# Exercise and ankylosing spondylitis with New York modified criteria: a systematic review of controlled trials with meta-analysis

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## ABSTRACT

Ankylosing spondylitis is a systemic rheumatic disease that affects the axial skeleton, causing inflammatory back pain, structural and functional changes which decrease quality of life. Several treatments for ankylosing spondylitis have been proposed and among them the use of exercise. The present study aims to synthesize information from the literature and identify the results of controlled clinical trials on exercise in patients with ankylosing spondylitis with the New York modified diagnostic criteria and to assess whether exercise is more effective than physical activity to reduce functional impairment. The sources of studies used were: LILACS, Pubmed, EBSCOhost, B-on, personal communication, manual research and lists of references. The criteria used for the studies selection was controlled clinical trials, participants with New York modified diagnostic criteria for ankylosing spondylitis, and with interventions through exercise. The variables studied were related to primary outcomes such as BASFI (Bath Ankylosing Spondylitis Functional Index) as a functional index, BASDAI (Bath Ankylosing Spondylitis Disease Activity Index) as an index of intensity of disease activity and BASMI (Bath Ankylosing Spondylitis Metrology Index) as a metrological index assessing patient's limitation on movement. From the 603 studies identified after screening only 37 articles were selected for eligibility, from which 18 studies were included. The methodological quality was assessed to select those with an high methodological expressiveness using the PEDro scale. A cumulative meta-analysis was subsequently performed to compare exercise versus usual level of physical activity. Exercise shows significant statistical outcomes for the BASFI, BASDAI and BASMI, higher than those found for usual level of physical activity.

**Keywords:** Exercise; Ankylosing Spondylitis; New York Modified Criteria; Review.

## INTRODUCTION

Ankylosing spondylitis (AS) is a common inflammatory rheumatic disease that afects the axial skeleton, causing characteristic inflammatory back pain, which can lead to structural and functional impairments and a decrease in quality of life[1]. The involvement of other joints as the complex articulation of the hip may be present[2,3]. The evolution of the signs and symptoms is very much related with pain, decrease of spinal mobility, column stiffness and function[4]. As other rheumatic diseases, AS provides a chronic inflammation resulting in the degradation of the axial skeleton, the spinal column and adjacent joints[1,3], and its progression leads to a decline in the functional capacity of the individual.

The term AS suggests a disease which can gradually cause a curvature through the inflammation and ossification of the spine. It has an ascending character, reaching all the vertebral segments, with a limited range of motion and a decrease in functionality. The initial position is characterized by flexed hips and knees to keep the center of gravity in the support base. The progressive involvement of the cervical spine contributes to the development of the "skier posture", characterized by straightening of the lumbar lordosis and increase of the dorsal kyphosis and forward head[5]. On

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average, AS incidence rates range from 0.2% to 1% of the adult population, which makes AS a disease as common as rheumatoid arthritis[6]. Symptoms of the disease appear in average around 23 years of age 7 and men are 2 to 3 times more likely to be affected than women[8].

The disease has no cure, but there are a number of treatments available to help the patients and to relieve the symptoms including medications and physical therapy[9-11], however a few studies examined other interventions such as electrotherapy, manual therapy and spa therapy[12]. Immobilization previously prescribed by physicians in rheumatic diseases has fallen into disuse. Nowadays, international guidelines and scientific societies recommend exercise as a tool to improve or maintain range of motion, muscle strength and well-being[13] and it is the most studied physical intervention in AS.

Exercise is a sub-category of physical activity that is conducted in a planned, structured and repetitive way, aiming to maintain or improve one or more components of physical fitness important to health, education, recreation and well-being. To produce more effective results, exercise should be supervised, planned in advance by a specialist, targeted accurately and corrected if necessary[14], however there are other types of informal exercise such as home exercise and balneotherapy that are frequently used for therapeutic purposes in AS.

Regular physical exercise seems to be beneficial for those affected by AS, in particular when it is planned according to the needs of the individual aiming to maintain or improve the level of physical fitness[15-17]. Nevertheless, there is a lack of studies showing evidence for the positive effects of exercise intervention programs in patients with AS and adequate exercise protocols to be used with these patients.

Ankylosing spondylitis research in clinical practice depends on knowledge about the different indicators of the disease and its measurements[18]. Different AS assessment tools are available in the literature to quantify the disease activity, functional impairment, degree of structural damage, patient outcomes and quality of life, including the BASFI (Bath Ankylosing Spondylitis Functional Index) for functional assessment, the BASDAI (Bath Ankylosing Spondylitis Disease Activity Index) as intensity of disease activity measurement index and the BASMI (Bath Ankylosing Spondylitis Metrology Index) as a metrology index assessing patient's limitation on movement[18].

The BASFI contains 10 questions referring to the functional capacity of patients with AS and about their performance of daily life activities. The items must be marked in a numeric rating scale, which can be used in an alternatively visual analog scale from 0 to 100. The result is the arithmetic mean of completed items. The higher the score, the higher the disability level[2]. The BASDAI index is a composite measure of disease progression to evaluate the intensity of fatigue, pain in peripheral joints and in the spine as well as the severity of morning stiffness. High scores mean higher severity or higher disease activity[2]. The BASMI is a metrological index that uses measurement to assess cervical rotation, tragus to wall distance, lumbar side flexion, lumbar flexion (modified Schober's test) and intermalleolar distance. The conversion of each measure uses a score of 0 to 10. The higher the BASMI score the more severe the patient's limitation of movement due to their AS[19].

The aim of this study is to perform a systematic review followed by a meta-analysis and summarize information about the results of controlled clinical trials on exercise in patients with AS with New York modified diagnostic criteria and assess whether exercise is more effective than physical activity as a treatment to improve functionality, to reduce intensity of disease activity and to increase mobility in patients with AS.

## METHODS

### IDENTIFICATION OF THE STUDIES

The methodological design of the present study was based on a systematic review using theoretical recommendations suggested by Moher, Liberati, Tetzlaff, Altman and The Prisma Group[20]. We searched in several electronic databases (LILACS, Pubmed, EBSCO host and B-On), using terms taken from Medical Subject Headings (MeSH) that included the following words: "ankylosing spondylitis", "exercise", "physical therapy", "randomized controlled trial", and "controlled clinical trial". The searches were performed within a predefined period of publication, excluding all studies prior to 1995 (search range from 1995 to 2012). We also examined bibliographies from articles included in the search and contacted experts through e-mail as well as performed a manual review in monographs and in Master and PhD thesis at the National Library of Portugal and in proceedings and abstract books of international scientific conferences and meetings. Two re-

searchers independently reviewed titles and available abstracts to retrieve potentially relevant studies. Studies needed to be identified by only one person to be retrieved.

### INCLUSION CRITERIA

Studies were included in the review for full analysis of the manuscript if they: i) include participants diagnosed with ankylosing spondylitis according to the modified New York criteria, ii) include controlled clinical trials and iii) include interventions with exercise. Studies in other languages rather than English or Portuguese, observational case series, follow-up studies where the first study has already been included, controlled trials when the type of clinical outcome was not proposed by the inclusion criteria, and outcome studies that used pain medication for pain relief concomitant with physical exercise were excluded from the review. Two authors independently extracted data (study identification, diagnostic criteria, participant details, intervention details, outcome measures, and the quality criteria), using a structured data extraction form. Discrepancies were resolved by referring to the original papers and discussion.

### STUDIES QUALITY

The methodological quality of the studies was assessed using the PEDro Scale developed by Moseley, Maher, Sherrington and Herbert[21]. The first criteria (criteria for selecting the sample) should not be scored according to the scale. The scale assesses 11 different criteria on the studys internal validity. Two of the three criteria for the use of procedures, such as masking, were not classified (criteria 5 and 6) because it is very difficult, if not impossible to apply it as exercise cannot be hidden. Thus, eight (2, 3, 4, 7, 8, 9, 10 and 11) of the eleven criteria of quality were evaluated for this systematic review. Articles with a score equal to or greater than five points on PEDro's Scale were considered as highly methodologically relevant.

### OUTCOME MEASURES

Primary clinical outcomes used different scales such as the BASFI (Bath Ankylosing Spondylitis Functional Index), the BASDAI (Bath Ankylosing Spondylitis Disease Activity Index) and the BASMI (Bath Ankylosing Spondylitis Metrology Index) as quantitative indicators of functionality, intensity of disease activity and patient's movement limitations were very useful to measure therapeutic interventions.

### STATISTICAL ANALYSIS

Studies results comparing exercise versus physical activity as a treatment to improve functionality in AS were homogeneous so for meta-analysis purposes we used the fixed effects inverse variance method[22]. The Kappa index was used to assess the inter-observer agreement in the selection of the studies included, thus reducing the possibility of bias[23]. This measure of agreement has the maximum value of 1, where this value represents a complete agreement. Values close to and below 0, indicate no agreement or that the agreement was exactly as expected by chance.

## RESULTS

### STUDY INCLUSION AND CHARACTERISTICS

According to the defined search strategy, the literature search identified 603 articles, summarized in Figure 1. In the screening, 542 articles were excluded leaving 61 records screened and 24 due to duplications. By reading the title and abstract, 37 studies were identified for full text analyses. However, from these 37 studies, 19 did not meet the inclusion criteria due to: i) series of cases (n = 7)[24-31]; ii) observational studies are cross-sectional (n=4)[32-34] (Rodrigues S, Master dissertation, Coimbra: University of Coimbra); iii) studies with intervention without exercise in both groups (n = 2)[35,36]; iv) studies that did not meet the inclusion criteria for participants (n = 4)[37-39]; v) the paper presented a clinical outcome outside the inclusion criteria (n = 1)[40]; and finally, vi) that corresponded to a follow-up of a study already included in the sample (n = 1)[41]. Thus, 19 articles of controlled trials of exercise intervention fulfilled the inclusion criteria and were selected for qualitative review. In our study there was concordance between the two reviewers, with kappa = 1.

Nineteen articles were evaluated for their methodological quality (see Table I). The characteristics of included studies are summarized in Table I, according to authorship, year of publication, country, diagnostic criteria used in the study, sample size, age and gender ratio. Eighteen (94.73%) of the 19 studies included were published in the twenty-first century, since the year 2001. Of these 18 studies, 12 were from Turkey (63.15%), 2 from South Korea (10.52%), and one each in different countries such as Spain, England, Brazil, Sweden and the Netherlands (5.26%). There were 858 individuals participating in these studies. The average

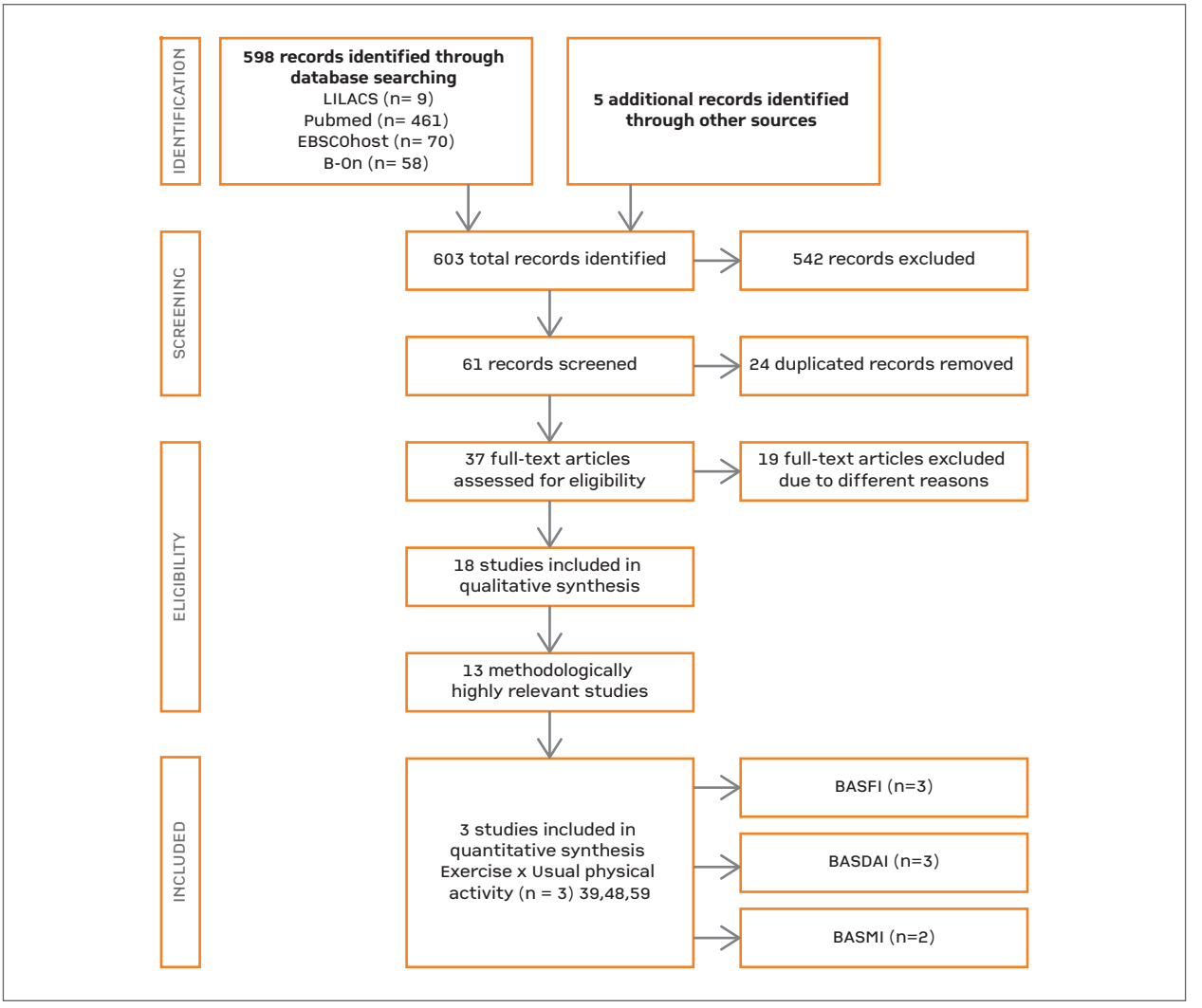


**FIGURE 1.** Progress of search for relevant studies. Adapted from Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group (2009)[20]. *Preferred Reporting Items for Systematic Reviews and Meta-Analyses:* The PRISMA Statement.

number of subjects *per* sample was 48. The study with a larger sample had 120 participants[42] and the smallest 30 participants[43]. In terms of gender, males prevailed to females in every study.

## TYPE OF EXERCISE, PROGRAM LENGTH AND SESSION DURATION

The type of exercise ranged between balneotherapy associated with home exercise (consisting of postural exercises, stretching, strength and breathing), aquatic exercise combined with home exercise, home exercise associated with swimming, biking associated with home exercise, pilates, GPR (global postural reeducation) and Tai Chi. The comparative form of intervention used was the home exercise (non-supervised) versus supervised exercise (n=4, 21.05%)[43-46]. Other studies compared home exercise and usual physical activity (n=3, 15.78%)[39,47,48] and balneotherapy associated with home exercise compared with home exercise (n=2, 10.52%)[42,49].We also did a comparison between conventional GPR and supervised exercise (n=2, 10.52%)[50].

The duration of the studies ranged from 3-16 weeks, with an average of 8 weeks. The frequency of doing exercise ranged from 1-7 times per week. The duration of the exercise sessions ranged between 20 and 120 minutes per session. Few studies mentioned any variables related with exercise intensity prescription (n=17,

**TABLE I. SUMMARY OF INCLUDED CONTROLLED TRIALS**

| Author/Year | Country | Diagnostic criteria | Sample size | Age (M ± SD) | Gender | Type of exercise | Frequency & duration of the intervention | Daily duration/ /intensity | Clinical outcome | Points on PEDro Scale |
|---|---|---|---|---|---|---|---|---|---|---|
| Altan *et al.*, 2006[38] | Turkey | Modified New York | G1: 28<br>G2: 26 | ?<br>? | ?<br>? | G1: Balneotherapy + Home exercise<br>G2: Home exercise | 1/week x 3 weeks | 30 min<br>? | BASFI, BASDAI, DFI | 7/8 |
| Altan *et al.*, 2012[39] | Turkey | Modified New York | G1: 29<br>G2: 24 | G1: 46,5±11,2<br>G2: 43,6±10,1 | ?<br>? | G1: Pilates<br>G2: Usual physical activity | 3/week x 12 weeks | 60 min<br>? | BASFI, BASDAI, BASMI | 7/8 |
| Analay *et al.*, 2003[40] | Turkey | Amor | G1: 23<br>G2: 22 | G1: 37,6 ±11,3<br>G2: 34,3 ± 7,9 | G1: 20M/3F<br>G2:18M/4F | G1: Supervised group<br>G2: Home exercise | 3/week x 6 weeks | 50 min<br>? | BASFI | 7/8 |
| Aytekin *et al.*, 2012[41] | Turkey | Modified New York | G1: 34<br>G2: 32 | G1:34,35 ±9,48<br>G2: 35,75 ±6.71 | G1: 25M/9F<br>G2: 27M/5F | G1: Home exercise (5/ week)<br>G2: Home exercise (Less than 5/week) | 5/week x 12 weeks | 30 min<br>? | BASFI, BASDAI | 3/8 |
| Cagliyan *et al.*, 2007[44] | Turkey | Modified New York | G1: 23<br>G2: 23 | G1:35,2±7,8<br>G2:36,8±9,4 | G1:18M/5F<br>G2:20M/3F | G1: Supervised group<br>G2: Home exercise | 1/week x 12 weeks | 120 min<br>? | VAS | 6/8 |
| Durmus *et al.*, 2009[a48] | Turkey | Modified New York | G1: 25<br>G2: 18 | G1:37,34 ±7,33<br>G2:42,32±8,19 | G1:21M/4F<br>G2:14M/4F | G1: Home exercise<br>G2: Usual physical activity | 7/week x 12 weeks | ?<br>? | BASFI, BASDAI | 5/8 |
| Durmus *et al.*, 2009[b51] | Turkey | Modified New York | G1: 19<br>G2: 19<br>G3: 13 | G1: 35,9±7,3<br>G2:38,1±11,1<br>G3: 43,5±7,3 | G1:17M/2F<br>G2: 14M/5F<br>G3:12M/1F | G1: Home exercise<br>G2: GPR<br>G3: Usual physical activity | 7/week x 12 weeks | ?<br>? | BASFI, BASDAI | 4/8 |
| Fernandez-de-las-Penas *et al.*, 2005[37] | Spain | Modified New York | G1: 20<br>G2: 20 | G1: 45±9<br>G2: 46±8 | G1: 15M/5F<br>G2: 16M/4F | G1: GPR<br>G2: Supervised | ? (15 sessions) 16 weeks | 60 min<br>? | BASFI, BASDAI, BASMI | 7/8 |
| Gunendi *et al.*, 2010[52] | Turkey | Modified New York | G1: 16<br>G2: 16 | G1:45,6±12,4<br>G2:43,4±12,0 | G1:13M/3F<br>G2:11M/5F | G1: Supervised<br>G2: Home exercise | 5/week x 3 weeks | 60 min<br>* | BASFI, BASDAI | 6/8 |
| Gurcay *et al.*, 2008[50] | Turkey | Modified New York | G1: 29<br>G2: 28 | G1:40,2±10,38<br>G2: 41,3±8,59 | G1:27M/2F<br>G2:22M/6F | G1: Balneotherapy + Home exercise<br>G2: Home exercise | 5/week x 3 weeks | | BASFI, BASDAI, BASMI | 7/8 |

*Continues on the next page*

**TABLE I. CONTINUATION**

| Author/Year | Country | Diagnostic criteria | Sample size | Age (M ± SD) | Gender | Type of exercise | Frequency & duration of the intervention | Daily duration/ /intensity | Clinical outcome | Points on PEDro Scale |
|---|---|---|---|---|---|---|---|---|---|---|
| **Helliwell *et al.*, 1996**[45] | England | Modified New York | G1:15<br>G2:15<br>G3:14 | G1:38,9±11,1<br>G2: 42,8±12,6<br>G3: 41,9±11,9 | G1:12M/3F<br>G2:14M/1F<br>G3: 13M/1F | G1: Supervised<br>G2: Aquatic + Home exercise<br>G3: Home exercise | 7/week x 3 weeks | | Evaluation of the spine mobility | 6/8 |
| **Ince *et al.*, 2006**[49] | Turkey | Modified New York | G1: 15<br>G2:15 | G1: 33,67±5,15<br>G2: 36,13±7,20 | G1:9M/6F<br>G2:9M/6F | G1: Supervised group<br>G2: Usual physical activity | 3/week x 12 weeks | | Evaluation of the spine mobility | 7/8 |
| **Karapolat *et al.*, 2008**[57] | Turkey | Modified New York | G1: 22<br>G2: 16 | G1: 47,5±11,78<br>G2: 46,6±14,8 | G1:15M/7F<br>G2: 11M/5F | G1: Supervised group<br>G2: Home exercise | 3/week x 6 weeks | 30 min<br>? | BASFI, BASDAI, BASMI | 4/8 |
| **Karapolat *et al.*, 2009**[43] | Turkey | Modified New York | G1: 13<br>G2:12<br>G3: 12 | G1: 50,15±12,39<br>G2: 46,92±13,39<br>G3: 48,42±9,47 | G1:10M/3F<br>G2:8M/4F<br>G3:9M/3F | G1: Swimming + Home exercise<br>G2: Walk + Home exercise<br>G3: Home exercise | 3/week x 6 weeks | ?<br>? | BASFI, BASDAI, BASMI | 5/8 |
| **Lee *et al.*, 2008**[54] | Korea South | Modified New York | G1: 13<br>G2:17 | G1: 35,2±11,5<br>G2: 34,9±12,9 | G1:10M/3F<br>G2:15M/2F | G1: *Tai Chi*<br>G2: Usual physical activity | (1/week x 6 weeks and 2/week x last weeks) 8 weeks | 50 min Aerobic (Karvonen's formula + Borg Scale) | BASDAI | 4/8 |
| **Lim *et al.*, 2005**[46] | Korea South | Modified New York | G1:25<br>G2:25 | G1: 28,8±9,3<br>G2: 28,1±7,5 | G1:19M/6F<br>G2: 20M/5F | G1: Home exercise<br>G2: Usual physical activity | 7/week x 8 weeks | 20 min<br>? | BASFI, EVA | 4/8 |
| **Silva *et al.*, 2011**[53] | Brazil | Modified New York | G1:20<br>G2:15 | G1: 35,3±12,2<br>G2: 44,27±10,55 | G1: 14M/6F<br>G2: 12M/3F | G1: GPR<br>G2: Supervised | 1/week x 16 weeks | 60 min<br>? | BASDAI | 5/8 |
| **Van Tubergen *et al.*, 2001**[55] | Nether-lands | Modified New York | G1: 40<br>G2: 40<br>G3: 40 | G1: 48±10<br>G2:49±9<br>G3:48±10 | G1:25M/15F<br>G2:28M/12F<br>G3:34M/6F | G1: Balneotherapy + Supervised group<br>G2: Balneotherapy<br>G3: Home exercise | 5/week x 3 weeks | 90 min<br>? | BASDAI | 8/8 |
| **Widberg *et al.* 2009**[59] | Sweden | Modified New York | G1: 16<br>G2: 16 | G1: 36,5<br>G2:35 | G1:16M<br>G2:16M | G1: Home exercise<br>G2: Usual physical activity | 2/week x 8 weeks | 60 min<br>? | BASFI, BASDAI, BASMI | 8/8 |

G1: Group 1 / G2: Group 2 / G3: Group 3; ?: No mention; VAS: visual analogue scale; *30 min of aerobic (60-80% Heart rate), Resistance (12 repetitions for muscle groups) and 10 min of stretching

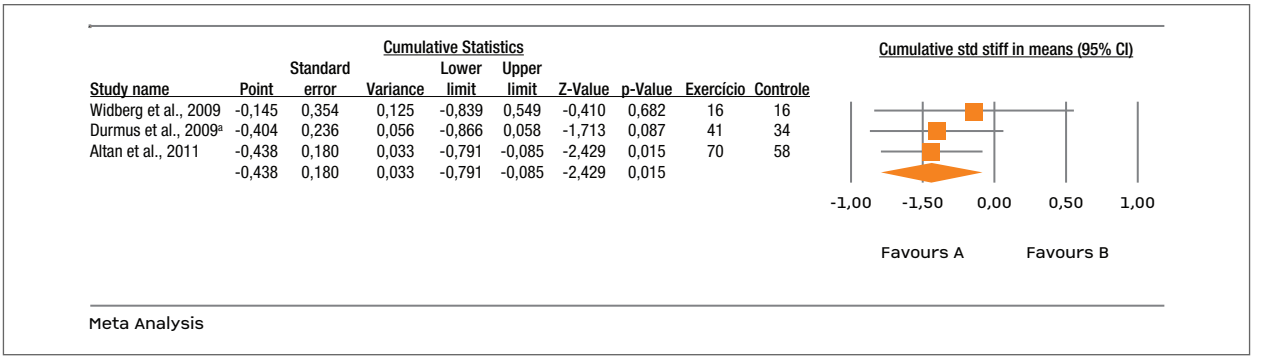


**FIGURE 2.** Standardized mean difference in size of effect of exercise compared with usual physical activity intervention for treatment to improve functionality in AS using BASFI

89.47%). Clinical outcomes evaluated more than one variable (n = 12, 63.15%)[37,39,43,45,47,49,50-52,46,53]. The most common were BASFI for functionality and BASMI for patient's movement limitations (n = 13, 68.42%) while the visual analogue scale (VAS) and the evaluation of the spine mobility occurred twice (n = 2, 10.52%). The total number of points to assess methodological quality for each one of the studies analysed using the PEDro's scale ranged from 3 to 8 points.

## EXERCISE VERSUS USUAL PHYSICAL ACTIVITY AS A TREATMENT TO IMPROVE FUNCTIONALITY, DECREASE INTENSITY OF DISEASE ACTIVITY AND INCREASE MOBILITY IN PATIENTS WITH AS

From all the studies analyzed, four of them were high-quality studies to compare exercise versus usual physical activity in ankylosing spondylitis[36,39,50,54]. For the exercise subgroup we considered the following studies: exercise at home (unsupervised)[36,43], exercise supervised[50] and pilates[39]. Three of these studies had BASFI and BASDAI outcomes in common[39,43,53], two studies had BASMI outcomes in common[39,55]. From the 138 patients enrolled, 70 participated in exercise and 58 in usual physical activity. The patients in the exercise group were compared with those from the usual physical activity group.

Figure 2 shows the standardised mean differences in effect size of the 3 studies that provided these data for BASFI outcomes as a functional index[39,43,55].

Pooling studies according to exercise versus physical activity intervention effects on BASFI outcomes revealed standardised mean differences, calculated using the fixed effects model, a cumulative analysis [weighted mean deviation= -0.438 (95%; CI= - 0.791 to -0.085)] and obtained a significant estimated effect size of Z= -2.429 (p = 0.015).

Figure 3 shows the standardised mean differences in effect size of the 3 studies that provided these data for BASDAI outcomes as a intensity of disease activity index[38,44,55].

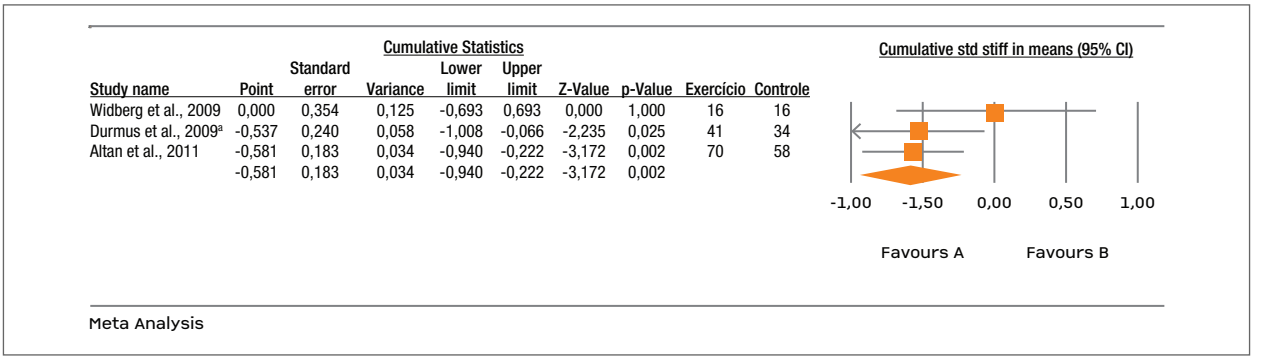


**FIGURE 3.** Standardized mean difference in size of effect of exercise compared with usual physical activity for treatment to reduce intensity of disease activity in AS using BASDAI

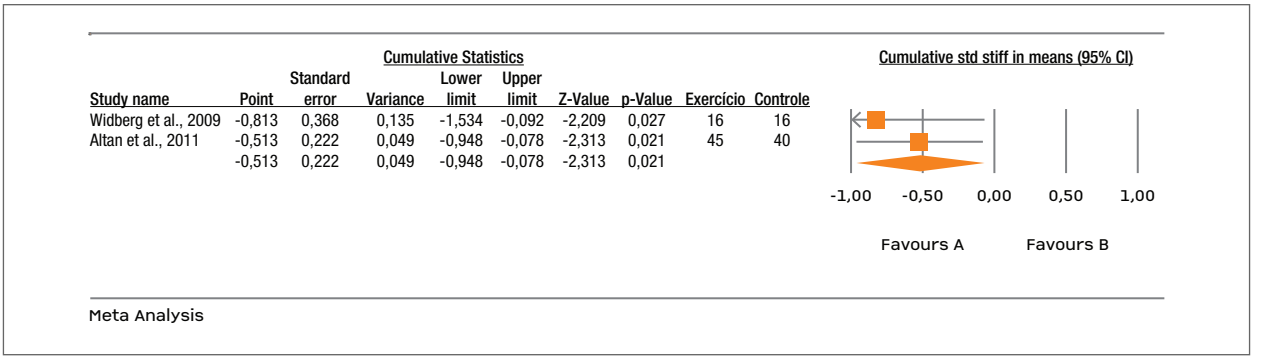


**FIGURE 4.** Standardized mean difference in size of effect of exercise compared with usual physical activity for treatment to improve mobility in AS using BASMI

Pooling studies according to exercise versus physical activity intervention effects on BASDAI outcomes revealed standardised mean differences, calculated using the fixed effects model, a cumulative analysis [weighted mean deviation= -0.581 (95%; CI= -0,940 to -0.222)] and obtained a significant estimated effect size of Z=-3,172 (p = 0,002).

Finally, and for the two studies that showed BASMI outcomes in common as an index to assess patient's limitation on movement44,55, from the 85 subjects enrolled 45 were involved in exercise and 40 in usual physical activity. Similarly, the patients in the exercise group were compared to those in the usual physical activity group. Figure 4 shows the standardised mean differences in effect size for these 2 studies.

Pooling studies according to exercise versus physical activity intervention effects on BASMI outcomes, revealed standardised mean differences, calculated using the fixed effects model, a cumulative analysis [weighted mean deviation= -0.513 [(95%; CI= -0,948 to -0,078)] and obtained a significant estimated effect size of Z=-2,313 (p =0,021).

## DISCUSSION

This systematic review aimed to investigate the effects of exercise versus physical activity in AS and provide evidence that exercise is more effective than physical activity as a treatment to improve the level of functionality, to reduce intensity of disease activity and to increase mobility in patients with AS. However, different effects were obtained when different types of exercise were analyzed. Publications on this particular topic are recent and most of them were published after 2001 (18 out of 19 studies). This increase shows an important direction to support evidence-based practice in health sciences.

The disease predominantly affects males[1] and that was confirmed in all the samples from the studies included in the systematic review, however structural changes are different in females with AS[8] and symptoms appear slightly later[56]. Further research is required on this particular topic. Studies also show differences between the results obtained with exercises for men and women.

Sampling techniques used in the studies are important to assure the quality of data and to provide evidence that participants were selected using the adequate procedures. When we classify the participants as part of an homogeneous sample we are referring that patients have AS using the diagnostic criteria of New York Modified, however it is very important to take in consideration the time of disease for each patient as the disease is a progressive one with an associated evolution of both signs and symptoms.

The articles analysed in the present study showed high values for standard deviation as a dispersion parameter. Standard deviation values show how much variation or dispersion from the average exists in a specific sample and a high standard deviation indicates that the data points are spread out over a large range of values. In the Karapolat's and colleges study[57], the mean and standard deviation values for age in group 1 are 47.5 ±11.78 and in group 2 are 46.6 ± 14.8. Being a progressive disease, the analysis of structural changes of the individual with AS is different over the years.

The type of exercise used with AS patients is broad and low impact, according to the majority of the analyzed studies. An important problem identified by re-

searchers[58] is the limited information about the type and intensity of exercise/physical activity used. The criteria for the appropriate exercise intensity prescription are practically nonexistent in the majority of the studies. Only one study explains the different components of the exercise program, including aerobic resistance, strength and flexibility[52]. Ince and colleges[49] study mentions that the intensity of aerobic exercise is controlled individually using Karvonen's formula and the Borg scale but no further information is provided about the intensity interval used in the study. It is also not easy to calculate the precise energy expenditure for a specific exercise and individual. There are many factors that may influence exercise intensity and duration, however exercise must be properly prescribed within an appropriate intensity and a minimal duration interval as not all types of exercise have positive effects on patient's health and well-being[42,59].

Some limitations were identified for the present study. First was the moderate heterogeneity of the exercise programs used by the authors, in each one of the studies included. Most of the studies reported very different types of exercise interventions, mainly informal and self-administrated, with no accurate information about volume or intensity, making comparability very difficult. Moreover, such heterogeneity did not allow us to perform a meta-analysis comparing all types of exercise used and conditioned our decision to perform more than one meta-analysis according to the different types of exercise, however decreasing the reliability of the meta-analysis results. A second limitation is due to the language criteria for inclusion in the data search. In spite of the extensive search of the databases, we may have missed some other studies, in other languages rather than English and Portuguese. This methodological procedure may have reduced the number of studies selected for analysis.

## CONCLUSIONS

Our aim was to assess clinical effectiveness - exercise versus usual physical activity as a more effective treatment tool to improve functionality in AS. According to the results of our study and based on BASFI, BASDAI and BASMI outcomes for clinical practice, physical exercise is a better therapeutic tool to improve functionality, to reduce intensity of disease activity and to improve mobility in patients with AS than usual physical activity. In spite of this positive therapeutic effect it is not possible to identify which type of exercise and which major guidelines should be used to maximize it.

Many of the problems identified in the present study highlighted the need for a better quality research in the area of exercise in patients with AS. Most of the studies analyzed showed important methodological limitations in the research design used to assess and monitoring exercise intensity, duration or frequency during the intervention program. This type of information is vital to understand which are the most appropriate programs and the most effective type of exercises to be used with patients with AS. It is necessary that future studies may include further detailed information about the main characteristics of the exercise programs used: i) type of exercise (ex: aerobic exercise, yoga, strength training), ii) major guidelines for exercise prescription (ex: method, intensity, frequency, duration and progression), since presently most of them omitted this important information. We hope this study encourages further researchers to improve the quality of their research in exercise and AS area.

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# WORKSHOP VASCULITES

## Coimbra, Portugal
## 30 a 31 de Janeiro de 2015