

Different Acupuncture Therapies Combined with Sulfasalazine for the Treatment of Ankylosing Spondylitis: Bayesian Network Meta-Analysis

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Background: Ankylosing Spondylitis (AS) is a serious challenge to public health. Acupuncture can effectively improve pain symptoms, activity function and quality of life in patients with AS. However, there is still significant heterogeneity in the evidence of its efficacy. Therefore, by conducting a Bayesian network meta-analysis, the efficacy of different acupuncture methods can be evaluated more systematically, providing a scientific basis for the optimization of treatment strategies for AS.

Methods: Randomized controlled trials of acupuncture combined with Sulfasalazine (SASP) for AS published in commonly used databases. Time up to July 8, 2025. Analysis was conducted using R4.2.0 and Stata16.0.

Results: 31 studies included 9 acupuncture methods. Network meta-analysis results: On the BASDAI indicator: Acupuncture combined with SASP did not have a significant advantage over SASP. In terms of BASFI, SASP and Acupotomy and Tuina or Fu's Subcutaneous needling and Traditional Chinese medicine had a significant advantage over SASP. In terms of Efficacy, compared with SASP, Acupotomy and SASP, Warm Needling and Tuina and SASP, Du Meridian Moxibustion and SASP Du Meridian Moxibustion and Traditional Chinese medicine and SASP, Du Meridian Moxibustion and Acupuncture and SASP Bowl moxibustio and SASP, Fu's Subcutaneous needling and Traditional Chinese medicine and SASP Acupuncture and SASP, Acupuncture and Traditional Chinese medicine and SASP have significant advantages. Du Meridian Moxibustion and Acupuncture and SASP are more effective than Du Meridian Moxibustion and SASP.

Conclusion: Based on the results of this study, Acupotomy, Du Meridian Moxibustion and Cupping and SASP combined with SASP have the best effects.

Keywords: acupuncture, ankylosing spondylitis, sulfasalazine, network meta-analysis as topic

Introduction

Ankylosing Spondylitis (AS) is a chronic immune-mediated inflammatory arthritis primarily affecting the axial skeleton, peripheral joints, and entheses. The global prevalence of AS varies significantly by region, affecting approximately 1 in 200 individuals on average, with higher prevalence rates reported in Asian populations.¹ AS imposes a multidimensional burden on patients, affecting physical health, mental well-being, and overall quality of life. Patients often experience substantial functional impairments, including restricted spinal mobility, joint stiffness, and chronic pain, which can significantly compromise their ability to perform daily activities.² Furthermore, AS is frequently associated with various extra-articular manifestations, such as uveitis, psoriasis, and inflammatory bowel disease, which further contribute to the disease burden.³ Notably, mental health comorbidities in AS patients have garnered increasing attention, with recent studies indicating a potential association between AS and an elevated risk of schizophrenia and anorexia nervosa.⁴ From a socioeconomic perspective, AS not only incurs substantial direct medical costs but also imposes indirect economic burdens through work disability, reduced productivity, and

early retirement.⁵ Additionally, the chronic inflammatory nature of AS is linked to multiple comorbidities, including cardiovascular diseases and certain cancers, collectively posing a significant public health challenge.⁶

While conventional pharmacological treatments such as non-steroidal anti-inflammatory drugs (NSAIDs) and biologic agents can alleviate symptoms, long-term use may lead to adverse effects, including gastrointestinal complications and an increased susceptibility to infections. Moreover, some patients exhibit inadequate responses to these therapies.⁷ Surgical interventions, such as total hip arthroplasty, can address severe joint deformities but are associated with surgical risks and potential postoperative complications.⁸ Importantly, current treatment modalities offer limited efficacy in managing persistent symptoms such as chronic pain and morning stiffness, and are generally unable to halt disease progression.⁹ In this context, acupuncture, as a traditional Chinese medicine therapy, demonstrates unique therapeutic advantages. Current evidence has confirmed that acupuncture is associated with higher safety, fewer side effects, and lower economic burden.¹⁰ Evidence suggests that acupuncture exerts its therapeutic effects through multiple mechanisms, including modulation of inflammatory cytokines and improvement of microcirculation.¹¹ Clinical studies have shown that various acupuncture techniques, such as electroacupuncture and moxibustion, can effectively alleviate pain, improve functional mobility, and enhance quality of life in patients with AS.¹² Notably, acupuncture has demonstrated particular efficacy in reducing morning stiffness and improving spinal range of motion.¹³ Currently, sulfasalazine (SASP) is widely used in pharmacological treatment, and numerous studies have incorporated complementary interventions such as acupuncture, moxibustion, bee venom acupuncture, or cupping therapy, achieving promising clinical outcomes.

Although acupuncture therapy demonstrates unique advantages in the treatment of autism spectrum disorder (ASD), the evidence regarding its efficacy remains incomplete across multiple dimensions, including its mechanism of action, study design, intervention protocols, operational techniques, control settings, and outcome measures. For instance, the therapeutic mechanisms of acupuncture encompass both specific and non-specific factors—such as placebo/contextual effects, which have been demonstrated to influence both acute and chronic pain.¹⁴ In particular, inconsistencies in acupuncture methodology may introduce bias into efficacy evaluations. Moreover, the invasive nature of needle insertion conveys a therapeutic significance that heightens patient awareness of the treatment process, thereby potentially influencing clinical outcomes.¹⁵ Key controversies in current research revolve around the standardization of acupuncture protocols and the methodological rigor of efficacy evaluations. On one hand, the coexistence of diverse acupuncture techniques presents a challenge in establishing standardized treatment regimens that ensure comparability across studies. On the other hand, although randomized controlled trials (RCTs) are considered the gold standard for evaluating therapeutic efficacy, the unique characteristics of acupuncture research—such as the difficulty in implementing double-blinding—have resulted in variable study quality. Moreover, the underlying mechanisms of acupuncture remain insufficiently explored, which may hinder the broader acceptance of its therapeutic benefits. These challenges underscore the need for high-quality, methodologically rigorous studies to further evaluate the efficacy of acupuncture. Therefore, conducting a Bayesian network meta-analysis would enable a more comprehensive and systematic evaluation of different acupuncture techniques, thereby providing a scientific basis for optimizing treatment strategies in AS.

Methods

Study Registration

Our study was conducted in accordance with the reporting guidelines for systematic reviews and network meta-analyses (PRISMA-NMA)¹⁶ and was prospectively registered in PROSPERO (ID: CRD420251088871).

Eligibility Criteria

Inclusion criteria:

Population: Patients clearly diagnosed with Ankylosing Spondylitis. No restrictions on race, nationality, gender, age, disease duration, etc. The diagnostic criteria lack uniformity, with most studies employing the 1984 New York revised AS classification criteria:¹⁷ ① persistent low back pain for at least 3 months, with pain improving upon activity but not alleviated by rest; ② limited lumbar spinal mobility in both anterior-posterior and lateral flexion; ③ chest expansion reduced relative to normal values for age and gender; ④ bilateral sacroiliitis grade II–IV or

unilateral sacroiliitis grade III–IV. A definitive diagnosis of AS can be established if criterion ④ is met along with any one of criteria ① to ③. Imaging findings suggestive of Spondyloarthritis (SpA) include: ① MRI evidence of active (acute) inflammation in the sacroiliac joints, highly indicative of SpA-associated sacroiliitis, or ② definitive radiographic changes of sacroiliitis according to the 1984 revised New York criteria.

Intervention: The use of acupuncture therapy (including acupuncture, electroacupuncture, fire acupuncture, bee acupuncture, needle knife, moxibustion, etc) in combination with sulfasalazine.

Comparison: Sulfasalazine.

Outcome: (1) Bath ankylosing spondylitis disease activity index (BASDAI) score:¹⁸ A total of 6 questions (A to F) were scored based on the patient's review of fatigue, axial and peripheral joint pain, morning stiffness, and tendon end pain symptoms over the past week. Except for morning stiffness, which was scored at 0, 2.5, 5, 7.5 and 10 respectively for duration (none, 30, 60, 90 and more than 120 minutes), the rest were scored using the Visual Analogue Scale (VAS) method. The final score is calculated by the formula $0.2 \times [A+B+C + D + (E+F)/2]$, with a total score of 0 to 10. Generally, a score greater than 4 indicates disease activity, and the higher the score, the more obvious the disease activity. (2) Bath ankylosing spondylitis functional index (BASFI) score:¹⁹ A total of 10 questions, with daily activities such as putting on socks, bending over, and standing as the main observation, were recorded using the Visual Analog Scale (VAS) method, with a total score of 10 points, to evaluate the comprehensive function of the patients. This index can change in the short term in the clinical trial, and the higher the score, the worse the situation. (3) Efficacy (effective number/total number *100%).

Study design: A randomized controlled trial.

Exclusion criteria: Non-randomized controlled trials such as animal tests, reviews, conference papers, etc. Unclear reporting of research results, incomplete research data; The treatment plan involves other treatment measures; Small sample size; Different studies derived from the same randomized controlled trial included one with the largest sample size, the most comprehensive follow-up time, and the most outcome measures.

Data Sources and Search Strategy

We systematically searched China National Knowledge Infrastructure (CNKI), Wanfang, VIP, SinoMed, PubMed, EMbase, Cochrane Library, and Web of Science for randomized controlled trials of acupuncture combined with SASP for ankylosing spondylitis. The search was conducted up to July 8, 2025. (Search strategy see [Supplementary Material 1](#)).²⁰

Study Selection

We imported the retrieved literature into EndNoteX9 software, which automatically marked duplicate literature by software and manually identified duplicate literature to propose duplicate published literature. For the remaining literature, we deleted the unqualified literature by reading the title and abstract, downloaded the full text of the qualified literature, and finally read the full text for further screening. To identify the original studies that fit into our systematic review. The literature screening process was conducted independently by two researchers, with cross-checks after completion and discussions with a third researcher in case of disagreement.

Data Extraction

Two researchers designed data extraction tables based on the information needed for the study and extracted independently. The content included: ① Basic information: Title, author, year, study type, diagnostic criteria, intervention measures, course of treatment, outcome measures; ② Demographic characteristics: Sample size, age, gender; ③ Methodological information: randomization methods, allocation concealment schemes, blinding, etc. When the information extracted by two people is inconsistent, discuss and resolve it first. If it still cannot be resolved, discuss and decide.

Risk of Bias in Studies

Two researchers used the Cochrane Randomized Controlled Trial bias risk assessment tool¹⁶ to assess the risk of bias. The assessment tool included seven items: generation of random sequences, allocation concealment, blinding of subjects

and intervention providers, blinding of outcome evaluators, incomplete outcome data, selective outcome reporting, and other sources of bias, each of which was assessed as low bias, high bias, or unclear. Use Revman5.4 to visually present the risk of bias assessment results.

Synthesis Methods

The Bayesian random effects model was adopted to compare the effects among intervention measures in order to compare the effectiveness of various intervention methods. Modeling was done using the Markov Chain Monte Carlo method, with four Markov chains running simultaneously, with 20,000 annealing cycles set, and after 50,000 simulation iterations. And we will use the Deviation Information Standard (DIC) to compare model fit with global consistency, and if there is a closed-loop mesh, we will use node splitting to analyze local consistency. In addition, SuCRA-based ranking of the interventions and generating league tables to compare the differences in effects among the interventions. When the number of studies included in the outcome measure was ≥ 10 , a funnel plot was used to visually show the response publication bias. Analysis at Stata 16.0 (Stata Corporation, College Station) TX) and R4.2.0 (R development Core Team, Vienna, <http://www.R-project.org>). $P < 0.05$ indicates a statistically significant difference.

Quality of Evidence Assessment

Use Confidence in Network Meta-Analysis (CINeMA)²¹ to assess the quality of evidence. CINeMA graded the quality of evidence from six domains, namely intra-study bias, inter-study bias, indirectness, imprecision, heterogeneity, and inconsistency, and the final quality of evidence grades were high, medium, and Low and very low quality are four grades.

Results

Study Selection

A preliminary search yielded 3303 relevant studies, and 1213 duplicate studies were excluded. 40 studies were retained after reading titles and abstracts, and 9 studies were excluded through full-text screening (8 with inconsistent intervention measures and 1 with unbalanced baseline). Finally, 31 studies were included^{22–52} (the literature screening process is shown in Figure 1).

Study Characteristics

This study included 31 studies, involving a total of 2458 patients (1232 in the experimental group and 1226 in the control group). The year of publication in the journal was 2009–2025. Including 9 acupuncture methods: Acupotomy, warm acupuncture, Du Meridian moxibustion, thunder fire moxibustion, bowl moxibustion, wheat grain moxibustion, floating needle, acupuncture, acupoint application. The intervention for the control group was sulfasalazine (basic characteristics of the included studies are shown in Table 1).

Risk of Bias in Studies

In terms of stochastic methods, 22 studies used random number table, 1 study assigned by treatment regimens. In terms of allocation concealment, 2 studies used envelopes. In terms of blinding, all studies did not specify whether blinding was used. Data from all studies were complete and no selective reporting or other publication biases were found. Figures 2 and 3 shows the risk of bias results for the included studies.

Meta Analysis

BASDAI

- (1) Associations between interventions

Seventeen studies reported BASDAI, with the trial groups containing 12 interventions. Each study only reported comparisons between the experimental group and the control group. The graphs show no closed loops (see Figure 4).

- (2) Synthesized results

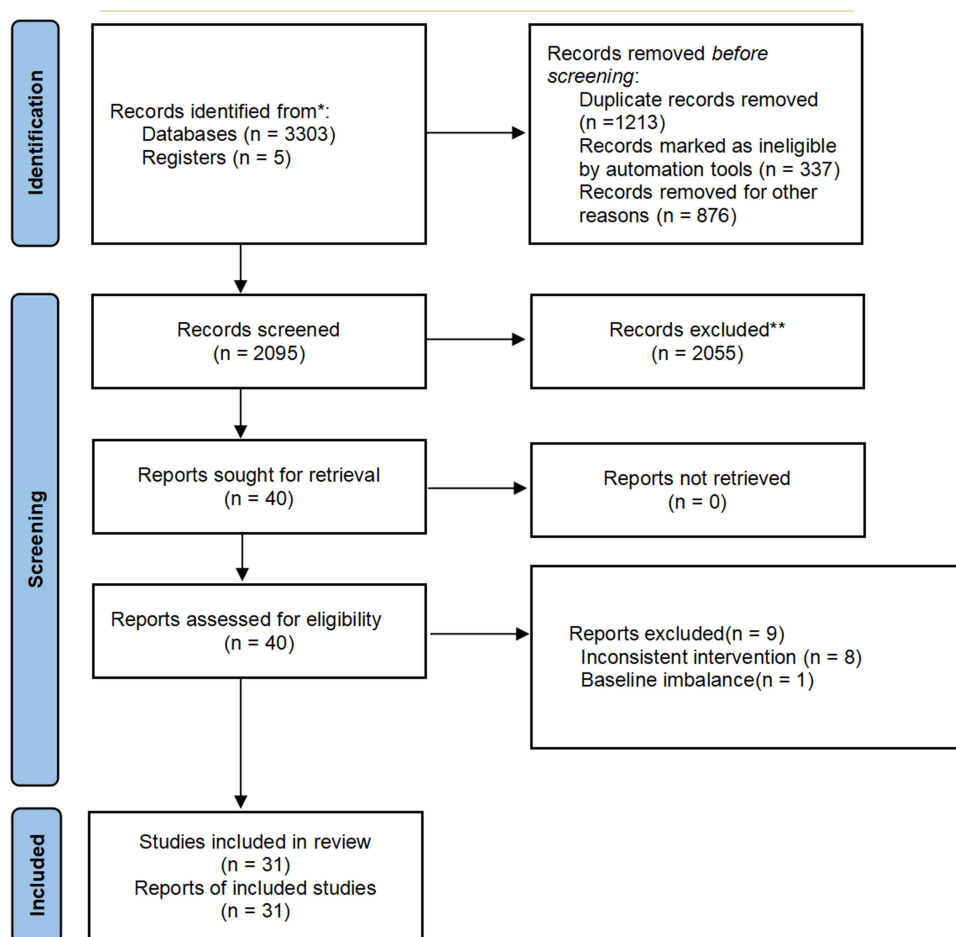


Figure 1 Literature screening process (*Consider, if feasible to do so, reporting the number of records identified from each database or register searched (rather than the total number across all databases/registers. **If automation tools were used, indicate how many records were excluded by a human and how many were excluded by automation tools).

Heterogeneity tests showed small heterogeneity ($I^2=3\%$). The results of the network meta-analysis showed no significant advantage for each intervention compared with the control group ($P > 0.05$) (see [Figure 5](#) and [Supplementary Material 2](#)). The top three SUCRas in order were: Fu's Subcutaneous needling and SASP (0.70), Du Meridian Moxibustion and Acupuncture and SASP (0.68) Thunderfire Moxibustion and SASP (0.62) ([Table 2](#)).

Table 1 Basic Characteristics of the Included Studies

Author	No	Year	Sample Size (I/C)	Intervention	Comparison	Time	Outcomes
Meng JH	22	2009	30/30	2 and I	I	24w	Efficacy
Zhou ZH	23	2011	28/28	3 and I	I (1g/bid)	3w	BASDAI, BASFI
Zhang L	24	2012	53/50	4 and I	I (0.25g/tid)	12w	Efficacy
Hu JG	25	2013	30/30	8 and I	I (0.25g/tid)	12w	Efficacy
Li HL	26	2014	40/40	11 and I	I (0.75g/tid)	4w	Efficacy, BASDAI, BASFI
Liang CM	27	2015	30/30	4 and I 3 and I	I (0.25g/tid)	12w	Efficacy
Wang HQ	28	2015	129/128	8 and I	I (0.75g/bid)	4w	Efficacy
Feng H	29	2016	30/30	4 and I	I (1g/qd)	8w	BASDAI, BASFI
Zhang MY	30	2016	38/38	4 and I	I (2g/bid)	12w	BASDAI, BASFI
Zhao L	31	2016	25/25	10 and I	I (0.75g/tid)	4w	Efficacy
Huang ZQ	32	2017	35/35	7 and I	I (0.25g/tid)	8w	Efficacy, BASDAI, BASFI
Zhang XJ	33	2017	40/40	9 and I 3 and I	I (0.5g/tid)	8w	Efficacy, BASFI

(Continued)

Table 1 (Continued).

Author	No	Year	Sample Size (I/C)	Intervention	Comparison	Time	Outcomes
Bai H	34	2018	48/48	4 and I	I (1g/bid)	2w	Efficacy, BASDAI, BASFI
Zhang HH	35	2019	45/45	4 and 10 and I	I (1g/bid)	8w	Efficacy
Gao TZ	36	2019	20/20	3 and I	I (0.5g/bid)	4w	Efficacy, BASDAI, BASFI
Liu H	37	2019	44/44	3 and 14 and I	I (1g/tid)	24w	Efficacy
Li Z	38	2020	50/50	4 and I	I (0.25g/tid)	12w	Efficacy
Yao ZC	39	2020	30/30	4 and I	I (0.25g/tid)	12w	Efficacy, BASDAI, BASFI
Xie FL	40	2021	30/30	4 and I	I	12w	Efficacy
Cao ZY	41	2021	30/30	10 and 13 and I	I (0.25g/tid)	4w	Efficacy, BASFI
Li N	42	2021	40/40	8 and 12 and I	I	2w	Efficacy, BASDAI, BASFI
Wang WY	43	2022	30/30	4 and 10 and I	I (0.25g/tid)	8w	Efficacy, BASDAI, BASFI
Wang ZR	44	2022	33/33	2 and I	I (0.5g/tid)	8w	Efficacy, BASDAI, BASFI
Wang P	45	2023	30/30	5 and I	I (1g/bid)	4w	Efficacy, BASDAI, BASFI
Fang WF	46	2023	63/62	2 and 13 and I	I (0.2g/qd)	12w	Efficacy, BASDAI, BASFI
Li XF	47	2024	35/35	4 and 10 and I	I (1g/bid)	8w	Efficacy, BASFI
Yi KL	48	2024	47/46	4 and 13 and I	I (1g/bid)	12w	Efficacy, BASDAI, BASFI
Lu ZS	49	2024	34/34	9 and I	I (1g/bid)	8w	BASDAI, BASFI
Luo YX	50	2024	30/30	10 and I	I (0.5g/bid)	4w	Efficacy, BASDAI, BASFI
Zhang YF	51	2024	40/40	4 and I	I (0.5g/qd)	36w	Efficacy
Wang P	52	2025	45/45	6 and I	I (0.5g/bid)	12w	Efficacy, BASDAI, BASFI

Notes: I: Intervention; C: Comparison; 1: SASP; 2: Acupotomy; 3: Warm Needling Method; 4: Du Meridian Moxibustion; 5: Thunderfire Moxibustion; 6: Bowl moxibustion; 7: Moxibustion with seed-sized moxa cone; 8: Fu's Subcutaneous needling; 9: Acupuncture; 10: Point application therapy; 11: Cupping; 12: Traditional Chinese medicine; 13: Tuina.

BASFI

(1) The correlation among intervention measures

Twenty studies reported BASFI, with 13 interventions included in the trial groups. The studies only reported comparisons between the groups and the controls. The graphs show no closed loops (see Figure 6).

(2) Synthesized results

Heterogeneity tests showed small heterogeneity ($I^2=3\%$). The results of the network meta-analysis showed that compared with the control group, 2 and 12 and 1 (MD=-2.40,95% CI (-4.30, -0.43), $P < 0.05$) and 4 and 11 and 1 (MD=

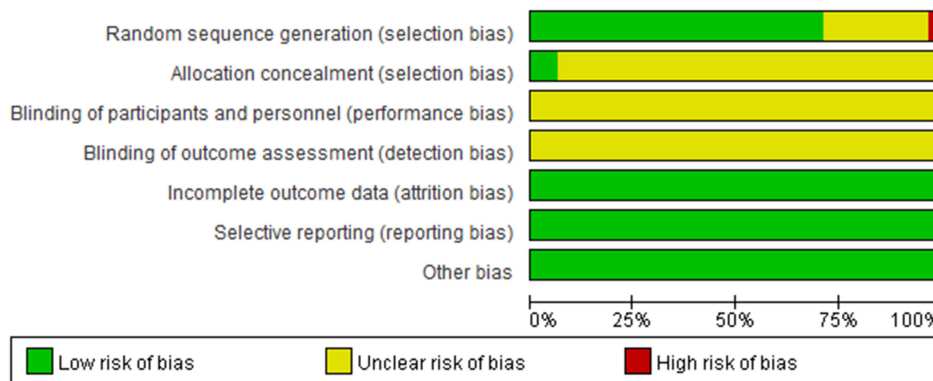


Figure 2 Risk of bias graph.

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
BAIH2018[34]	?	?	?	?	+	+	+
CAOZY2021[41]	+	?	?	?	+	+	+
FANGWF2023[46]	+	?	?	?	+	+	+
FENGH2016[29]	+	?	?	?	+	+	+
GAOTZ2019[36]	?	?	?	?	+	+	+
HUANGZQ2017[32]	+	?	?	?	+	+	+
HUJG2013[25]	+	?	?	?	+	+	+
LIANGCM2015[27]	?	?	?	?	+	+	+
LIHL2014[26]	+	?	?	?	+	+	+
LIN2021[42]	+	?	?	?	+	+	+
LIUH2019[37]	+	?	?	?	+	+	+
LIXF2024[47]	+	?	?	?	+	+	+
LIZ2020[38]	+	?	?	?	+	+	+
LUOYX2024[50]	+	?	?	?	+	+	+
LUZS2024[49]	?	?	?	?	+	+	+
LZHANGYF2024[51]	+	+	?	?	+	+	+
MENGJH2009[22]	?	?	?	?	+	+	+
WANGHQ2015[28]	+	?	?	?	+	+	+
WANGP2023[45]	+	?	?	?	+	+	+
WANGP2025[52]	+	?	?	?	+	+	+
WANGWY2022[43]	+	+	?	?	+	+	+
WANGZR2022[44]	+	?	?	?	+	+	+
XIEFL2021[40]	+	?	?	?	+	+	+
YAOZC2020[39]	+	?	?	?	+	+	+
YIKL2024[48]	?	?	?	?	+	+	+
ZHANGHH2019[35]	+	?	?	?	+	+	+
ZHANGL2012[24]	?	?	?	?	+	+	+
ZHANGMY2016[30]	+	?	?	?	+	+	+
ZHANGXJ2017[33]	+	?	?	?	+	+	+
ZHAOL2016[31]	?	?	?	?	+	+	+
ZHOUZH2011[23]	+	?	?	?	+	+	+

Figure 3 Risk of bias summary.

-7.20,95% CI (-14.00, -0.16), P < 0.05) had a significant advantage (see Figure 7 and Supplementary Material 2). The top three SUCRA rankings are: Du Meridian Moxibustion and 11Cupping and SASP (0.95), Acupotomy and Traditional Chinese medicine and SASP (0.81) Fu’s Subcutaneous needling and SASP (0.66) (Table 2).

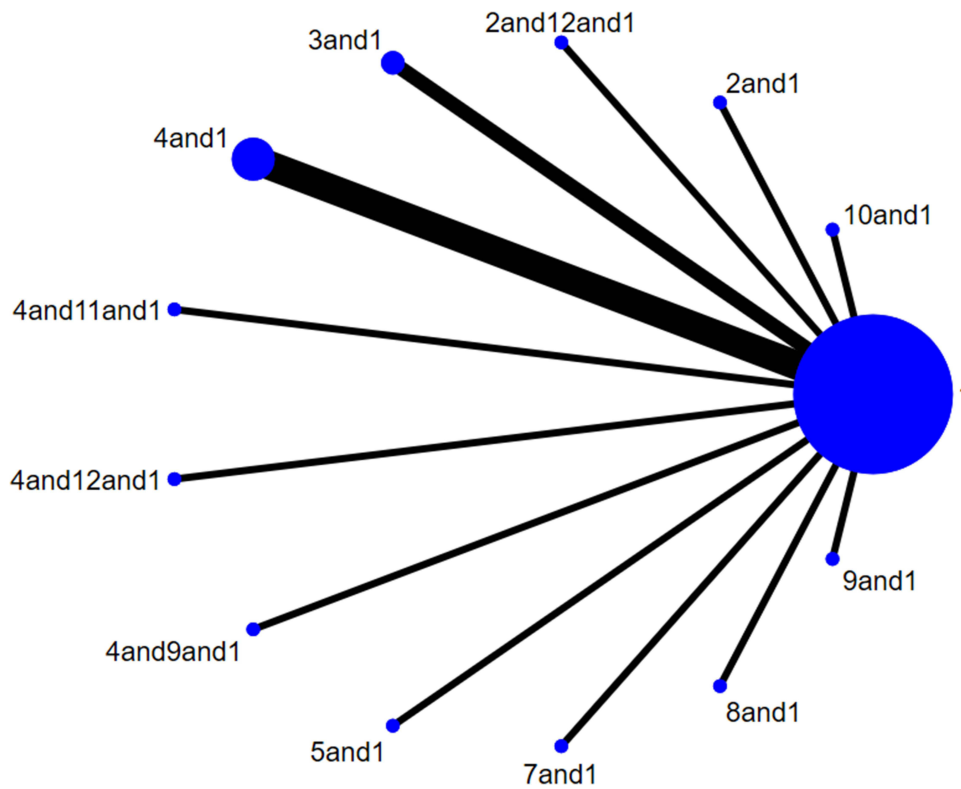


Figure 4 Network Diagram of acupuncture combined with SASP for AS (BASDAI).

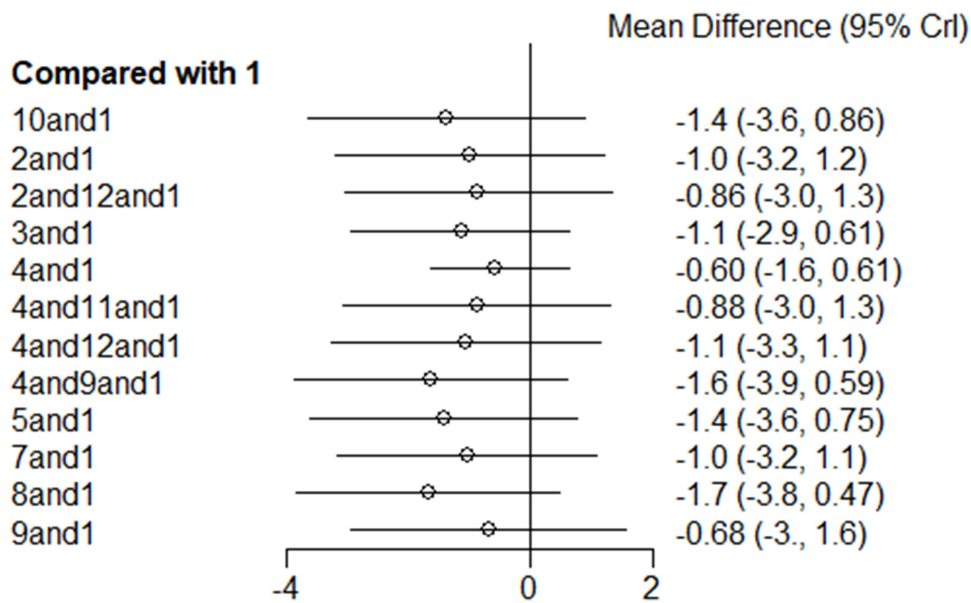


Figure 5 Forest map of acupuncture combined with SASP for AS (BASDAI).

Efficacy

(1) Associations between interventions

Twenty-nine studies reported Efficacy, with the trial groups containing 15 interventions, and the graph showed no closed loop (see Figure 8).

Table 2 SUCRA Rank

Interventions	Efficacy		BASFI		BASDAI	
	SUCRA	Rank	SUCRA	Rank	SUCRA	Rank
I	0.02	16	0.11	15	0.13	13
10 and I	0.31	14	0.46	9	0.61	4
2 and I	0.78	1	0.54	8	0.49	8
2 and I2 and I	0.34	13	0.81	2	0.45	9
3 and I	0.42	10	0.39	12	0.54	5
3 and I3 and I	0.49	9				
4 and I	0.24	15	0.20	14	0.35	12
4 and I1 and I	0.39	12	0.95	1	0.45	10
4 and I2 and I	0.52	8	0.56	7	0.51	7
4 and I9 and I	0.75	3	0.44	10	0.68	2
5 and I	0.67	4	0.59	4	0.62	3
6 and I	0.62	5	0.57	6		
7 and I	0.42	11	0.59	5	0.51	6
8 and I2 and I	0.77	2				
9 and I	0.61	6	0.22	13	0.40	11
9 and I2 and I	0.55	7	0.41	11		
8 and I			0.66	3	0.70	1

Notes: I: Intervention; C: Comparison; I: SASP; 2: Acupotomy; 3: Warm Needling Method; 4: Du Meridian Moxibustion; 5: Thunderfire Moxibustion; 6: Bowl moxibustion; 7: Moxibustion with seed-sized moxa cone; 8: Fu's Subcutaneous needling; 9: Acupuncture; 10: Point application therapy; 11: Cupping; 12: Traditional Chinese medicine; 13: Tuina.

(2) Synthesized results

Heterogeneity tests showed small heterogeneity ($I^2=0\%$). The results of the network meta-analysis showed that compared with the control group, Acupotomy and I (RR=1.41,95% CI 1.16,1.75), $P < 0.05$, Warm Needling and Tuina and SASP (RR=1.23,95% CI 1.01,1.53), $P < 0.05$ Du Meridian Moxibustion and SASP (RR=1.13,95% CI 1.06,1.21), $P < 0.05$ Du Meridian Moxibustion and Traditional Chinese medicine and SASP (RR=1.24,95% CI 1.01,1.50), $P < 0.05$ Du Meridian Moxibustion and Acupuncture and SASP (RR=1.38,95% CI 1.18,1.66), $P < 0.05$ Bowl moxibustion and SASP (RR=1.31,95% CI 1.02,1.77), $P < 0.05$ Fu's Subcutaneous needling and Traditional Chinese medicine and SASP (RR=1.41,95% CI 1.13,1.88), $P < 0.05$ Acupuncture and SASP (RR=1.29,95% CI 1.07,1.69) Acupuncture and I Traditional Chinese medicine and SASP (RR=1.26,95% CI 1.00,1.67), $P < 0.05$) had significant advantages. Du Meridian Moxibustion and Acupuncture and SASP were more effective than Acupuncture and SASP (RR=1.22,95% CI 1.03,1.48), $P < 0.05$) (Figure 9). The results of the network meta-analysis showed no significant difference among the acupuncture methods ($P > 0.05$) (see [Supplementary Material 2](#)). The top three SUCRA results were: Acupuncture and Tuina and SASP (0.78), Acupotomy and SASP (0.77) Du Meridian Moxibustion and point application therapy and SASP (0.75) (Table 2).

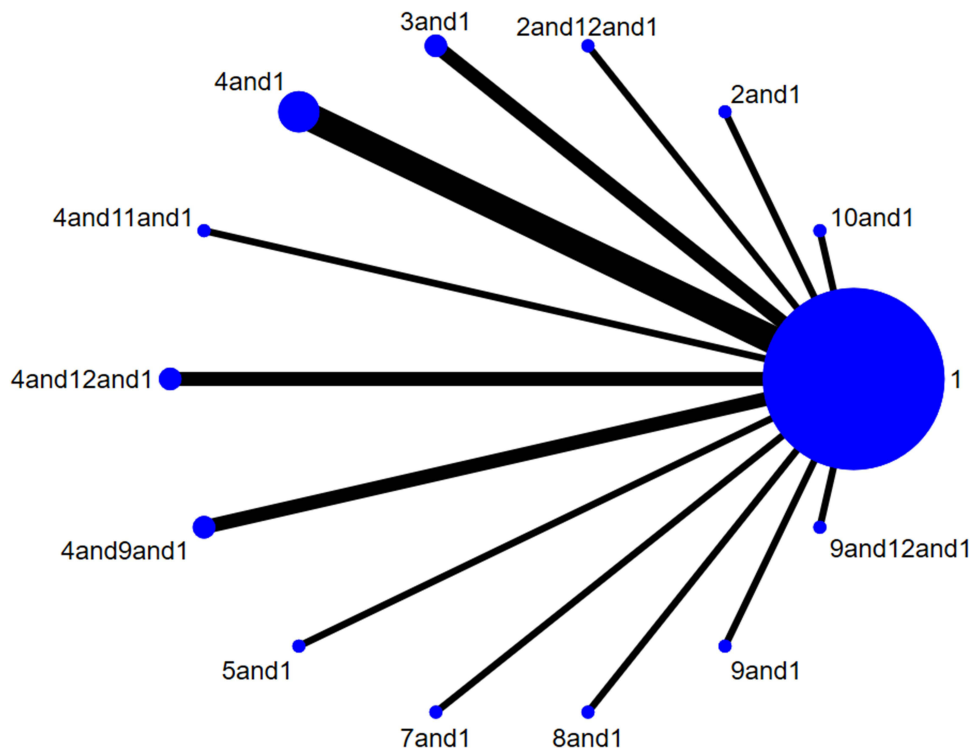


Figure 6 Network diagram of acupuncture combined with SASP for AS (BASFI).

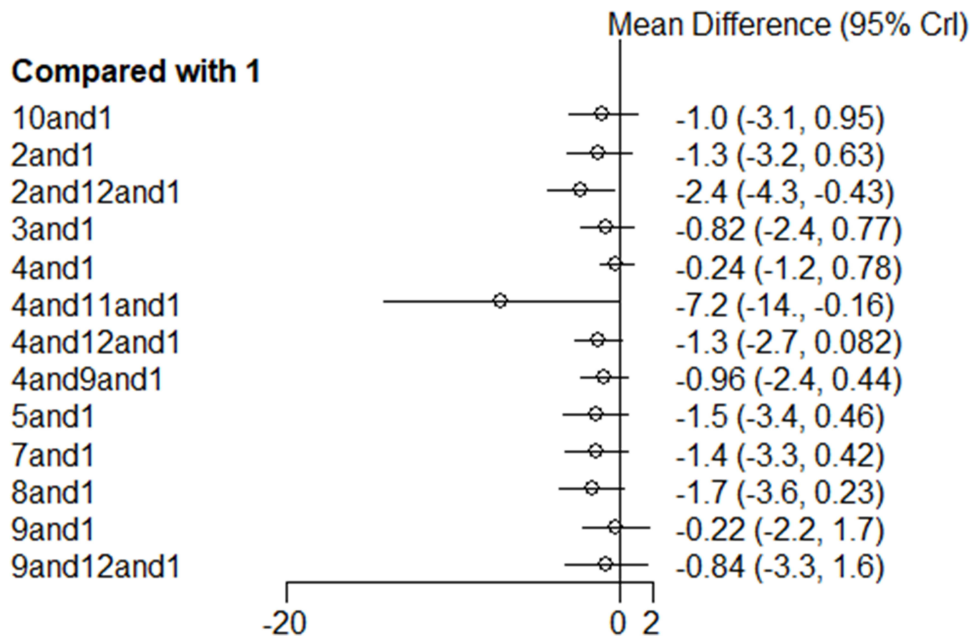


Figure 7 Forest map of acupuncture combined with SASP for AS (BASFI).

Publication Bias and Quality of Evidence Assessment

Egger’s test for the three outcome measures showed no significant differences (BASDAI: P=0.99, BASFI: P=0.99, Efficacy: P=0.78). Quality of evidence was assessed using CINEMA. The results showed that the main reasons for degradation were Imprecision and Incoherence ([Supplementary Material 3](#)).

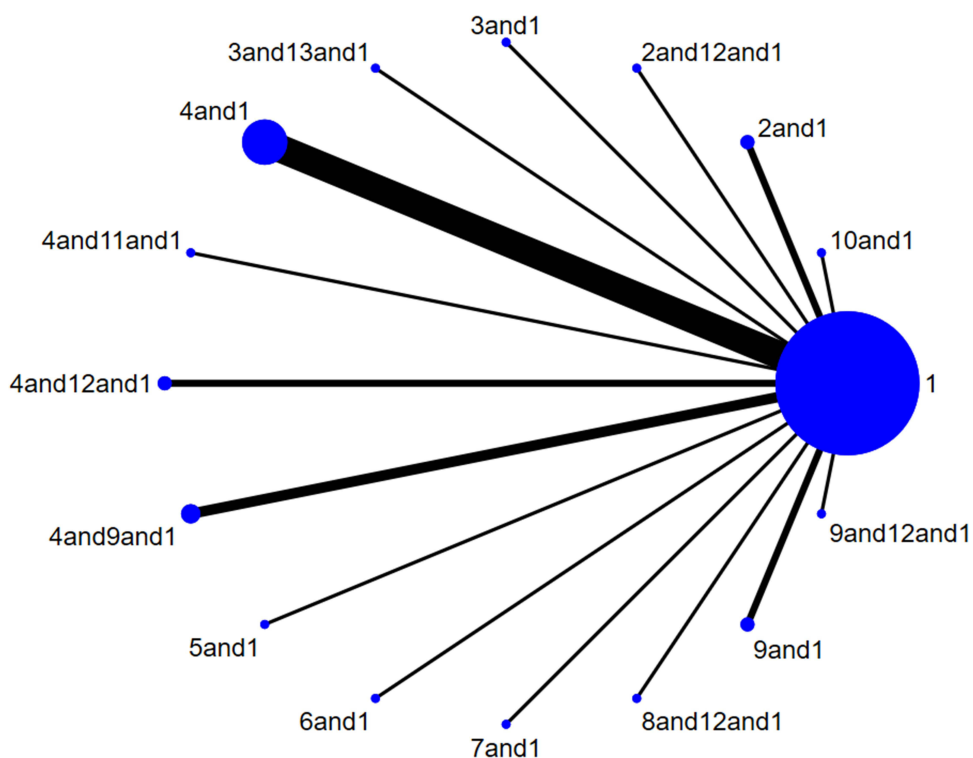


Figure 8 Network Diagram (Efficacy) of acupuncture combined with SASP for AS.

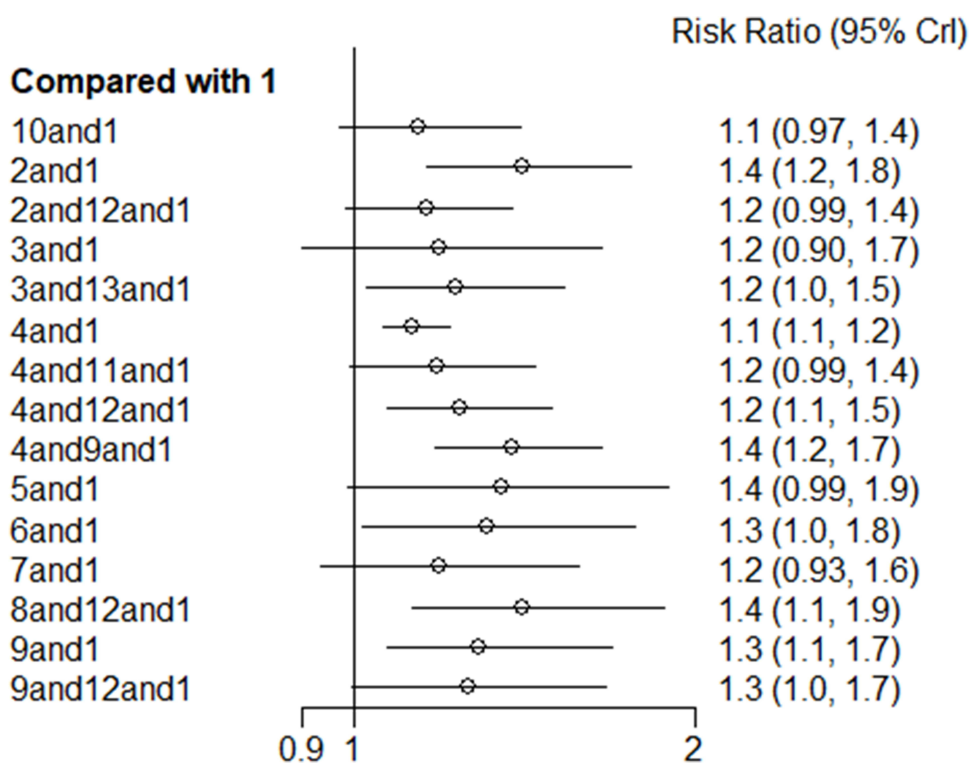


Figure 9 Forest map of acupuncture combined with SASP for AS (Efficacy).

Discussion

This study included 31 studies encompassing nine acupuncture methods: Acupotomy, warm acupuncture, Du meridian moxibustion, thunder fire moxibustion, noodle bowl moxibustion, wheat grain moxibustion, floating needle, acupuncture, and acupoint application. A total of three outcome indicators were analyzed. Regarding BASDAI scores, acupuncture combined with sulfasalazine (SASP) did not demonstrate a significant advantage over SASP alone. In terms of BASFI scores, combinations such as acupotomy with SASP, Fu's subcutaneous needling with Tuina, and traditional Chinese medicine (TCM) with SASP showed significant improvements compared to SASP alone. Regarding overall efficacy, several treatment regimens—including acupotomy combined with SASP, warm needling combined with Tuina and SASP, Du meridian moxibustion combined with SASP, Du meridian moxibustion combined with TCM and SASP, Du meridian moxibustion combined with acupuncture and SASP, noodle bowl moxibustion combined with SASP, Fu's subcutaneous needling combined with TCM and SASP, acupuncture combined with SASP, and acupuncture combined with TCM and SASP—demonstrated significant advantages over SASP alone. Notably, the combination of Du meridian moxibustion and acupuncture with SASP showed greater efficacy than Du meridian moxibustion combined with SASP alone. Adverse reactions were reported in two studies. Acupuncture combined with SASP was associated with fewer adverse reactions compared to SASP alone, and severe adverse events were rare. Reported symptoms included one case of gastrointestinal discomfort (loss of appetite, abdominal distension, nausea) and two cases of minor subcutaneous bleeding that resolved spontaneously. In the control group, nine cases of gastrointestinal reactions and two cases of rash were observed. Based on the meta-analysis results and SUCRA ranking, the most effective combinations appeared to be acupotomy with SASP and Du meridian moxibustion combined with cupping and SASP. The operation steps are in [Supplementary Material 4](#).

Published meta-analyses have confirmed the efficacy of acupuncture in treating SASP. Zhao Wenjia's study⁵³ included a total of 21 studies involving 1820 patients. The meta-analysis results showed that acupuncture was statistically superior to Western medicine in terms of effective rate [OR = 3.25; 95% CI (2.52; 4.20)], thoracic expansion degree [SMD = 0.32; 95% CI (0.09; 0.54)], fingertip-to-floor distance [SMD = -1.01; 95% CI (-1.27; -0.76)], occipital-to-wall distance [SMD = -0.73; 95% CI (-1.19; -0.27)], Schober test [SMD = 0.37; 95% CI (0.22; 0.53)], and erythrocyte sedimentation rate [SMD = -0.80; 95% CI (-1.21; -0.40)]. However, it did not compare the effects of different acupuncture methods. Our study controlled for variables, with SASP as the control group, to minimize heterogeneity and compare the effects of different acupuncture methods, which has clinical reference value.

Acupotomy therapy can repair tissue damage and restore mechanical balance. Acupotomy release therapy can effectively separate adhesions between muscles and ligaments, alleviate pathological traction caused by muscle contracture on the vertebral bodies, and disrupt scar tissue to promote tissue reorganization and restore normal joint biomechanics. By cutting, stripping, and releasing the affected areas, Acupotomy therapy can enhance local micro-circulation, restore the elasticity of the lumbar and dorsal muscles, improve muscle contractility, reduce stiffness in small joints, and increase spinal mobility. Additionally, Acupotomy therapy can regulate immune and inflammatory factors. Studies have shown that Acupotomy therapy significantly reduces levels of inflammatory cytokines such as TNF- α , IL-6, and IL-2 in patients with axial AS.⁵⁴ Clinical evidence supports the efficacy of Acupotomy therapy. Zhong⁵⁵ randomly divided 80 AS patients into two groups: 40 received nimesulide treatment (control group), and 40 received Acupotomy therapy (treatment group). Post-treatment assessments showed that the treatment group exhibited significantly greater improvements in cervical range of motion, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels compared to the control group ($P < 0.05$). Shi⁵⁶ treated 24 AS patients with Acupotomy therapy targeting the interspinous ligament, costo-transverse process joint, and facet joints. The results indicated significant improvements in spinal mobility, suggesting that Acupotomy therapy alone can effectively reduce inflammation and improve joint mobility in AS patients. Meta-analysis results further confirmed the efficacy of Acupotomy therapy in treating AS. Compared with the control group, the Acupotomy treatment group showed statistically significant improvements in overall efficacy [OR = 6.80, 95% CI (4.29, 10.77), $P < 0.00001$], BASDAI score [MD = -1.06, 95% CI (-1.49, -0.63), $P < 0.00001$], BASFI score [MD = -0.92, 95% CI (-1.27, -0.56), $P < 0.00001$], Schober test [MD = 1.20, 95% CI (0.70, 1.70), $P < 0.0001$], morning stiffness duration [MD = -18.05, 95% CI (-20.78, -15.31), $P < 0.00001$], thoracic expansion [MD = 1.20, 95% CI (1.07, 1.34), $P < 0.0001$], and finger-to-ground distance [MD = -3.81, 95% CI (-5.39, -2.23), $P < 0.00001$].⁵⁶

Du meridian moxibustion, through the application of thermal stimulation to the Du meridian and bladder meridian, promotes local blood circulation and enhances tissue oxygenation, thereby alleviating pain and stiffness symptoms. Research has demonstrated that the combination of moxibustion and sulfasalazine (SASP) in the treatment of cold-dampness-blocking type ankylosing spondylitis (AS) significantly reduces inflammatory markers such as CRP and ESR, while improving clinical signs without a notable increase in adverse events.⁵⁷ Multiple studies have confirmed that the integration of Du meridian moxibustion into treatment regimens offers significant advantages in symptom relief and inflammatory marker reduction. Liao et al⁵⁸ reported that the combination of Du meridian moxibustion and SASP significantly reduced CRP and ESR levels and improved clinical sign scores compared to conventional pharmacological treatment alone. Chen et al⁵⁹ further demonstrated that the total effective rate of Du meridian moxibustion combined with acupuncture was 96.4%, significantly higher than the 88.9% observed in the acupuncture-only group. Moreover, improvements in BASFI and BASDAI scores were more pronounced in the combination therapy group. Cupping therapy, which utilizes the thermal and negative pressure effects of cupping devices, provides benign stimulation to specific acupoints, thereby accelerating metabolism and promoting the absorption of inflammatory substances.⁶⁰ This therapeutic approach complements moxibustion by optimizing the internal environment in AS patients and enhancing local blood circulation. The negative pressure effect facilitates the removal of stasis and metabolic waste, effectively relieving local muscle tension, reducing joint stiffness, alleviating pain in the spinal and lumbosacral regions, improving microcirculation, promoting tissue repair and regeneration, and restoring joint structure and function. Meta-analytical evidence further supports the efficacy of Du meridian moxibustion. For instance, Li's meta-analysis indicated that Du moxibustion significantly improved spinal mobility in AS patients. The finger-to-ground distance [SMD = 0.63, 95% CI (0.30, 0.97), $P = 0.000$], Distance from the pillow to the wall [MD = 0.96, 95% CI (0.19, 1.73), $P = 0.01$], thoracic mobility [MD = 0.41, 95% CI (0.30, 0.53), $P < 0.0001$], and lumbar range of motion [MD = 1.56, 95% CI (1.22, 1.90), $P < 0.0001$] all showed significant improvements compared to control interventions.⁶¹ He's meta-analysis further revealed that Du moxibustion significantly increased the overall effective rate (RR = 1.19, 95% CI 1.07–1.32, $P < 0.05$), reduced VAS scores (MD = -1.15, 95% CI -1.95 to -0.35, $P < 0.05$), improved PGA scores (MD = 1.23, 95% CI 0.90–1.55, $P < 0.05$), and reduced morning stiffness duration (MD = -4.51, 95% CI -7.55 to -1.47, $P < 0.05$). However, no statistically significant differences were observed in BASFI scores (MD = 0.76, 95% CI -0.39 to 1.91, $P > 0.05$) or adverse reaction rates (RR = 0.62, 95% CI 0.32–1.19, $P > 0.05$).⁶²

The quality of evidence and heterogeneity across outcomes represent critical challenges in existing meta-analyses of acupuncture and its combination therapies for AS. Despite accumulating evidence supporting the clinical efficacy of acupuncture, methodological inconsistencies and variations in outcome reporting across studies limit the comparability and reliability of findings. First, discrepancies in inclusion criteria—such as the inclusion of only randomized controlled trials versus mixed designs—introduce potential biases. Second, the diversity of outcome measures, including BASDAI scores, inflammatory markers (CRP, ESR), and quality of life assessments (SF-36), complicates direct comparisons. Additionally, the lack of standardized acupuncture parameters—such as acupoint selection, treatment duration, and frequency—further contributes to result variability. These factors collectively undermine the consistency and robustness of the available evidence, highlighting the need for more rigorous methodological frameworks and standardized protocols in future research.

This study employed a Bayesian network meta-analysis approach, offering significant methodological innovation in evaluating the comparative efficacy of acupuncture combined with SASP for AS treatment. Compared to traditional frequentist methods, the Bayesian framework allows for more flexible handling of complex intervention networks, enabling direct comparisons among multiple treatment strategies and providing intuitive efficacy rankings through posterior probability distributions. This is particularly advantageous for interventions like acupuncture, which involve diverse operational parameters and complex treatment modalities. The Bayesian approach can better accommodate heterogeneity across studies and offer more comprehensive evidence to support clinical decision-making. Nonetheless, this study has several limitations. First, the relatively small sample sizes of included studies may compromise the precision of effect estimates. Second, variations in acupuncture manipulation parameters—such as acupoint selection, stimulation intensity, and treatment duration—across studies may affect the reliability of network meta-analysis results. Third, the methodological quality of some included studies was suboptimal, with inadequate reporting of randomization and blinding procedures, which could introduce bias into the analysis. This study is the failure to quantitatively report inter-rater consistency measures (such as Kappa values) during the literature screening and data extraction phases. However, we have endeavored to minimize subjective bias and ensure process reliability through pre-reviewer training, pre-experiment calibration, and consensus discussions on all disagreements.

Evidence degradation primarily stems from imprecision and incoherence. Imprecision is often due to small sample sizes, low event rates, or wide confidence intervals, which are particularly evident in studies of acupuncture combination therapy for AS. For example, several studies reported excessively wide confidence intervals due to limited sample sizes, making definitive conclusions difficult. Furthermore, inconsistencies in acupuncture parameters exacerbate heterogeneity, leading to incoherent evidence, especially in indirect comparisons, thereby reducing the reliability of network meta-analysis findings. To enhance the quality of evidence, future research should focus on the following areas: (1) establishing standardized acupuncture protocols, including uniform acupoint selection, stimulation parameters, and treatment frequency; (2) conducting large-scale, multicenter randomized controlled trials to increase statistical power; (3) implementing long-term follow-up studies to assess the sustained efficacy and safety of combined acupuncture and moxibustion therapies; and (4) employing sensitivity and subgroup analyses to explore the impact of varying operational parameters on treatment outcomes, thereby providing more precise clinical guidance. Also, placebos actually do affect treatment outcomes. Giacomo Rossetini and others point out that designing placebos for physical therapy research is tricky, “cause manual treatments” involve tons of specific and situational factors that can sway the results. He stresses that researchers should try to pick sham treatments that are hard to tell apart from the real thing, to cut down on bias. They also need to account for all the context stuff in the treatment setting—like how the therapist and patient interact, the whole treatment ritual, and so on. The big challenge is balancing these contextual factors between the test and control groups in RCT designs. You have gotta fine-tune the sham procedures to make sure the groups are really comparable. Bottom line: we should rethink how we set up RCTs to better measure the placebo’s role and boost both the internal and external validity of the studies.⁶³

Conclusions

Based on the findings of this study, the combination therapies of 2 and 1, 4 and 11, and 1 with sulfasalazine demonstrated the most favorable outcomes. In terms of clinical translation, this study provides valuable evidence-based support for the application of acupuncture in the treatment of ankylosing spondylitis. However, to further enhance the clinical relevance and applicability of the evidence, future research should focus on addressing several key areas: establishing standardized protocols for acupuncture manipulation, including consistent acupoint selection and stimulation parameters, to improve inter-study comparability; conducting larger-scale, high-quality randomized controlled trials to increase the precision of efficacy estimates; and strengthening the evaluation of long-term efficacy and safety profiles to provide more comprehensive data for informed clinical decision-making.

Abbreviations

AS, Ankylosing Spondylitis; NSAIDs, non-steroidal anti-inflammatory drugs; SASP, sulfasalazine; RCTs, randomized controlled trials; BASDAI, Bath ankylosing spondylitis disease activity index; BASFI, Bath ankylosing spondylitis functional index; VAS, Visual Analog Scale; CNKI, China National Knowledge Infrastructure; DIC, Deviation Information Standard; CINeMA, Confidence in Network Meta-Analysis; TCM, traditional Chinese medicine; ESR, Erythrocyte sedimentation rate; CRP, C-reactive protein.

Disclosure

The authors report no conflicts of interest in this work.

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