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ORIGINAL ARTICLE

Effects of home-based exercise intervention on health-related quality of life for patients with ankylosing spondylitis: a meta-analysis

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Abstract The objective of this paper was to objectively evaluate the effectiveness of home-based exercise interventions for improving health-related quality of life in patients with ankylosing spondylitis (AS). Databases including PubMed, Web of Science, EMBASE, Ovid-Medline, and The Cochrane Library were electronically searched published from inception through October 2014 involving home-based exercise intervention in AS patients. Studies that measured the Bath Ankylosing Spondylitis Functional Index (BASFI), the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI), depression and pain as outcomes were included. Studies involving patients with multiple diseases or received combinations of other interventions were excluded. Two independent investigators screened the identified articles, extracted the data, and assessed the methodological quality of the included studies. Qualitative descriptions were conducted, and quantitative analysis was performed with RevMan software (version 5.2). A total of six studies comprising 1098 participants were included in the study. Meta-analyses showed that home-based exercise interventions significantly reduced the BASFI scores (*MD*=−0.39, 95 % CI −0.57, −0.20, p=0.001), BASDAI scores (*MD*=−0.50, 95 % CI −0.99, −0.02, p=0.04), depression scores (*MD*=−2.31, 95 % CI −3.33, −1.30, p=0.001), and for pain scores because of different evaluation methods among these studies; therefore, a subgroup analysis should be conducted for comparison. The results show that home-based exercise interventions can effectively improve the health-related quality of life in patients with AS. The benefit and clinical performance of home-based exercise care requires further investigation by a series of multicenter, large-sample size randomized controlled trails.

Keywords Ankylosing spondylitis · Home-based exercise intervention · Meta-analysis · Quality of life

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Introduction

Ankylosing spondylitis (AS) is a chronic, progressive rheumatic disease characterized by inflammation and ankylosis of the axial skeleton, especially sacroiliitis, which is regarded as the sign of the disease [1]. The main clinical features are inflammatory back pain, joint stiffness, and fatigue, resulting in varying degrees of structural and functional impairments and reduced general health [2, 3]. The survey shows that AS often occurs in young men 15 to 30 years old, the prevalence of the world is 0.21 to 1.9 %, the prevalence of 1 to 2 % in Europe [4], and the prevalence of our country is 0.2 to 0.3 % [5].

The best management of AS needs a combination of nonpharmacologic and pharmacologic treatment forms to maximize long-term health-related quality of life throughout controlling inflammation and preventing of structural damage progression. Moreover, assessment of spondyloarthritis international society (ASAS)/European league against rheumatism (EULAR) recommendations suggests health education, physical exercise, physical therapy, and rehabilitation tailored to individual patient in reducing the overall burden of the disease [2, 6–8]. The main physical exercise included a multimodal exercise program [9], the Global Posture Reeducation method [10], Tai Chi [11], swimming or aerobic exercise [12], home-

based exercise [13], aquatic exercise [14], and so on at present.

Over the past years, a revolution in the treatment of AS has taken place, in terms of improving understanding of basic disease mechanisms, new imaging techniques and criteria for classification and early diagnosis, use of biological drugs (especially tumor necrosis factor alpha (TNF-α) blockers), such as etanercept, infliximab, and adalimumab have been widely used for the clinical, but increased the risk of cardiovascular disease (CVD) [15–18] and the price is very high. With the big advances in pharmacologic treatment, it is debatable whether exercise programs are needed for patients with AS. However, recent studies have shown that a combination of biological treatment and physical therapy (PT) [19], occupational therapy (OT) [20], or multidisciplinary rehabilitation programs [21–23] had synergetic effects and produced positive benefits on pain, function, and health-related quality of life, which indicated that nonpharmacologic interventions will also be important for AS patients in the future.

Some studies suggested that home-based exercise interventions are good to patients with AS, but the sample is still very small. Therefore, this meta-analysis aimed to assess the effects of home-based exercise on health-related quality of life in patients with AS.

Materials and methods

Search strategy

We aimed to study the effects of home-based exercise in AS. The research team searched five electronic databases—PubMed, Web of Science, EMBASE, Ovid-Medline, The Cochrane Library-using combinations of the terms home-based exercise, intervention, and AS.

Eligibility criteria

Adults diagnosed by a rheumatologist as having AS were included. Participants under 18 years or with juvenile-onset of AS were excluded. Quasi-randomized and randomized controlled trials (RCT), in which at least one of the groups received home-based exercise therapy, were included. Review articles, observational studies without controls, case reports, cross-sectional studies, and commentaries were excluded.

For the purpose of this meta-analysis, home-based exercise program including muscle relaxation, flexibility exercises for cervical, thoracic and lumbar spine, range of motion exercises of coxofemoral joints, stretching exercises for the major muscle groups (erector spine, abdominal muscles, shoulder muscles, hip flexors, hamstring, and quadriceps stretch), muscular strengthening, straight posture, and respiratory exercises was practically demonstrated with a CD presentation. Moreover, a training and exercise manual booklet and CD were prepared and given to all of them. They were asked to follow this exercise program at home individually five times a week at least 30 min per session for 10 weeks [24]. However, interventions offering general advice to exercise without prescribing specific exercises were excluded. Home-based exercise interventions delivered in an inpatient setting were excluded, unless being compared to a distinct outpatient exercise group. Studies in which exercise-based interventions were administered in conjunction with other modalities (e.g., manual therapy) were excluded, except they are both education and home-based exercise.

Information sources and study selection

Studies were retrieved by searching electronic databases (PubMed, Web of Science, EMBASE, Ovid-Medline, The Cochrane Library) from their inception to October 2014. Search terms were adapted for use with each database. Common keywords and medical subject headings related to three components: (1) the condition (AS), (2) the intervention (home-based exercise). Search restrictions (English language) were imposed. Finally, a hand search of the reference lists of included studies was conducted.

Two authors independently screened titles and abstracts to identify studies that potentially met the eligibility criteria. Full texts of these reports were retrieved and independently assessed for eligibility by the same two authors.

Data extraction and quality assessment

Searches were conducted, and data were extracted by two independent researchers. Each study identified in the search was evaluated for design, eligibility criteria for participants, and outcome measures. Any disagreements on inclusion were resolved by discussion to achieve consensus, and failing agreement, a third reviewer was consulted. Duplicate studies and records were excluded by screening the titles and abstracts. All remaining articles were screened by examining the full text. The quality of the trials included in this study was assessed by each researcher according to the Cochrane Handbook for Systematic Reviews of Interventions, version 5.1.0.

Outcome measures

The outcome measures of interest were BASFI, BASDAI, depression, and pain.

Statistical analyses

Outcome measures were compared between participants who were treated with home-based exercise interventions and the control group within each study. The homogeneity among trials was evaluated using I^2, and a fixed effects model was

used to compare homogeneous trials (I^2<50 %); otherwise, a random effects model was used. Pooled differences in ratios or means were calculated, and a two-tailed p value <0.05 was considered to indicate statistical significance. Sensitivity analyses were conducted using the leave-one-out approach, and publication bias was assessed from funnel plots. All analyses were performed using Comprehensive Meta-Analysis statistical software, version 5.2.0 (Cochrane Collaboration, Copenhagen, Denmark).

Results

Study selection and characteristics

A total of 87 trials were identified by the initial literature search (Fig. 1). Of these, six trials comprising 1098 participants were deemed eligible for inclusion in further analyses (Table 1). Four of the eligible studies were conducted in the Turkey [25–28], one in Spain [29], and one in UK [30]. Home-based exercise interventions employed in these studies included home-based exercise program (HEP), education, and home-based exercise. The duration of the interventional programs ranged from 6 to 24 weeks.

BASFI

Six studies involving 1098 AS patients [25–30] reported on BASFI after the intervention was initiated. A fixed effects model evaluation revealed no significant heterogeneity between home-based exercise groups and control groups in BASFI (p=0.14, I^2=39 %). A statistically significant difference was observed (MD=−0.39, 95 % CI −0.57, −0.20, p<0.001), which indicated that home-based exercise interventions reduced the BASFI scores, compared to the control groups (Fig. 2a).

BASDAI

Six studies involving 1098 AS patients [25–30] reported on BASDAI after the intervention was initiated. A random effects model was applied because of significant heterogeneity between home-based exercise groups and control groups in BASDAI (p=0.0002, I^2=79 %). A statistically significant difference was observed (MD=−0.50, 95 % CI −0.99, −0.02, p=0.04), which indicated that home-based exercise interventions reduced the BASDAI scores, compared to the control groups (Fig. 2b).

Figure 2b shows the pooled differences in the BASDAI scores after intervention, which revealed a difference between the intervention and the control groups, MD=−1.05, 95 % CI (−1.40, −0.70), p<0.001 for the 12 weeks and MD=−0.15, 95 % CI (−0.37, 0.07), p=0.18 for the 24 weeks.

Depression

Three studies involving 121 AS patients [25, 27, 28] reported on depression after the intervention was initiated. A fixed effects model evaluation revealed no significant heterogeneity between home-based exercise groups and control groups in

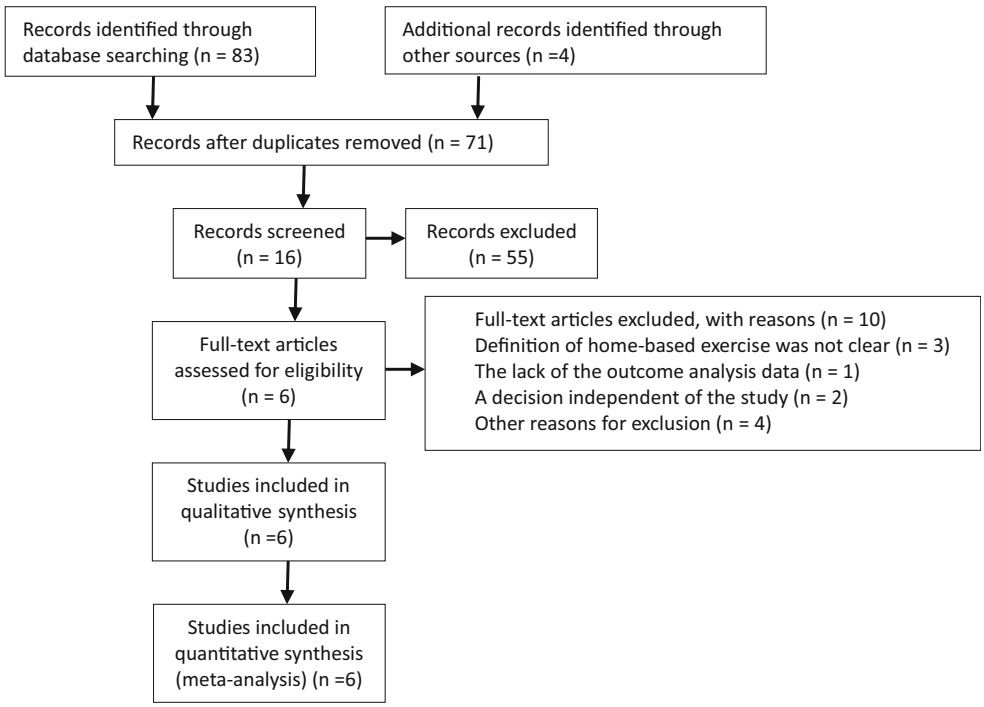

Fig. 1 Flow chart of literature retrieval and trial selection

Table 1 Characteristics of included studies

Studies	Sample size I/C	Randomization method	Age (I/C)	Intervention	Outcomes measures
Karapolat H et al. 2008	22/16	Unclear	47.5±11.78/ 46.6±14.8	I: group-based exercise C: home-based exercise	BASMI/BASFI/BASDAI/NHP/BDI
Durmus D et al. 2009	25/18	Unclear	37.34±7.33/ 42.32±8.19	I: home-based exercise C: medical therapy	BASFI/BASDAI/MAF/BDI/SF-36
Yigit S et al. 2013	20/20	Unclear	40.30±8.05/ 36.45±7.19	I: home-based exercise C: routine medical therapy	BASFI/BASDAI/MAF/BDI/SF-36
Aytekin E et al. 2012	34/32	Unclear	34.35±9.48/ 35.75±6.71	I: home-based exercise C: medical therapy	BASFI/BASDAI/VAS/ASQOL
Rodriguez-Lozano C et al. 2013	381/375	RCT	45±12/ 46±11	I:education and home-based exercise C:medical therapy	BASFI/BASDAI/VAS/ASQOL
Sweeney S et al. 2002	75/80	RCT	47±10.2/ 47±9.6	I: home-based exercise C: medical therapy	BASFI/BASDAI/BAS-G/ESE/SES

I intervention, *C* control, *BASFI* The Bath Ankylosing Spondylitis Functional Index, *BASDAI* The Bath Ankylosing Spondylitis Disease Activity Index, *BASMI* The Bath Ankylosing Spondylitis Metrology Index, *NHP* The Nottingham Health Profile, *BDI* Beck Depression Inventory, *MAF* Multidimensional Assessment of Fatigue Scale, *SF-36* Short Form 36, *VAS* Visual Analog Scale, *ASQoL* ankylosing spondylitis quality of life, *BAS-G* the Bath Ankylosing Spondylitis Global Index, *ESE* exercise self-efficacy, *SES* Self-Efficacy Scale

depression ($p=0.24$, $I^2=30$ %). A statistically significant difference was observed *(MD*=−2.31, 95 % CI −3.33, −1.30, $p=0.001$), which indicated that home-based exercise interventions reduced the depression scores, compared to the control groups (Fig. 2c).

Pain

Six studies involving 1098 AS patients [25–30] reported on pain after the intervention was initiated. The use of varying evaluation methods among these studies required that a subgroup analysis should be conducted for comparison. For this measure, homogeneity existed in the pain scores after intervention for two studies that fell into the SF-36 ($p=0.32$, $I^2=1$ %), and homogeneity existed in the pain scores after intervention for two studies of that fell into the VAS ($p=0.20$, $I^2=38$ %). Therefore, a fixed effects model of analysis was used.

Figure 2d shows the pooled differences in the pain scores after intervention, which revealed a difference about the SF-36 or VAS between the intervention and the control groups, *SMD*=0.98, 95 % CI (0.52, 1.44), $p<0.001$ for the SF-36 and *SMD*=−0.22, 95 % CI (−0.49, 0.06), $p=0.13$ for the VAS. However, the Nottingham Health Profile (NHP) and Self-Efficacy Scale (SES) are *SMD*=0.33, 95 % CI (−0.32, 0.98), $p=0.32$, and *SMD*=0.07, 95 % CI (−0.25, 0.38), $p=0.68$, respectively.

Quality assessment

Two of the six studies included in this study could be identified as having adequate sequence generation [29, 30], one having allocation concealment and blinding [29], the five studies addressed incomplete outcome data [25, 26, 28–30], and one having selective reporting bias [28]. Furthermore, the baselines were comparable in all the studies. The quality assessment outcome is summarized in Figs. 3 and 4.

Funnel plot of publication bias

The research team performed an analysis of all included studies, using a funnel plot to determine publication bias in all the literature. The outcome from the funnel plot analysis is summarized in Fig. 5, which shows asymmetry, thereby indicating that publication bias possibly exists in the included studies.

Discussion

This meta-analysis found evidence that home-based exercise intervention has greater benefits than control group in reducing BASFI, BASDAI, and depression scores in adults with AS; evidence from studies examining pain is conflicting. Because different evaluation methods among six studies, which a subgroup analysis should be conducted for comparison, the total pooled existed heterogeneity ($p<0.001$, $I^2=81$ %), there was no significant effect of intervention on pain scores (*SMD*=0.22, 95 % CI (−0.16, 0.60), $p=0.25$). However, subgroup analysis suggested that home-based exercise interventions significantly reduced the pain scores, which revealed a difference between the SF-36 or VAS and the control groups, *SMD*=0.98, 95 % CI (0.52, 1.44), $p<0.001$ for the SF-36 and *SMD*=−0.22, 95 % CI (−0.49, 0.06), $p=0.13$ for the VAS. For BASDAI, the total pooled existed heterogeneity ($p=0.0002$, $I^2=79$ %), we found the intervention time different among six studies so that a subgroup analysis should be conducted for comparison, the subgroup analysis results revealed a

difference between the intervention and the control groups, $MD=-1.05$, 95 % CI (−1.40, −0.70), $p<0.001$ for the 12 weeks and $MD=-0.15$, 95 % CI (−0.37, 0.07), $p=0.18$ for the 24 weeks. Therefore, we indicated that home-based exercise interventions reduced the BASDAI scores, compared to the control groups. Clinical and methodology homogeneity are key factors to rational pooled results of meta-analysis. Clinical homogeneity refers to participants, and methodology homogeneity refers to research protocol design, statistical method design, and interventions [31]. A comprehensive analysis of the studies found that the evaluation methods are different, especially for the two studies [28, 30]; hence, methodological heterogeneity existed in the two trials, and the research team performed a descriptive analysis to interpret the results mentioned earlier.

The study mainly aimed to evaluate the overall effects of home-based exercise outpatient program for patients with AS. The results demonstrated that the intervention program resulted in sustained improvement, in terms of significant reductions in BASDAI, BASFI, depression, and pain scores. The improvement in patient reported disease activity (BASDAI) is noteworthy, as this captures the patients' experienced

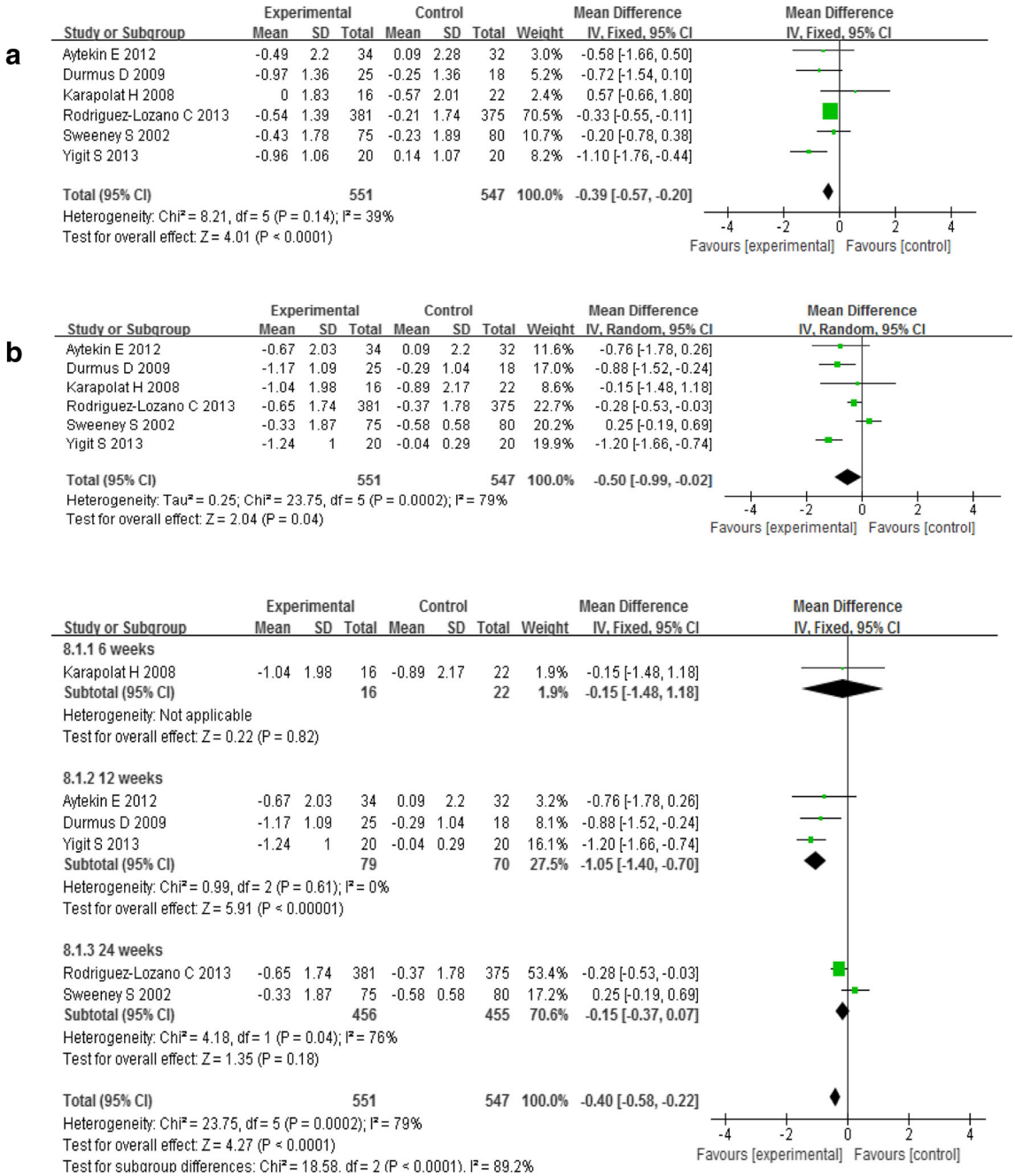

Fig. 2 Meta-analyses. Results showing **a** BASFI score, **b** BASDAI score, **c** depression, **d** pain between intervention and control groups

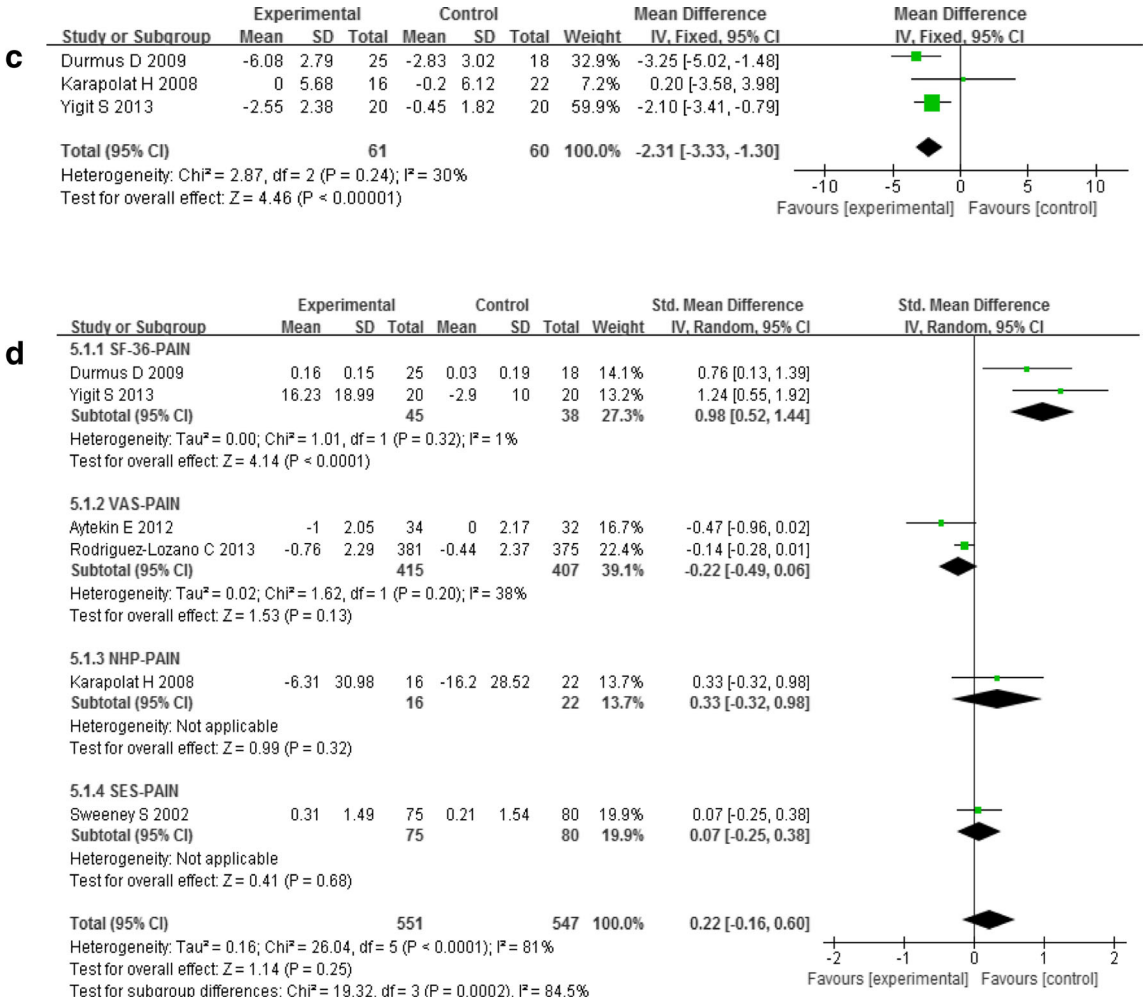

Fig. 2 (continued)

reduction in the main AS symptoms pain, stiffness, and fatigue, which are important determinants for daily functioning and health-related quality of life [3, 8, 32]. However, there were two [25, 27] of six studies that showed significant positive overall intervention effects in the SF-36 variable social functioning, role physical, role mental, and bodily pain and so on. Meanwhile, two [26, 29] of six studies also showed significant positive overall intervention effects in the Ankylosing Spondylitis Quality of Life (ASQoL). ASQoL have been translated other languages to evaluate quality of life of AS patients, and it is a good generic instrument to measure QoL in patients with AS [33–36].

Six studies are home-based exercise, but the interventions still were a little bit different. Such as, in one study, the

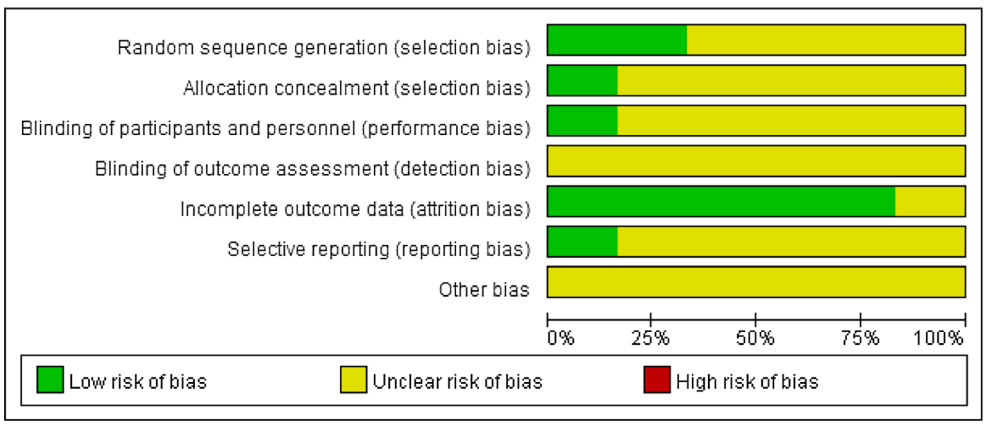

Fig. 3 Percentage of risk of bias: authors' judgments about percentages of each risk of bias item in all included studies

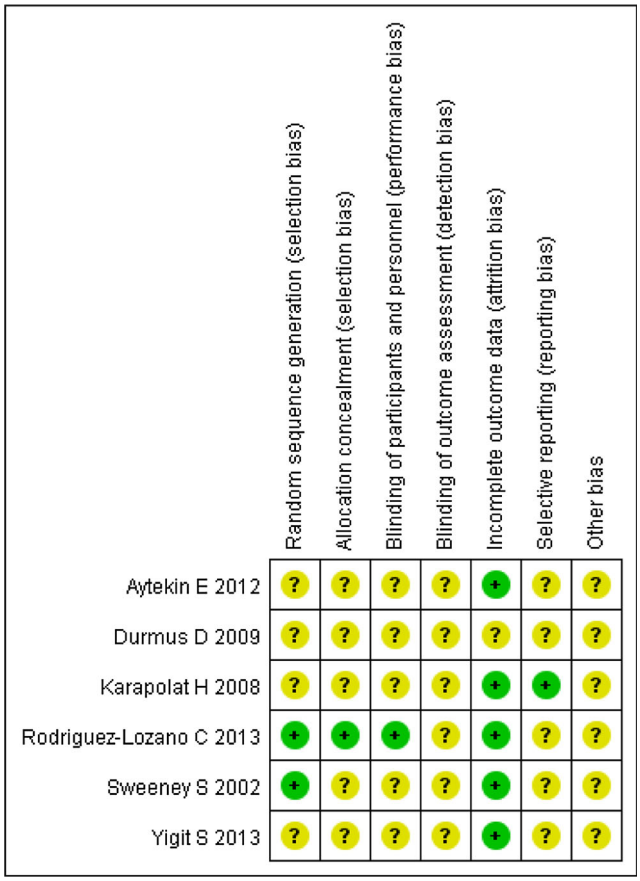

Fig. 4 Risk of bias summary: authors' judgments about each risk of bias item for each included study

exercises were individually at home 3 days a week for 6 weeks, compared to the control only no supervision [28], one study the patients were asked to practice these exercises at home individually for 7 days a week for 12 weeks and were called weekly by the researcher and to check whether they were performing the program or not. The control group they were asked to continue their normal daily activities [27]. Subjects were eligible to participate in the program if they were receiving TNF-α inhibitors at least 3 months, according to the study by Uhrin et al. [24],

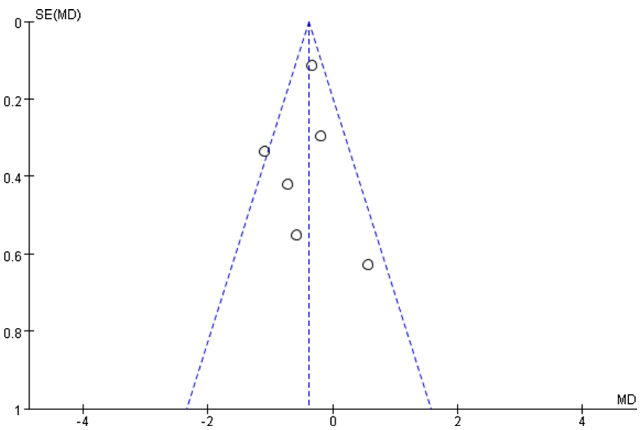

Fig. 5 Funnel plot of publication bias

patients following HEP five times a week at least 30 min per session on a regular basis (exercise group) were compared with those exercising less than five times a week (control group) [25], but we have no idea the patients whether receiving TNF-α inhibitors [26]. One study combination education and home-based exercise for intervention group, the exercise included 30 home exercises and 10 water exercises for the swimming pool and patients assigned to the nonintervention group followed the usual pharmacologic and nonpharmacologic treatments recommended by the rheumatologist in charge [29]. The intervention methods included an exercise and educational video, an educational booklet, and an exercise progress wall chart and exercise reminder stickers in the study in UK [30]. Therefore, future studies should focus on the same exercise intervention method.

Strengths, limitations, and future research

To our knowledge, to date, no article has systematically examined the effect of home-based exercise interventions in AS patients, although home-based exercise is frequently advised as part of their management. So, the aims of this article were to assess the effects of home-based exercise on health-related quality of life in adults with AS. However, there are a number of limitations to this meta-analysis that should be acknowledged. First, perhaps the most notably, only a small number of studies met the inclusion criteria, thus reducing the power of the analyses. Second, the inclusion of only English-language literature may also have restricted the number of available relevant articles; at the same time, there are only two RCT studies, existence of publication bias for studies was included, and has a negative effect on the pooled results of current meta-analyses. Therefore, future studies with a multicentered sample, large sample size, and randomized methodology are needed to draw conclusions from the current study. Meanwhile, methodological quality among studies in this article was mixed. Random sequence generation, adequate allocation concealment, and blinding of outcome assessment in future RCTs would go some ways toward addressing methodological shortcomings.

Conclusions

The findings do suggest that intervention with home-based exercise intervention may be more effective at reducing BASFI, BASDAI, depression, and pain of AS than control group. Insufficient high-quality evidence is available in the current literature regarding the effects of home-based exercise for the quality of life with AS. Hence, the findings from the current meta-analyses are by no means definitive. So, the high-quality RCTs are needed to clarify the effectiveness of home-based exercise interventions for patients with AS.

Disclosures None.

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