2001	16 weeks	Spa exercise therapy	Pain, VAS (0-10)	80	4.6	3.3	0.9	18.5% (I), s	Silver
		Control group		40	4.8	4.4			
Van Tuber- gen 2001	28 weeks	Spa exercise therapy	Pain, VAS (0-10)	80	4.6	4.2	0.4	8.3% (I), ns	Silver
		Control group		40	4.8	4.8			
Van Tuber- gen 2001	40 weeks	Spa exercise therapy	Pain, VAS (0-10)	80	4.6	4.7	-0.3	6.3% (W), ns	Silver

Table 6. Spa-therapy vs PT: pain (Continued)

Control group	40	4.8	5.0
s=significant ns=non-significant			

Table 7. Spa-therapy vs PT: BASFI

Study	Assess- ment Point	Treatment Group	Outcome (scale)	No. of Pa- tients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Differ- ence	Level of evidence
Van Tubergen 2001	4 weeks	Spa exercise therapy	BASFI (0-10)	80	4.6	3.6	1.0	24% (I), ns	Silver
		Control group		40	4.2	4.2			
Van Tubergen 2001	16 weeks	Spa exercise therapy	BASFI (0-10)	80	4.6	3.9	0.7	17% (I), ns	Silver
		Control group		40	4.2	4.2			
Van Tubergen 2001	28 weeks	Spa exercise therapy	BASFI (0-10)	80	4.6	4.2	0.5	11.9% (I), ns	Silver
		Control group		40	4.2	4.3			
Van Tubergen 2001	40 weeks	Spa exercise therapy	BASFI (0-10)	80	4.6	4.4	0.3	7.1% (I), ns	Silver
		Control group		40	4.2	4.3			
ns=non-signifi- cant									

Table 8. Spa-therapy vs PT: BAS-G

Study	Assessment point	Treatment Group	Outcome (Scale)	No. of Patients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Difference	Level of evidence
Van Tubergen 2001	4 weeks	Spa exercise therapy	BAS-G (0-10)	80	5.3	3.7	1.3	27% (I), s	Silver

Table 8. Spa-therapy vs PT: BAS-G (Continued)

					40	4.9	4.6		
Van Tubergen 2001	16 weeks	Spa exercise therapy	BAS-G (0-10)	80	5.3	3.4	1.4	29%(I), s	Silver
		Control Group		40	4.9	4.4			
Van Tubergen 2001	28 weeks	Spa exercise therapy	BAS-G (0-10)	80	5.3	3.5	1.4	29%(I), s	Silver
		Control Group		40	4.9	4.5			
Van Tubergen 2001	40 weeks	Spa exercise therapy	BAS-G (0-10)	80	5.3	4.5	1.1	22.4%(I), ns	Silver
		Control Group		40	4.9	4.6			
									s=significant ns=non-significant

Table 9. Balneotherapy+exercise vs exercise: pain

Study	Assessment point	Treatment group	Outcome (scale)	No of patients	Baseline mean	Follow-up mean	Absolute benefit	Relative difference	Level of evidence
Altan 2006	3 weeks	Balneotherapy + exercise	Pain day (0-10)	28	3.46	1.96	0.03	0.8% (w), ns	Silver
		Control		26	3.53	2.00			
Altan 2006	24 weeks	Balneotherapy + exercise	Pain day (0-10)	28	3.46	1.92	0.12	3.4% (I), ns	Silver
		Control		26	3.53	2.11			
Altan 2006	3 weeks	Balneotherapy + exercise	Pain night (0-10)	28	5.00	3.26	0.20	4.2% (I), ns	Silver
		Control		26	4.77	3.23			
Altan 2006	24 weeks	Balneotherapy + exercise	Pain night (0-10)	28	5.00	2.84	0.39	8.2% (I), ns	Silver
		Control		26	4.77	3.00			

Table 9. Balneotherapy+exercise vs exercise: pain (Continued)

ns=non-significant

Table 10. Balneotherapy +exercise vs exercise: BASFI

Study	Assessment Point	Treatment Group	Outcome (scale)	No of Patients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Difference	Level of evidence
Altan 2006	after treatment	Balneotherapy + exercise	BASFI (0-10)	28	1.28	0.50	0.48	52.7%	Silver
		Control		26	0.91	0.61			
Altan 2006	24 weeks	Balneotherapy + exercise	BASFI (0-10)	28	1.28	0.38	0.53	58.2%	Silver
		Control		26	0.91	0.54			

Table 11. Balneotherapy+exercise vs exercise: patient global assessment

Study	Assessment Point	Treatment Group	Outcome (scale)	No of Patients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Difference	Level of evidence
Altan 2006	3 weeks	Balneotherapy + exercise	Patient global assessment (1-5)	28	2.89	1.92	0.55	21.1% (I), ns	Silver
		Control		26	2.61	2.19			
Altan 2006	24 weeks	Balneotherapy + exercise	Patient global assessment (1-5)	28	2.89	2.12	0.39	14.9% (I), ns	Silver
		Control		26	2.61	2.23			

ns=non-significant

Table 12. Balneotherapy vs fresh water: movement

Study	Assess- ment Point	Treatment Group	Outcome (scale)	No of Pa- tients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Differ- ence	Level of evidence
Codish 2005	after treat- ment	Balneotherapy	movement (0-10)	14	6.3	5.9	-1.6	22.5% (W), ns	Silver
		Fresh water therapy		14	7.1	5.1			
Codish 2005	4 weeks	Balneotherapy	movement (0-10)	14	6.3	5.9	-1.3	18.3% (W),ns	Silver
		Fresh water therapy		14	7.1	5.4			
Codish 2005	12 weeks	Balneotherapy	movement (0-10)	14	6.3	6.1	-1.3	18.3% (W), ns	Silver
		Fresh water therapy		14	7.1	5.6			
ns=non-evidence									

Table 13. Two diff exercise programs: spinal mobility

Study	Assess- ment Point	Treatment Group	Outcome (scale)	No of Pa- tients	Baseline Mean	Follow-up Mean	Absolute Benefit	Relative Differ- ence	Level of evidence
D'Las Peñas 2005	after treat- ment	Experimental exercise	Tragus-wall (cm)	20	7.0	5.1	0	0	
		Conventional exercise		20	6.2	4.3			
D'Las Peñas 2005	one year	Experimental exercise	Tragus-wall (cm)	20	7.0	5.2	1.2	19.3% (I), ns	
		Conventional exercise		20	6.2	5.4			
D'Las Peñas 2005	after treat- ment	Experimental exercise	Schober test (cm)	20	1.8	2.4	0.4	16% (I), ns	
		Conventional exercise		20	2.5	2.7			
D'Las Peñas 2005	one year	Experimental exercise	Schober test (cm)	20	1.8	2.4	0.5	20% (I), ns	
		Conventional exercise		20	2.5	2.6

Table 13. Two diff exercise programs: spinal mobility *(Continued)*

D'Las Peñas 2005	after treat- ment	Experimental exercise	Cervical rotation (degrees)	20	46	57	8	14.8% (I), ns	
		Conventional exercise		20	54	57			
D'Las Peñas 2005	one year	Experimental exercise	Cervical rotation (degrees)	20	46	52	5	9.3% (I), ns	Silver
		Conventional exercise		20	54	55			
D'Las Peñas 2005	after treat- ment	Experimental exercise	Lumbar side flex- ion (cm)	20	3.9	6.3	1.0	20.8% (I), ns	Silver
		Conventional exercise		20	4.8	6.2			
D'Las Peñas 2005	one year	Experimental exercise	Lumbar side flex- ion (cm)	20	3.9	5.4	0.9	18.8% (I), ns	Silver
		Conventional exercise		20	4.8	5.4			
D'Las Peñas 2005	after treat- ment	Experimental exercise	Intermall. dis- tance (cm)	20	81.7	90.8	6.7	7.8% (I), ns	Silver
		Conventional exercise		20	86.1	88.5			
D'Las Peñas 2005	one year	Experimental exercise	Intermall. dis- tance (cm)	20	81.7	86.8	6.4	7.4% (I), ns	Silver
		Conventional exercise		20	86.1	84.8			
								ns=non- significant	

WHAT'S NEW

Date	Event	Description
15 September 2008	Amended	Converted to new review format. CMSG ID: C066-R

HISTORY

Protocol first published: Issue 4, 2000

Review first published: Issue 1, 2000

Date	Event	Description
14 November 2007	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

HD planned and initiated the review, searched for RCTs, assessed the trials, extracted data, contacted authors of RCTs and drafted and redrafted the update of the review. KBH planned and initiated the review, contacted authors of RCTs and assessed the trials and extracted data. TKK contributed substantially in the updating process with comments and interpretation of the data. HD is the guarantor for the review.

DECLARATIONS OF INTEREST

None known.

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