The Cochrane Review of Physiotherapy Interventions for Ankylosing Spondylitis

HANNE DAGFINRUD, TORE K. KVIEN, and KÅRE B. HAGEN

ABSTRACT. ***Objective.*** To update the Cochrane review on the effectiveness of physiotherapy interventions in the management of ankylosing spondylitis (AS).

Methods. All randomized studies available in systematic searches (electronic databases, contact with authors, reference lists) up to February 2004 were included. Two reviewers independently selected trials for inclusion, assessed the validity of included trials, and extracted data. Investigators were contacted to obtain missing information.

Results. Six trials with a total of 561 participants were included. Two trials compared individualized home exercise programs with no intervention. Low quality evidence for effects in favor of the home exercise program was found in physical function and spinal mobility [absolute benefit 10.3 cm on fingertip to floor distance; relative percentage difference (RPD) 37%)]. Further, the trials showed low quality evidence for no group differences in pain. Three trials compared supervised group physiotherapy with an individualized home exercise program. Moderate quality evidence for effectiveness was found in patient global assessment and spinal mobility in favor of the supervised group. The trials showed moderate quality evidence for no differences in pain intensity between the groups. One trial compared a 3-week inpatient spa-exercise therapy followed by weekly outpatient group physiotherapy with weekly outpatient group physiotherapy alone. Moderate quality evidence was found for effects in pain (absolute benefit 0.9 cm on visual analog scale; RPD 19%), physical function (absolute benefit 1 cm; RPD 24%), and patient global assessment (absolute benefit 1.3 cm; RPD 27%), in favor of the combined spa-exercise therapy.

Conclusion. The current best available evidence suggests that physiotherapy is beneficial for people with AS. However, it is still not clear which treatment protocol should be recommended in the management of AS. (J Rheumatol 2005;32:1899–906)

Key Indexing Terms:
ANKYLOSING SPONDYLITIS — PHYSIOTHERAPY
SYSTEMATIC REVIEW — RANDOMIZED CONTROLLED TRIAL

Ankylosing spondylitis (AS) is a chronic, progressive, inflammatory disease predominantly affecting young men and women. The disorder mainly affects the axial skeleton and the sacroiliac joints, with an aseptic inflammation of synovial tissue, the spinal ligaments, intervertebral discs, and facet joints. The sacroiliac joint involvement is often regarded as the hallmark of the disease, and the presence of radiographic sacroiliitis is considered obligatory for classification of AS according to both the original and the modified New York criteria[1,2]. Some patients also experience peripheral joint involvement and extraarticular manifestations like acute anterior uveitis and cardiac problems. AS is found worldwide, but more often in Caucasians than in other races. The prevalence is most frequently reported to be 0.1% to 0.2%[3-5]. Clinically, the disease is more commonly seen in men, with a 2–3:1 male to female ratio[3,5-7]. The etiology of AS is unclear[8-10].

The most active disease phase is between the ages of 20 and 50 years, and patients with AS experience various degrees of functional limitations. The main clinical characteristics are pain, stiffness, reduced spinal mobility, and reduced energy. Physiotherapy is therefore recognized as being an important part of the management program in AS. The main goals are to maintain the patient's maximal potential movement, prevent postural deformities, improve muscle strength and fitness, and relieve pain[11-18]. Further, advice and education about the condition are important factors, enabling patients to manage the disease better and to seek assistance at the appropriate time[19].

The previous review included data from 3 randomized controlled trials (RCT). The results indicated a positive effect of physiotherapy interventions for patients with AS,

From the Section for Health Science, University of Oslo; Norwegian Resource Centre for Rehabilitation in Rheumatology; and Department of Rheumatology, Diakonhjemmet Hospital, Oslo, Norway.

Supported by The National Foundation for Postgraduate Physiotherapists.

H. Dagfinrud, RPT, MSc, PhD Student, Section for Health Science, University of Oslo; K.B. Hagen, RPT, PhD, Norwegian Resource Centre for Rehabilitation in Rheumatology, Oslo; T.K. Kvien, PhD, MD, Professor, Department of Rheumatology, Diakonhjemmet Hospital, Oslo, Norway.

Address reprint requests to H. Dagfinrud, Section for Health Science, University of Oslo, PO Box 1153, Blindern, 0316 Oslo, Norway. E-mail: h.s.dagfinrud@medisin.uio.no

Accepted for publication May 30, 2005.

but the few studies, examining a small range of modalities, represented limited evidence. Recently, 3 more RCT have been conducted, and the purpose of this updated review was to assess the effectiveness of various physiotherapy interventions in the management of patients with AS.

The following main comparisons were made: (1) physiotherapy versus other interventions (including no intervention); and (2) comparison of different modalities or applications of physiotherapy.

MATERIALS AND METHODS

Criteria for considering studies for this review

Studies. Randomized or quasi-randomized controlled studies examining the effectiveness of physiotherapy in AS were evaluated.

Participants. Men and women with the diagnosis of AS according to the classification system described in the modified New York criteria[2]. Trials were excluded if the diagnostic criteria were unclear or were not met.

Interventions. Studies were included if the interventions were any physiotherapy modality considered relevant in the management of AS. If cointerventions were included, they had to be similar in the comparison groups. Relevant physiotherapy modalities included: supervised and unsupervised exercises, training, manual therapy, massage, hydrotherapy, electrotherapy, acupuncture, and patient information and educational programs.

Outcome measures. As designated by the ASsessments in AS (ASAS) Working Group[20], the main outcomes of interest were pain, stiffness, spinal mobility, physical function, and patient global assessment. Other relevant outcome measures were also considered.

Search strategy for identification of studies. Relevant studies were identified by searching the Cochrane Central Register of Controlled Trials (CENTRAL), AMED, Medline, Embase, CINAHL and PEDro (up to February 2004), with no language restrictions.

The search strategy recommended in the Cochrane Collaboration Handbook was used. The reference lists of retrieved studies were scanned to identify additional relevant trials, and authors of relevant studies were contacted.

Methods of the review. Trials included in the review were independently selected by the 2 reviewers (HD and KBH) using a standard form that had been pilot-tested.

Methodological quality. Internal validity was independently assessed by 2 reviewers (HD and KBH) using the criteria described in the Cochrane Collaboration Reviewers' Handbook[21]. The criteria included assessment of the following: concealment of allocation, use or control with cointerventions, use of intention-to-treat analysis and losses to followup, outcome assessment, and blinding of patients. These 5 criteria were rated as "met," "unclear," or "not met." The operationalization of the 5 methodological quality criteria is presented in Table 1. Disagreement was easily resolved by discussion. Blinding of providers is clearly not possible, so the outcome criteria focus upon blinding of assessors and patients. However, the included trials compared exercises and educational programs in different settings, and blinding of patients was therefore rated as not met in these trials. An overall assessment of internal validity was based on a summary of these 5 criteria: low risk of bias means that 4 to 5 criteria were met; moderate risk of bias means that 3 criteria were met; and high risk of bias means that less than 3 criteria were met (Appendix).

Finally, the quality of evidence was assessed according to a recently developed systematic and explicit method[22]. 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 influence on our confidence in the estimate of effect and may change the estimate.

Low: Further research is very likely to have an important influence 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 that were not employed in this review[22].

Data extraction and analyses

Data were independently extracted by 2 reviewers (KBH and HD) using a pilot-tested data extraction form. Disagreement was resolved by discussion.

If the articles did not provide sufficient information for methodological assessment or necessary data for statistical analyses, letters were sent to investigators to collect missing data. Six letters were sent and 4 of the authors replied to our request. Two provided additional information regarding methodological quality and 2 provided additional data for statistical analyses.

For Main comparison 1 (physiotherapy interventions versus other interventions or no intervention), the preplanned stratified analyses were: Trials comparing home programs of therapeutic exercises and disease education with no intervention.

For Main comparison 2 (different modalities or applications of physiotherapy), the preplanned stratified analyses were:

(1) trials comparing home exercise regimes with supervised, inpatient or outpatient group physiotherapy (including hydrotherapy);

(2) trials comparing inpatient spa-exercise therapy with supervised, weekly group physiotherapy.

Where possible, weighted mean differences (WMD) with corresponding 95% confidence intervals (CI) were calculated[23]. Both random effect models and fixed effect models were employed. For studies not providing sufficient data, qualitative analyses were undertaken. In one trial[24], 2 intervention arms were considered clinically similar and were therefore combined for analytical purposes.

Clinical relevance

In order to improve the clinical relevance of the review, absolute benefit and relative percentage differences (RPD) were calculated, if possible, for statistically significant differences. 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[25]. According to the Philadelphia Panel, an improvement at 15% relative to a control group was considered clinically relevant[26].

RESULTS

We considered 43 studies for inclusion in this review. Thirty-three of them were excluded due to study design, the participants, the interventions, or the outcome measures. Two conference abstracts[27,28] were considered potentially eligible, but full reports were not available. Eight published studies were RCT and investigated the effects of physiotherapy in the management of patients with AS[12,13,16,29,30]. However, 2 of these were crossover or followup studies that did not provide independent results and they were consequently excluded from the review[30,31]. Six studies with a total of 561 participants were included in this updated review, compared to 3 trials and 241 patients in the previous

Table 1. Criteria used for rating internal validity. An overall assessment of internal validity was based on a summary of these 4 criteria: low risk of bias means that all criteria were met; moderate risk of bias means that 3 criteria were met; and high risk of bias means that < 3 criteria were met.

Criteria	Met	Unclear	Not Met
Concealment of allocation	Randomization independent of provider and investigator, i.e., use of centralized computer system or sequentially numbered, sealed, opaque envelopes	Concealment approach not reported and could not be verified by contacting the investigators	Alternative allocation, case record numbers, dates of birth, day of week, and any allocation procedure that was entirely transparent before assignment
Cointervention	Interventions other than physiotherapy were avoided or used similarly across comparison groups	Cointerventions not reported and could not be verified by contacting investigators	Dissimilar use of interventions other than physiotherapy
Intention-to-treat analysis and losses to followup	Intention-to-treat analysis performed and losses to followup < 20% and equally distributed between comparison groups	Intention-to-treat analysis or losses to followup not reported and could not be verified by contacting the authors	Exclusion not reported and could not be verified by contacting the investigators or losses to followup > 20%
Outcome assessment	Assessors unaware of the assigned treatment when collecting outcome measures	Blinding of assessor not reported, and could not be verified by contacting the investigators	Assessor aware of the assigned treatment when collecting outcome measures
Blinding of patients	Patients unaware of the assigned treatment	Blinding of patients not reported	Patients aware of the assigned treatment or blinding of patient not possible

version. The included studies were undertaken in Canada[12], The Netherlands[16], United Kingdom[13,32], Austria, Germany and Netherlands[24], and Turkey[29]. A description of the studies is presented in the Appendix.

The overall assessment of the methodological quality of the trials in this review was as follows: Two studies[16,24] met 4 criteria of internal validity and were rated to have low risk of bias. Two studies[12,29] met 3 criteria and were assessed to have moderate risk of bias; and 2 studies did not meet any of the criteria and were assessed to have high risk of bias[13,32]. The overall assessment and the assessments of each criterion are presented in the Appendix.

Comparisons

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

Two trials compared home exercise and educational programs with no intervention[12,32]. In one of the studies, 3 of the methodological quality criteria were met, and the study was assessed to have moderate risk of bias[12]. In one study, less than 3 methodological criteria were met, and the study was assessed to have high risk of bias[32]. The results are summarized in Table 2.

Pain. None of the included studies reported any clinically relevant differences in pain. We therefore conclude that there is low quality evidence for no group differences in pain reduction.

Stiffness. Stiffness was not measured in the studies, except one, where it was reported as part of the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI)[33]. No group differences were found on the BASDAI in the study of Sweeney, *et al*[32].

Spinal mobility. Kraag, *et al*[12] found a significant difference in fingertip-to-floor distance in favor of the home exercise program at 4 months (end of trial; RPD 37%). However, no significant difference was found in the Schober test (RPD 2.3%). Sweeney, *et al*[32] did not measure spinal mobility. We conclude that there is low quality evidence for a positive effect of a home exercise program on some measures of spinal mobility.

Physical function. Physical function score was significantly better at end of trial in the experimental group than in the no-intervention group in the study of Kraag, *et al*[12]. Mean difference after treatment was about 4 points on a 33-point scale ($p < 0.001$, modified Toronto Activities of Daily Living Questionnaire). Sweeney, *et al*[32] reported no significant group difference after treatment (at 6 months) on the Bath Ankylosing Spondylitis Functional Index (BASFI)[34] (RPD 7.5%). In conclusion, there is low quality evidence for a treatment effect on self-reported physical function.

Patient global assessment. Patient global assessment was not measured in Kraag, *et al*[12]. Sweeney, *et al* reported no group differences on the Bath Ankylosing Spondylitis Patient Global Score (BAS-G)[35]. 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

A. Trials comparing supervised group physiotherapy (including hydrotherapy) with home exercise regimes.

Three trials were included in this comparison. One trial met all the methodological quality criteria, and was assessed to have low risk of bias[16]; one trial met 3 criteria and was assessed to have moderate risk of bias[29]; and one trial met less than 3 methodological quality criteria, and was assessed to have high risk of bias[13]. The results are summarized in Table 3.

Pain. Hidding, *et al*[16] found no significant differences in pain between the groups (RPD 10%). Analay, *et al* measured

Table 2. Results from individual studies in main comparison 1 (physiotherapy vs other treatment, including no treatment), trials comparing home exercise, and educational program with no treatment.

Study	Treatment Group	Outcome (scale)	No. of Patients	Baseline Mean	End of Study Mean	Absolute Benefit	Relative Percentage Difference
Sweeney, 2002	Home	SES, pain	75	6.49	6.80	0.13	2.1 (?)*
	Control	(1–10*)	80	6.06	6.24		NS
Sweeney, 2002	Home	BASDAI	75	3.9	3.65	–0.06	1.6 (W)
	Control	(0–100)	80	3.8	3.49		NS
Kraag, 1994	Home	FFD, cm	26	23.6	15.3	10.3	37 (I)
	Control		27	27.5	29.5		
Kraag, 1994	Home	Schober test, cm	25	13.7	11.3	–0.3	2.3 (W)
	Control		27	13.3	10.6		NS
Sweeney, 2002	Home	BASFI	75	3.5	3.06	0.27	7.5 (I)
	Control	(0-100)	80	3.6	3.43		NS
Sweeney, 2002	Home	BAS-G	75	4.0	3.60	0.31	8.4 (I)
	Control	(0–100)	80	3.7	3.61		NS

NS: no statistically significant differences between groups; SES pain: Stanford Self-Efficacy Scale (* direction of scale not reported); BASDAI: Bath Ankylosing Spondylitis Disease Activity Index; FFD: Fingertip-to-floor distance; BASFI: Bath Ankylosing Spondylitis Functional Index; BAS-G: Bath Ankylosing Spondylitis Patient Global Score; I: improvement; W: worsening.

Table 3. Results from individual studies in main comparison 2 (different modalities or applications of physiotherapy). Comparison 2A, trials comparing supervised group physiotherapy (including hydrotherapy) with home exercise regimes.

Study	Treatment Group	Outcome (scale)	No. of Patients	Baseline Mean	End of Study Mean	Absolute Benefit	Relative Percentage Difference
Analay, 2003	Supervised PT	Pain at rest	23	3.8	3.3	0.5	16 (I)
	Control	(0-100)	22	3.1	3.1		NS
Analay, 2003	Supervised PT	Pain activity	23	4.5	4.2	0	0
	Control	(0–100)	22	4.6	4.3		
Helliwell, 1996	Supervised PT	Pain and stiffness	15	8.1	4.1	3.9	48 (I)
	Control	(0–200)	14	8.1	8.0		
Analay, 2003	Supervised PT	Morning stiffness,	23	38.7	20.9	18.2	49.7 (I)
	Control	minutes	22	36.6	37.0		NS
Helliwell, 1996	Supervised PT	Cervical rotation,	15	95.3	112	14.9	17 (I)
	Control	degrees	14	88.8	90.6		NS
Analay, 2003	Supervised PT	FFD, cm	23	20.8	15.5	4.3	22.5 (I)
	Control		22	19.1	18.1		NS
Analay, 2003	Supervised PT	TWD, cm	23	17.0	14.0	2.3	14.8 (I)
	Control		22	15.5	14.8		NS
Analay, 2003	Supervised PT	BASFI, cm	23	26.3	20.0	6.0	21.7 (I)
	Control		22	27.6	27.3		NS

NS: no statistically significant differences between groups; FFD: Fingertip-to-floor distance; TWD: Tragus-wall distance; BASFI: Bath Ankylosing Spondylitis Functional Index; I: improvement; W: worsening.

pain at rest and during activity and found no significant differences after treatment or after 3 months. Helliwell, *et al* combined pain and stiffness in one variable. The RPD was 48% immediately after treatment in favor of the supervised group. However, this study was assessed to have high risk of bias and the results were therefore given low weight. Six months after the intervention no significant differences were found. 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 after 9 months in Hidding, *et al* (RPD 8%). Analay, *et al*[29] measured duration of morning stiffness in minutes. The authors reported statistically significant within-group improvement after treatment and after 3 months. However, between-group analyses showed no significant differences at the 2 measurement points. The quality of evidence for no group difference is therefore considered to be moderate.

Spinal mobility. Hidding, *et al*[16] found a statistically significant difference for thoraco-lumbar mobility in favor of group physiotherapy after the 9-month intervention period (RPD 7.5%). This group also performed slightly but not significantly better on the other spinal mobility outcomes. The pooled analyses of chest expansion and the Schober test

(lumbar flexion)[13,29] showed no significant differences, but Analay, *et al*[29] found a significant difference in Schober score at 3 months (RPD 18%).

Further, no difference in cervical rotation was found in Helliwell, *et al*[13]; and Analay, *et al*[29] found no difference between the groups on fingertip-to-floor distance or tragus-to-wall distance. In conclusion, the quality of evidence for small differences on some measures of spinal mobility is considered to be moderate.

Physical function. No significant differences in self-reported physical function measured after intervention were found in the study of Hidding[16] (RPD 7%) or in the study of Analay[29] (RPD 22%) (Table 3). The quality of evidence is moderate.

Patient global assessment. The supervised group reported significantly better scores on the patient global assessment after the 9-month intervention period in the study of Hidding, *et al*[16] [mean change difference 1.46 cm (10 cm scale); 95% CI 1.05 to 1.87]. Relative difference was not calculated due to insufficient reporting of baseline data. Patient global assessment was not measured in the 2 other studies[13,29]. The quality of evidence for a difference in favor of group physiotherapy is considered to be moderate.

Main comparison 2 – different modalities or applications of physiotherapy

B. Trials comparing the effectiveness of spa therapy with weekly group physiotherapy.

One study was included, meeting all the methodological quality criteria and assessed as having low risk of bias[24]. The 2 spa-exercise interventions took place at 2 different spa resorts, but the therapy programs were standardized for both spa resorts. The 2 interventions were therefore considered clinically similar, and they were combined to perform as one group in this review (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. The results are summarized in Table 4.

Pain. Significant effects of the spa-exercise intervention were found regarding pain 1 and 4 months after start of the 3-week intervention (RPD 19%). 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 (minutes) of morning stiffness. 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 the BASFI, included in the pooled index of change. Evaluated as a separate variable, the BASFI results were not statistically significant. However, the RDP were 24% and 17% (1 and 4 months, respectively), and may thus be considered clinically relevant[26]. No statistically significant group differences were found, and the quality of evidence is moderate.

Patient global assessment. Significant positive effects of the spa-exercise interventions were found for patient global assessment at 1, 4, and 7 months (RPD 26.5%, 29%, and 29%, respectively) in favor of the spa-exercise group. At 10 months no differences between the groups were found. There is moderate quality evidence for a clinically relevant effect in favor of an additional combined spa-exercises course.

DISCUSSION

The results of this review showed that patients with AS had some beneficial effects from individualized home exercise programs compared to no intervention. Further, supervised group physiotherapy programs were better than individualized home exercise regimes, and a 3-week combined spa-exercise intervention was better than weekly group physiotherapy alone. Six studies met the inclusion criteria of this review, with a total of 561 patients with AS. Two of the studies were assessed to have low risk of bias, 2 studies were assessed to have moderate, and 2 to have high risk of bias. Patients or providers were not blinded in the included trials.

Table 4. Results from individual studies in main comparison 2 (different modalities or applications of physiotherapy). Comparison 2B, trials comparing the effects of spa therapy with weekly group physiotherapy.

Study	Treatment Group	Outcome (scale)	No. of Patients	Baseline Mean	End of Study Mean	Absolute Benefit	Relative Percentage Difference
Van Tubergen, 2001	Spa exercise	Pain	80	4.6	3.6	0.9	19 (I)
	Control	(0–10)	40	4.8	4.7		
Van Tubergen, 2001	Spa exercise	BASFI	80	4.6	3.6	1.0	24 (I)
	Control	(0–10)	40	4.2	4.2		
Van Tubergen, 2001	Spa exercise	BAS-G	80	5.3	3.7	1.3	26.5 (I)
	Control	(0–10)	40	4.9	4.6		

BASFI: Bath Ankylosing Spondylitis Functional Index; BAS-G: Bath Ankylosing Spondylitis Patient Global Score; I: improvement.

Nearly all the studies in this review included more than 70% men in the participant groups. Among the exclusion criteria were patients using disease modifying antirheumatic drugs, patients with peripheral joint involvement, severe comorbidity, and diagnosis of AS more than 20 years ago. Thus, the applicability of the results to women and patients severely affected with AS may be limited.

The main goal of the 6 trials in this review was to study the effectiveness of physiotherapy in the management of AS. However, the interventions were often poorly described, so that the exact content of the programs remained partly unclear, and the external validity was thereby unclear. Another problem related to the external validity was the somewhat unusual interventions in some of the included trials, such as treatment programs in spa resorts. Although the spa-exercise intervention showed favorable cost-effectiveness and cost-utility ratios compared to self-exercising and group-exercising[36], spa resorts are not readily available in many parts of the world and the generalizability of the results may therefore be limited.

The included studies measured spinal mobility with different methods and for different parts of the spinal column. The varying results may indicate that mobilizing exercises have to be specifically designed for each part of the column, and a general effect of exercising on spinal mobility is not to be expected. Further, measures of spinal extension range of motion are lacking in the included studies, and future trials should aspire to include more specific spinal mobility movements and measurements.

Compared to the previous version of this review[37] (not published in a paper journal), 2 substantial changes have been made. First, 3 new studies with a total of 320 patients have been included. Second, the clinical relevance of the effect sizes and the quality of evidence has been assessed according to systematic and explicit methods[22,26]. These changes have reinforced the tendency toward positive effects of physiotherapy in terms of exercise programs in the management of AS. A new high quality study is added in this update, showing good results of combined spa-exercise therapy[24]. Another study with moderate methodological quality indicates positive results, although not statistically significant, of intensive group physiotherapy compared to home exercises[29].

The trials included in this review 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. That the patients who participated in the groups (both inpatients and outpatients) improved more than the patients who did exercises on their own may be ascribed partly to the contribution of nonphysical factors, such as mutual encouragement, increased motivation, and exchange of experiences with fellow sufferers. These are important factors for the total well being of the AS patients, but does not give evidence to identify the most appropriate and effective exercise program.

The random allocation of patients in physiotherapy studies may lead to reduced effectiveness of the interventions. Physiotherapy interventions are often time-consuming and compliance is dependent on highly motivated patients. Helliwell, *et al*[13] addressed this problem in their study, considering that the large number of dropouts may have been due to lack of motivation and a time-consuming treatment program that the patients had not chosen. With use of intention-to-treat analyses, the high degree of noncompliance will influence the treatment effects negatively. To avoid noncompliance or poor recruitment, physiotherapy researchers may have a tendency to compare active and quite similar interventions. Significant differences of clinically relevant treatment effects may therefore be hard to obtain.

The trials included in this review compared different active interventions, and blinding of the participants was therefore not considered as a methodological quality criterion. Blinding of providers and patients is regarded as very difficult in physiotherapy studies. However, lack of blinding weakens the methodological quality of trials and should therefore be used if possible, for example in electrotherapy modalities, and possibly by means of different kinds of attention placebos.

Publication bias is discussed as a problem when developing systematic reviews. Research has suggested that studies with positive results are more likely to be published than studies with negative results[38]. Further, our literature search identified reports of 2 possibly eligible studies, published as conference abstracts, that did not provide sufficient data to be included[27,28]. Due to the small number of included studies and insufficient data reporting, the possible extent of publication bias could not be explored further in this review.

No randomized trials investigating relevant physiotherapy interventions other than exercise programs were found through this systematic search strategy. Other commonly used physiotherapy interventions (e.g., different hands-on techniques such as manual therapy, electrotherapy, and information and education programs) should be investigated. Future trials should compare different treatment and exercise programs, and aspire to an accurate description of the content, dose and application of training and exercise programs, as well as duration and frequency of the interventions. Further, future trials should apply standardized, validated outcome measures suitable for assessing effects of physiotherapy interventions.

According to the current research evidence, we do not know which particular treatment protocol should be recommended in the management of AS.

This review identified and summarized data from all available RCT investigating the effects of physiotherapy in the management of AS. Due to a small number of partici-

pants, some of the studies may be underpowered and prone to bias due to baseline differences. Further, because of heterogeneous interventions and outcome measures, varying methodological quality, and deficient reporting of data in the included studies, the review does not provide strong evidence. However, systematic reviews also have the potential to identify areas of poor knowledge, leading to new hypotheses and constituting a valuable guide for further research. The tendency toward positive effects of physiotherapy in the management of AS calls for further research, and future trials should address other physiotherapy interventions commonly used in clinical practice.

ACKNOWLEDGMENT

Louise Falzon at the editorial office of the Cochrane Musculoskeletal Group conducted the literature searches for this updated version. The authors of the primary studies are acknowledged for their cooperation.

REFERENCES

1. Moll JM, Wright V. New York clinical criteria for ankylosing spondylitis. Ann Rheum Dis 1973;32:354-63.
2. van der Linden S, Valkenburg HA, Cats A. Evaluation of diagnostic criteria for ankylosing spondylitis. A proposal for modification of the New York criteria. Arthritis Rheum 1984;27:361-8.
3. Gran JT, Husby G. The epidemiology of ankylosing spondylitis. Semin Arthritis Rheum 1993;22:319-34.
4. Robbins L, Burckhardt CS, Hannan MT, De Horatius, editors. Clinical care in the rheumatic diseases. 2nd ed. Atlanta: Association of Rheumatology Health Professionals; 2001.
5. Silman A, Hochberg MC, editors. Epidemiology of the rheumatic diseases. 2nd ed. Oxford: Oxford University Press; 2001.
6. van der Linden S, van der Heijde D. Ankylosing spondylitis. Clinical features. Rheum Dis Clin North Am 1998;24:663-76.
7. Will R, Edmunds L, Elswood J, Calin A. Is there sexual inequality in ankylosing spondylitis? A study of 498 women and 1202 men. J Rheumatol 1990;17:1649-52.
8. Khan M. Ankylosing spondylitis. In: Klippel JH, Dieppe PA. Rheumatology. 2nd ed. London: Mosby; 1998.
9. van der Linden S, van der Heijde D. Clinical aspects, outcome assessment, and management of ankylosing spondylitis and postenteric reactive arthritis. Curr Opin Rheumatol 2000;12:263-8.
10. Imboden J, Hellmann DB, Stone JH. Current in rheumatology; diagnosis and treatment. New York: McGraw-Hill Inc.; 2004.
11. Bulstrode SJ, Barefoot J, Harrison RA, Clarke AK. The role of passive stretching in the treatment of ankylosing spondylitis. Br J Rheumatol 1987;26:40-2.
12. Kraag G, Stokes B, Groh J, Helewa A, Goldsmith C. The effects of comprehensive home physiotherapy and supervision on patients with ankylosing spondylitis — a randomized controlled trial. J Rheumatol 1990;17:228-33.
13. Helliwell P, Abbott CA, Chamberlain MA. A randomised trial of three different physiotherapy regimes in ankylosing spondylitis. Physiotherapy 1996;82:85-90.
14. Viitanen JV, Suni J, Kautiainen H, Liimatainen M, Takala H. Effect of physiotherapy on spinal mobility in ankylosing spondylitis. Scand J Rheumatol 1992;21:38-41.
15. Viitanen JV, Suni J. Management principles and physiotherapy in ankylosing spondylitis — which treatments are effective? Physiotherapy 1995;81:322-9.
16. Hidding A, van der Linden S, Boers M, et al. Is group physical therapy superior to individualized therapy in ankylosing spondylitis? A randomized controlled trial. Arthritis Care Res 1993;6:117-25.
17. van der Linden S, van Tubergen A, Hidding A. Physiotherapy in ankylosing spondylitis: what is the evidence? Clin Exp Rheumatol 2002;20 Suppl 28:S60-S64.
18. Gall V. Exercise in the spondyloarthropathies. Arthritis Care Res 1994;7:215-20.
19. David C, Lloyd J, editors. Rheumatological physiotherapy. London: Mosby; 1999.
20. van der Heijde D, Calin A, Dougados M, Khan MA, van der Linden S, Bellamy N. Selection of instruments in the core set for DC-ART, SMARD, physical therapy, and clinical record keeping in ankylosing spondylitis. Progress Report of the ASAS Working Group. J Rheumatol 1999;26:951-4.
21. Alderson P, Green S, Higgins J. Cochrane Reviewers Handbook, 4.2.1. Chichester, UK: John Wiley & Sons Ltd.; 2004.
22. Atkins D, Best D, Briss PA, et al. Grading quality of evidence and strength of recommendations. BMJ 2004;328:1490.
23. Deeks J, Higgins J, Altman DG. Analysing and presenting results. The Cochrane Reviewers Handbook, 4.2.1. Chichester, UK: John Wiley & Sons Ltd.; 2004:68.
24. Van Tubergen A, Landewe R, van der Heijde D, et al. Combined spa-exercise therapy is effective in patients with ankylosing spondylitis: a randomized controlled trial. Arthritis Rheum 2001;45:430-8.
25. Cochrane Musculoskeletal Group. Cochrane Musculoskeletal Group methods; draft guidelines. Cochrane Musculoskeletal Group; 2003.
26. Philadelphia Panel. Philadelphia Panel evidence-based clinical practice guidelines on selected rehabilitation interventions for low back pain. Phys Ther 2001;81:1641-74.
27. Ahmad N. A randomised comparison of intensive versus less intensive exercise for ankylosing spondylitis and the spondylarthropathies [abstract]. Aust NZ J Med 2000;30:536.
28. Pickering K. Two arm clinical trial evaluating exercise in ankylosing spondylitis with a metrology index as the primary outcome variable [abstract]. Aust NZ J Med 2000;30:548.
29. Analay Y, Ozcan E, Karan A, Diracoglu D, Aydin R. The effectiveness of intensive group exercise on patients with ankylosing spondylitis. Clin Rehabil 2003;17:631-6.
30. Hidding A, van der Linden S, Gielen X, de Witte L, Dijkmans B, Moolenburgh D. Continuation of group physical therapy is necessary in ankylosing spondylitis: results of a randomized controlled trial. Arthritis Care Res 1994;7:90-6.
31. Kraag G, Stokes B, Groh J, Helewa A, Goldsmith CH. The effects of comprehensive home physiotherapy and supervision on patients with ankylosing spondylitis — an 8-month followup. J Rheumatol 1994;21:261-3.
32. Sweeney S, Taylor G, Calin A. The effect of a home based exercise intervention package on outcome in ankylosing spondylitis: a randomized controlled trial. J Rheumatol 2002;29:763-6.
33. Garrett S, Jenkinson T, Kennedy LG, Whitelock H, Gaisford P, Calin A. A new approach to defining disease status in ankylosing spondylitis: the Bath Ankylosing Spondylitis Disease Activity Index. J Rheumatol 1994;21:2286-91.
34. Calin A, Garrett S, Whitelock H, et al. A new approach to defining functional ability in ankylosing spondylitis: the development of the Bath Ankylosing Spondylitis Functional Index. J Rheumatol 1994;21:2281-5.
35. Jones SD, Steiner A, Garrett SL, Calin A. The Bath Ankylosing Spondylitis Patient Global Score (BAS-G). Br J Rheumatol 1996;35:66-71.
36. Van Tubergen A, Boonen A, Landewe R, et al. Cost effectiveness of combined spa-exercise therapy in ankylosing spondylitis: a randomized controlled trial. Arthritis Rheum 2002;47:459-67.
37. Dagfinrud H, Hagen K. Physiotherapy interventions for ankylosing spondylitis. Cochrane Database Syst Rev 2001;CD002822.
38. Dickersin K, Chan S, Chalmers TC, Sacks HS, Smith H Jr. Publication bias and clinical trials. Control Clin Trials 1987;8:343-53.

APPENDIX The RCT included in this review.

Author (country)	Methodological quality	Participants	Interventions	Outcomes
Analay 2003 (Turkey)	Concealment of allocation: MET Co-intervention: UNCLEAR Exclusions or losses to follow-up: MET Outcome assessment: MET Blinding of patients: NOT MET Overall assessment: moderate risk of bias	45 participants age between 18 and 55 years, 84% men. Inclusion: AMOR criteria, able to participate in exercise group Exclusion: systemic organic involvement, hip and knee deformities, treated by physiotherapy last three months or practising regular exercises, receiving DMARDS	Group 1: Intensive exercise program, 6 weeks, 3 days pr week, supervised. The exercise program included stretching, mobilization and strengthening exercises, aerobic exercises and postural and respiratory exercises. 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.	Pain at rest and during activity (VAS, 0-10), duration of morning stiffness. Anthropometric 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
Helliwell 1996 (United Kingdom)	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 Overall assessment: High risk of bias	44 participants, mean age 38.9 years, 89% men. Inclusion: New York criteria Exclusion: participated in inpatient program within last year, peripheral joint involvement, unable to exercise.	Group 1: 3 weeks inpatient, supervised group physiotherapy, 5 days / week, 1 hour group exercise + hydrotherapy 3 times pr week+ occasionally massage and interference Group 2: outpatient hydrotherapy and home-exercise: 6 weeks, 2 times pr week hydrotherapy + home exercise program Group 3: Home exercises: 6 weeks home exercise regime	1: Anthropometric measures: cervical rotation, chest expansion, Schober test 2. Subjective scores: Pain and stiffness (combined, VAS, 0-20). Points of assessment: two times prior to treatment, after treatment, 2, 4 and 6 months after treatment
Hidding 1993 (Netherlands)	Concealment of allocation: MET Co-intervention: MET Exclusions or losses to follow-up: MET Outcome assessment: MET Blinding of patients: NOT MET Overall assessment: Low risk of bias	144 participants, age between 17 and 69 years, 76% men. Inclusion: New York criteria + one or more of the following features: Pain, stiffness or functional limitation last 3 months. Exclusion: Hip replacement, BP>100mmHg at rest, pregnancy	Group 1: A home-exercise program, directed at the hip joints, peripheral joints and the entire spinal column. The participants were encouraged to exercise for 30 minutes daily during the 9 months study period. Group 2: The home exercise program + supervised group physical therapy once a week over the 9 months study period. The group exercise program consisted of: 1hour physical training, 1 hour sporting activity, 1 hour hydrotherapy	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 Spondylarthropathies, Functional Index 4: Patient global assessment of wellbeing (VAS, 0-10). Points of assessments: baseline and subsequently every 3 months up to 9 months
Kraag 1990 (Canada)	Concealment of allocation: UNCLEAR Co-intervention: MET Exclusions or losses to follow-up: MET Outcome assessment: MET Blinding of patients: NOT MET Overall assessment: moderate risk of bias	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: 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. Exclusion: more than 10% loss of hip flexion– contravening treatment	Group 1: Home physiotherapy program. One-to-one design, educational strategy, disease information and exercises. The treatment objectives were: disease education, pain control, improved posture and function. Planned visits were 8-16 during the intervention period of 4 months Group 2: control-group, no intervention	Main outcome: finger-tip-to-floor-distance Secondary outcomes: the Toronto Activities of Daily Living Questionnaire, occiput-wall-distance, Schober test, pain (VAS, 0-10), morning stiffness and sleep pattern. Points of assessments: baseline and after intervention (4 months)
Sweeney 2002 (United Kingdom)	Concealment of allocation: UNCLEAR Co-intervention: UNCLEAR Exclusions or losses to follow-up: NOT MET Outcome assessment: UNCLEAR Blinding of patients: NOT MET Overall assessment: High risk of bias	155 participants aged between 16-65 years, 67% men. Inclusion: members of the National AS Society or outpatients of the Royal National Hospital for Rheumatic Diseases Exclusion: not described	Group 1: The 6 months home-based intervention, delivered by mail, consisted of: an exercise/ educational video, an educational booklet, an exercise progress wall chart and exercise reminder stickers. Group 2: control-group, no intervention	Physical function (BASFI, 0-10), disease activity (BASDAI, 0-10), global well-being (BAS-G, 0-10), exercise self efficacy (ESE), arthritis self efficacy (SES), quantity of AS exercise. Points of assessments: baseline and after intervention (6 months)
Van Tubergen 2001 (The Netherlands, Germany and Austria)	Concealment of allocation: MET Co-intervention: MET Exclusions or losses to follow up: MET Outcome assessment: MET Blinding of patients: NOT MET Overall assessment: Low risk of bias	120 participants (3 groups of 40). Group 1: 67% men, mean (SD) age 48 (10). Group 2: 70% men, mean (SD) age 49 (9). Group 3 (control-group): 85% men, mean (SD) age 48 (10). Inclusion: New York criteria, pain and stiffness or functional limitations for at least 3 months before entry, able to stay away from home and work for 3 weeks. Exclusion: inability/unwillingness to participate in weekly group physical therapy, pregnancy, claustrophobia, severe comorbidity and/or AS for more than 20 year	Group 1: Spa- exercise therapy Austria Group 2: Spa-exercise therapy Netherlands The 3 weeks standardized spa-exercise therapy consisted of group physical exercises, walking, correction therapy (lying supine), hydrotherapy, sports and sauna. Group 3: control group, 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	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