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SYSTEMATIC REVIEW

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Efficacy of acupuncture for primary osteoporosis: a systematic review and meta-analysis of randomized controlled trials

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Abstract

Background Primary osteoporosis (POP) is a common metabolic bone disorder that has a devastating effect on their quality of life in patients. Acupuncture, a traditional Chinese therapy, has been used to treat osteoporosis for over 2000 years. This study aimed to determine the efficacy of acupuncture in treating POP compared to conventional medicine or placebo.

Methods We searched for potentially relevant studies in PubMed, Web of Science, Embase, Cochrane Central Register of Controlled Trials, China National Knowledge Infrastructure, China Biology Medicine disc, Wanfang database and ClinicalTrials.gov up to December 20, 2024. Randomized controlled trials investigating treatment of POP for which acupuncture was administered as a stand-alone treatment or combined with conventional medicine compared to conventional medicine or placebo, were included. The outcomes included bone mineral density (BMD), visual analogue scale (VAS) scores, clinical effectiveness rate, estradiol (E_2), Oswestry Disability Index (ODI), and levels of serum alkaline phosphatase (ALP). Data were synthesized using a random-effects meta-analysis model, and the observed heterogeneity was investigated using subgroup analyses. Study quality was appraised using the Cochrane RoB 2 tools, and the quality of the aggregated evidence was evaluated using the GRADE guidelines. Publication bias was assessed by funnel plots and validated by Egger's test.

Results Forty eligible articles with 2654 participants were identified. Compared to the control group, acupuncture effectively increased the BMD (MD 0.04 [0.03–0.06], $P<0.001$, $I^2=92\%$), clinical efficacy (RR 1.24 [1.14–1.34], $P<0.001$, $I^2=81\%$), and levels of E_2 (SMD 0.30 [0.09–0.52], $P=0.006$, $I^2=0\%$), and reduced the VAS scores (SMD −1.79 [−2.29 to −1.29], $P<0.001$, $I^2=95\%$). Data on ODI and ALP were insufficient for meta-analysis.

Conclusion The current evidence suggests that the efficacy of acupuncture in improving the symptoms of POP are encouraging for its use in clinical practice as a physical intervention for patients with POP. However, since the included

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patients were all from China, there was a risk of sample bias, high-quality multicenter studies in different countries or regions should be conducted in the future.

Keywords Osteoporosis, Acupuncture, Traditional Chinese Medicine, Meta-analysis, Systematic review

Introduction

Osteoporosis (OP) is defined by low bone quality, strength and increased fracture risk [1]. Approximately 21.7% of the world's population is affected by osteoporosis with a predominance in elderly females as compared to males (35.3% vs 12.5%) [2]. Given the progressive ageing of populations, osteoporosis-related fragility fractures become common in the elderly, leading to a significant increase in disability and mortality and a devastating impact on their quality of life [3].

OP can be divided into primary and secondary osteoporosis based on the factors affecting bone metabolism [4]. Primary osteoporosis (POP) develops due to aging or menopause-related bone demineralization. Postmenopausal and senile osteoporosis are the two subtypes of POP. Secondary osteoporosis is caused by pathological conditions and medications other than aging or menopause. Corticosteroid-induced osteoporosis is the most common type of secondary osteoporosis, leading to fractures and increased morbidity and mortality [5].

Currently approved drugs for POP can be divided into anti-resorptive and anabolic medications [6]. The most commonly prescribed agents are anti-resorptive drugs (e.g. denosumab, romosozumab, ibandronate, alendronate and raloxifene), which are safer and effective in preventing fractures [7, 8]. However, the extended efficacy of these agents is limited and associated with serious adverse events [9]. Therefore, many researchers are dedicated to more advanced concepts and therapies, such as individualized therapy [10], acupuncture, exercises, and Chinese herbal medicines.

Acupuncture is a traditional Chinese medical therapy and has been widely used for OP in Asia throughout its long history [11]. It is a physical therapy that works by inserting a needle at a specific point called the acupoint. Some studies reported that acupuncture showed very clear efficacy in the treatment of POP. At present, the effect mechanism of POP by acupuncture has been not completely found. According to the related research reported that multiple mechanisms could be involved in this effect of acupuncture. Acupuncture has been shown to regulate estrogen levels in the body, which is crucial for bone metabolism [12]. Additionally, acupuncture stimulates the nervous system to release endorphins and other substances that help alleviate pain [13], and improves the blood flow to bone tissue, thereby aiding in the repair and regeneration of bone [14]. Moreover, some studies indicated that acupuncture may improve bone metabolism by promoting the proliferation and differentiation of osteoblasts while reducing the activity of osteoclasts [15, 16].

Since 2018, several systematic reviews and meta-analyses have investigated the use of acupuncture in treating OP [17–22]. Most reported encouraging results, but many systematic reviews and meta-analyses tested acupuncture in conjunction with Chinese herbal medicine or moxibustion interventions [17, 22, 23], which made it difficult to distinguish the effects of acupuncture. In this review we included newly published randomized controlled trials (RCTs) and encompasses a broader range of acupuncture modalities to determine the efficacy of acupuncture in treating POP compared to conventional medicine or placebo.

Materials and methods

Guidelines followed

This review protocol has been registered in the International Prospective Register of Systematic Reviews as CRD42024540470. We have reported our findings in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) 2020 guidelines [24].

Search strategy

Seven major electronic bibliographic databases were searched: (1) English databases: EMBASE, the Cochrane Library, Web of Science, and PubMed; and (2) Chinese databases: China Biological Medicine Database, Wanfang database, and China National Knowledge Infrastructure. Unpublished and gray literature was sought through registries of past and ongoing trials (e.g., ClinicalTrials.gov). A combination of subject terms and free words was used in the search. The search terms included "acupuncture", "warming needle", "electroacupuncture", "acupoints", "auriculoacupuncture", and "osteoporosis" and were adapted for each database. Additionally, we manually retrieved the reference lists of the included studies. The original search was performed in February 2024, and an updated search was conducted on December 20, 2024. The details of the search strategies are in Supplementary Material (Fig. 1).

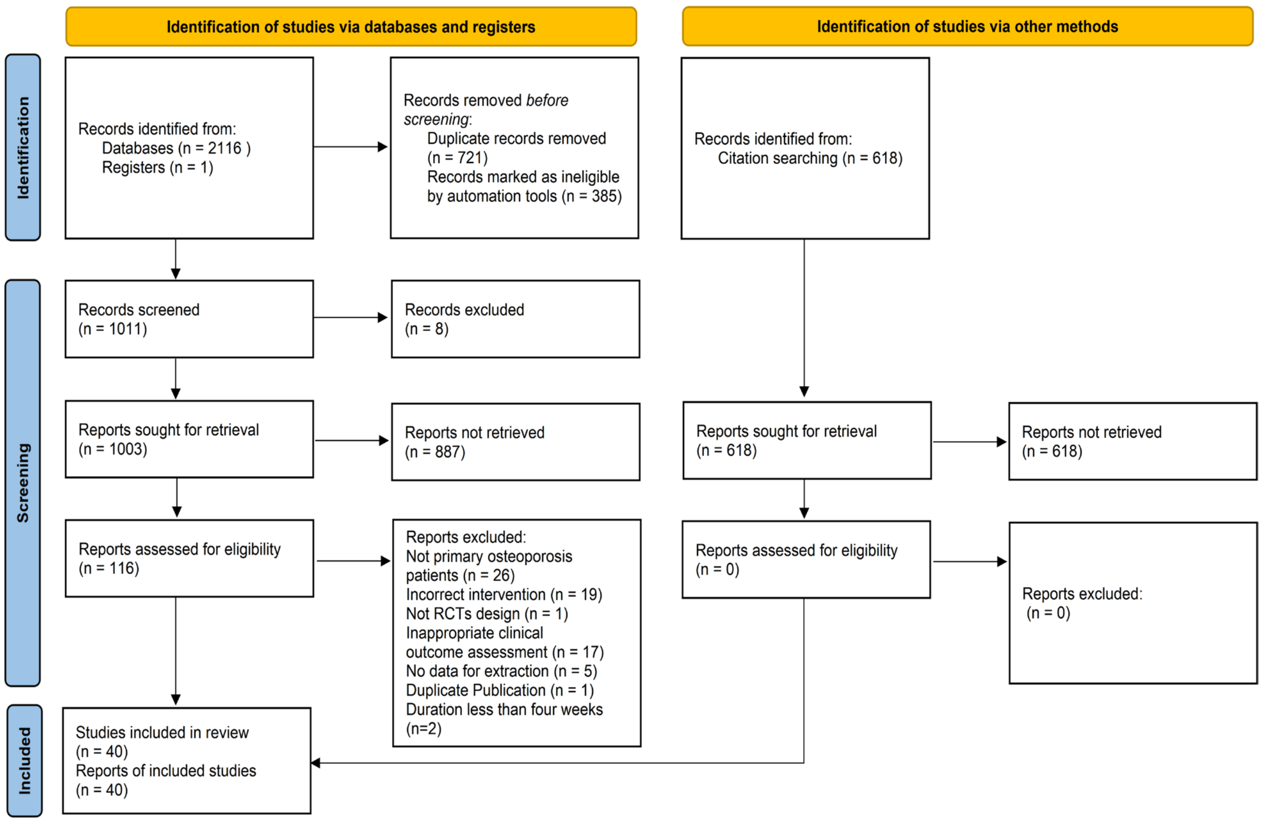

Fig. 1 PRISMA flow diagram of literature search

Inclusion criteria

Included studies have to meet the following PICOS (participant, intervention, comparator, outcome, study design) criteria: (1) Participants: patients with POP regardless of age, sex, or ethnic origin; (2) Interventions: traditional acupuncture inserting needles into traditional meridian points tradititional, including manual acupuncture, warm acupuncture, electroacupuncture, and auriculoacupuncture; (3) Comparators: comparing acupuncture to sham acupuncture, blank, or a conventional medicine control, but in addition one form of acupuncture comparing with another form of active acupuncture or a different type of Traditional Chinese Medicine (TCM) (e.g. Chinese herbal medicine), and allowing adjuvant treatments, either conventional medicine or TCM, as long as they had been given to both intervention groups; (4) Outcomes: reporting at least one primary outcome: bone mineral density (BMD) or visual analogue scale (VAS) scores, and secondary outcomes such as clinical effectiveness rate, estradiol (E_2), Oswestry Disability Index (ODI), and levels of serum alkaline phosphatase (ALP) to be reported selectively. The efficacy of acupuncture-related therapies is determined based on the criteria of Chinese medicine clinical evidence points for the clinical standard, and the overall clinical effectiveness rate is divided into four levels: (1) clinically cured, (2) markedly effective, (3) effective, and (4) invalid [25]. The overall clinical effectiveness rate was calculated as follows: overall clinical effectiveness rate (%) = ([number of patients clinically cured + markedly effective + effective]/number of patients * 100); (5) Study design: RCTs of four weeks or longer duration irrespective of blinding, publication status or language. Studies were excluded if they met any of the following criteria: patients with secondary osteoporosis, observational studies, protocols, case reports, animal experimental studies, duplicated publications, or full-text unavailable articles.

Data extraction

The results of the literature search were imported into the NoteExpress reference management software. Two researchers (Tianyi Ma and TianTian Zhang) independently completed the standard literature screening process, removing duplicate studies and excluding ineligible studies by reading the title, abstract, and full text and then extracting data from eligible studies using a predesigned form, including first author name, year of publication, age, sample size, key contents of intervention, acupoints, and outcomes. In studies where meta-analysis data were missing or unavailable, attempts were made to contact the corresponding authors by email. If necessary, the need for extraction of incomplete data was waived. Any disagreements were discussed and arbitrated by a third reviewer (Le Zhang).

Quality assessment

Two reviewers (Tianyi Ma and TianTian Zhang) Independently assessed the methodological quality of RCTs based on the Cochrane RoB 2 tools [26]. Each study was evaluated on based seven items: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessments, incomplete outcome data, selective reporting, and other biases. Each item was ranked low, unclear, or at a high risk of bias. Any disagreements were discussed and arbitrated by a third reviewer (Le Zhang). Additionally, we calculated Cohen's kappa coefficient and the Kappa scores for the inter-reviewer agreement were as follows: bad, <0.20; normal, 0.40–0.59; good, 0.60–0.74; and very good, ≥ 0.75.

Credibility of evidence

The credibility of the aggregated evidence was evaluated using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) [27]. Evidence may be reduced by five factors: study limitations, inconsistency, indirectness, imprecision, and publication bias; factors that may improve the credibility of evidence from observational studies: large effect sizes, negative bias, and dose–effect relationships. The results of studies with moderate or large effect sizes may lead to an improved credibility of evidence. Four credibility levels were used: high, moderate, low, and very low credibility.

Statistical analyses

A meta-analysis was performed using Review Manager Software version 5.4. For dichotomous variables, the relative risk (RR) with a 95% confidence interval (CI) was calculated. For continuous variables, mean difference (MD) and standardized mean difference (SMD) with a 95% CI were calculated. Statistical heterogeneity was tested using the χ^2 test (significance level $P<0.1$) and I^2 statistic. When $I^2 \geq 50\%$ or $P<0.1$, it indicates the presence of significant heterogeneity [28]. We used a random-effects model because of variations in the participants' personal characteristics, treatment frequency and duration, acupuncture points for injection, and types of comparators [29]. The sources of heterogeneity were explored using subgroup analysis, and the potential effects on the results are discussed. Publication bias was assessed using a funnel plot and Egger's test. All publication bias analyses were performed using Stata 14 (StataCorp LP, 2015). Furthermore, we performed a sensitivity analysis by using one out remove method to estimate the robustness of the results of meta-analysis.

Results

Study selection

The flowchart of the study selection process is described in Fig. 1. A total of 2117 titles were retrieved from the databases and registries. After the removal of duplicate records, we screened the abstracts and titles of 1003 reports. After screening of the title and abstract, 116 titles remained for full text review. Overall, 40 studies totalling 2654 participants were eligible [30–68]. During an updated search on 20 December 2024, no further studies were included.

Descriptive analysis

Essential characteristics of the included studies are described in Table 1. A total of 2654 subjects, including 1339 patients from the treatment group and 1315 patients served as controls, were included into this systematic review. The participants' mean ages ranged from 51 to 70 years. One study had 3 study arms, which compares acupuncture to conventional medicine to a combination of acupuncture and conventional medicine [57]. The remaining 39 studies had 2 study arms, of which 18 studies [34–38, 42, 44, 49, 50, 53–55, 61, 66, 67, 69] chose needling, 8 studies [33, 40, 41, 51, 52, 58, 62, 63] chose electroacupuncture as the intervention method and 12 studies [31, 32, 43, 45–47, 59, 60, 64, 65, 68] chose warm acupuncture as the intervention method. In these trials, frequency of acupuncture intervention was at least three times one week and the total duration of treatment ranged from 1 to 6 months.

Risk of bias in included trials

The overall Kappa score for the consistency of methodological quality assessment between the two evaluators was 0.890 (Additional file 1). The methodological quality of the included studies is described in Fig. 2. Of the 40 included studies, only two study [36, 43] did not provide detailed information regarding random sequence generation. Five trials [32, 33, 51, 58] clearly reported the allocation concealment. Two studies [34, 43] clearly described the blinding of participants and personnel, and four studies [34, 37, 51, 58] distinctly reported the blinding of outcome assessment. Incomplete outcome data was high risk in three studies [39, 51, 66], since the reason of withdrawal and loss of follow-up are not described. Selective reporting could not be judged in all the studies because of the insufficient information provided. Other bias was evaluated to be of low risk in all the studies.

Table 1 Summary of studies included in meta-analysis

Author, year	Participants		Sample size		Interventions					Outcomes
	EG	CG	EG	CG	EG	CG	Frequency	Duration of treatment	Acupoints	
Cai 2014	WA:51 ± 6 EA:52 ± 7	50 ± 6	WA:30 EA:30	30	WA + EA	Calci D tablets	qd	1 month	BL11, BL23, GB39	1), 2)
Cai 2015	51 ± 7	50 ± 6	43	42	WA + calcil D tablets	Calcci D tablets	qd	4 months	BL11, BL23, GB39	1)
Chen 2004	58.12 ± 7.25	57.63 ± 7.68	30	30	WA + calcage D	Calcci D	qod	6 months	DU14, ST36, BL23, BL26	1), 3), 5)
Chen 2022	64 ± 5	64 ± 5	31	32	needling + Calcage D	Calcitriol gel pills	qod	12 weeks	BL23, BL20, RN4, ST36, GB39, SP6	1), 3)
Chen 2022	67.04 ± 4.82	67.39 ± 4.40	27	28	EA + Calci D	Calcci D	qod	4 weeks	ST36, ST30, GB34, GB39, BL18, BL20, BL23	2), 3)
Dong 2014	65.8 ± 5.3	66.7 ± 5.6	20	20	needling	Alfacalciferol softgels	6 times a week	3 months	RN12, RN6, RN4, SP15, KI14, KI13	2)
Du 2011	64 ± 8	66 ± 9	32	32	needling	Leli capsules	qod	3 months	LR14, BL18, BL20, BL23, ST36, GB34, GB39, SP6, KI3, LR3	1), 3), 5)
Feng 2021	63.91 ± 5.58	63.57 ± 5.63	34	33	needling + calcium carbonate tablets + alfacalciferol softgels + alendronate tablets	Calcium carbonate tablets + alfacalciferol softgels + alendronate sodium tablets	tiw	13 weeks	BL20, BL21, SP3, ST42, SP2, ST41	1), 3), 6)
Ge 2015	77.6 ± 8.3	79.2 ± 2.6	49	44	needling	Calcium carbonate D3 + calcitriol + alendronate sodium	once every three days	3 months	RN12, RN6, RN4, ST24, ST26, SP15	1), 2), 3), 4)
Hu 2016	61.4 ± 8.3	62.1 ± 8.7	35	35	needling	Calcium carbonate D3 tablets	qd	3 months	BL20, BL21, BL23, BL18, ST36	1), 3), 5)
Huang 2016	68.59 ± 4.43	68.44 ± 4.35	40	40	EA	Calcitriol softgels	qd	3 months	BL18, BL20, BL23, EX-B2, BL40, ashi point	1)
Jin 2003	60.70 ± 5.34	66.82 ± 6.51	32	30	EA	Tablets	tiw	3 months	EX-B2, ashi point, BL23, BL20, DU4, ST36, GB34	1), 2)
Li 2018	58.6 ± 4.3	59.4 ± 4.9	30	30	needling + zolescophospic acid injection	zole-lephosphate injection	qd	2 months	BL23, GB39, DU4, ST36, RN4	1), 3)
Liang 2007	61.3	61.3	40	40	WA	Calcci D	qod	3 months	BL11, DU14, DU4, BL23, BL20, ST36, GB39	1), 3)
Liu 2023	60.03 ± 5.06	59.45 ± 5.34	31	29	needling	Calcium carbonate D3	qod	3 months	BL23, ST36, BL11, EX-B2, DU4, KI3, BL20, RN12, SP10, BL17	1), 3)
Luo 2015	54.8 ± 6.2	54.8 ± 6.2	18	18	WA	Leli calcium capsules	qod	6 months	BL18, BL23, GB34, ST36, BL11, SP6, GB39, RN4	1), 3)

Table 1 (continued)

Author, year	Participants		Sample size		Interventions					Outcomes
	EG	CG	EG	CG	EG	CG	Frequency	Duration of treatment	Acupoints	
Nong 2011	67.75 ± 6.83	69.42 ± 4.12	32	31	WA	Vidine calcium tablets	qod	3 months	BL11, BL18, BL23, ST36, GB34, GB39, SP6, RN4	1), 2), 3)
Ou 2011	64.4 ± 5.3	65.6 ± 6.6	25	30	WA + alenphosphate sodium	Alendronate sodium	qod	6 months	BL20, BL23, DU4, RN8, ST36, SP6	1)
Pang 2008	68.8 ± 5.2	68.3 ± 5.3	30	30	WA	Vidine calcium tablets	qd	3 months	BL23, ST36, GB39, BL11, RN4, BL18, SP6, GB34	2), 3)
Qiu 2018	62.2 ± 9.3	61.4 ± 8.9	30	30	needling	Alendronate sodium tablets	qod	6 months	BL23, BL20, BL40, BL11, GB34, ST36	1), 3)
Shi 2010	66.70 ± 5.34	65.82 ± 6.51	15	15	needling + Calcium needle	Calcium breath needle 50 IU intramuscular injection	5 times a week	3 months	RN12, RN6, RN4, SP15	2)
Sun 2017	59.88 ± 6.18	59.88 ± 6.18	30	30	EA + Calci D	Calcci D	qod	3 months	BL23, BL20, BL21, KI3, BL11, GB39, SP6	1), 2)
Tan 2016	59.4 ± 2.5	60.3 ± 3.6	40	40	EA	Calcium carbonate D3 chewable tablets	qd	6 months	BL23, SP6, DU4	1), 2), 3)
Tian 2020	65 ± 5	64 ± 6	32	33	needling	Alendronate tablets	tiw	3 months	BL23, GB25, BL20, LR13, BL18, LR14, BL11, GB39, ST36, GB34, GB31, ST31, ST33	1), 2), 3), 4)
Tian 2023	66 ± 4	65 ± 5	36	36	needling	Alendronate tablets	tiw	6 months	BL18, LR14, BL23, GB25, BL20, LR13, BL21, RN12, GB34, GB39, GB31, ST31, ST33	1), 2)
Wang 2004	47.87	49.62	50	50	needling	Gaitianli + gamma oryzanol	qd	3 months	BL23, BL18, ST36, KI1, SP10	1), 3)
Wang 2013	58 ± 5	56 ± 7	G1:50 G2:50	50	G1:EA G2:EA + Calcitriol Soft Capsules	Rogue full gel pills	qd	6 months	BL20, BL21, BL23, BL18, DU3, DU4, BL40, ashi point, RN12, ST25, RN4, EX-CA1, ST36, SP6, KI3, GB39	1), 2), 3), 5), 6)
Wang 2016	61.83 ± 4.71	62.23 ± 4.29	30	31	EA	Calcium carbonate D3 tablets	qod	6 months	BL11, BL23, ST36	1), 3)
Wang 2019	62.93 ± 7.23	62.93 ± 6.95	30	30	needling	Manual acupuncture	qd	3 months	BL23, BL20, DU4, ST36, RN4, ashi point	1), 2), 3)
Wu 2012	68 ± 5.27	68 ± 5.27	25	30	WA + alfacalciferol + calciferol D	Alfacalciferol + Calcil D	tiw	3 months	BL23, DU4, ST36, GB39	1), 2)
Xin 2021	66.95 ± 4.6	67.26 ± 4.58	40	40	WA + calcitonin + salmon calcitonin injection + alendronate sodium	Calci + Salmon Calcitonin Injection + Alendronate Sodium	qod	3 months	BL11, BL23, ST36, GB39, BL18, SP6, GB34	1), 2), 3)

Table 1 (continued)

Author, year	Participants		Sample size		Interventions					Outcomes
	EG	CG	EG	CG	EG	CG	Frequency	Duration of treatment	Acupoints	
Yang 2016	60.8 ± 4.3	61.2 ± 4.7	54	50	needling + salmon calcitonin + Alan phosphate sodium + calci	Salmon calcitonin + Alan phosphate sodium + calciton	qod	6 months	ST36, BL23, BL26, KI3, BL20, SP6, ashi point	1), 2), 3)
Zhang 2014	62.21 ± 4.65	62.74 ± 5.07	25	25	EA	Alfacalciferol softgels	qod	3 months	BL23, DU4, ST36, RN4, BL20, BL40, KI3	1), 2), 3)
Zhang 2016	65.6 ± 6.6	64.4 ± 5.3	20	20	EA + Fairy Bone Capsules	Fairy Bone Capsules	qd	6 months	EX-B2	1), 2)
Zhang 2021	63.62 ± 7.76	63.49 ± 7.81	39	39	WA + alendronate sodium + calcium carbonate D3 tablets	Calcium carbonate D3 tablets + alendronate sodium	qod	8 weeks	BL23, BL11, GB39, ST36, DU4	1), 3)
Zhao 2008	64.00 ± 5.99	66.90 ± 5.89	20	20	WA	Vidine calcium tablets	qod	3 months	BL11, BL18, BL23, ST36, GB34, GB39, SP6, RN4	1), 3), 5)
Zhao 2013	65.6 ± 3.4	64.2 ± 2.32	50	50	needling + Calci D + Luo Gaiquan	Calcil D + Rogai Whole + Alendronate Sodium Tablets	qod	4 months	EX-B2	1), 2)
Zhao 2015	62.4 ± 8.5	61.9 ± 9.0	34	32	needling	Salmon calcitonin or sodium allenphosphate + calcium carbonate D3 or calcitriol	qod	6 months	GB39, BL23, RN4, RN6, DU4, ST36, SP6, SP9, GB34	1), 2), 3)
Zhou 2014	62.39 ± 7.12	61.37 ± 8.06	30	30	WA + risedronate	Risedronate sodium	qd	1 month	BL18, BL23, BL20	1), 2), 3)
Zhu 2015	70.5 ± 3.3	69.3 ± 3.6	30	30	needling	group health management interventions	qd	5 months	DU14, DU4, BL20, KI3, ST36	1), 2), 3)

EG: experimental group; CG: control group; WA: warming acupuncture; EA: electroacupuncture; qd: once daily; qod: once every other day; tiw: 3 times a week

outcomes: 1) bone mineral density (BMD); 2) pain visual analog scale (VAS); 3) clinical therapeutic effect; 4) Oswestry disability index (ODI); 5) level of serum alkaline phosphatase, and 6) level of E_2

Fig. 2 Risk of bias graph

Acupoints

After analysis of points adopted in these trials, we found that Shenshu (BL23), Zusanli (ST36), Pishu (BL20) were the top three commonly used acupoints. The top 10 commonly used acupoints for OP were presented in Fig. 3.

Bone mineral density

A total of 36 studies [30, 31, 34, 36–46, 49, 51–68] reported the BMD. Meta-analysis found that compared with the control group, acupuncture can effectively improve the BMD of patients with POP (MD 0.04 [0.03–0.06], $P<0.001$, $I^2=92\%$) (Fig. 4). To more accurately evaluate the therapeutic effect of acupuncture, we conducted subgroup analysis based on different types of acupuncture used, including needling, electroacupuncture, and warm acupuncture. Firstly, a subgroup analysis with 16 studies [34, 36–38, 42, 44, 49, 53–55, 61, 66, 67, 69] showed needling significantly improved

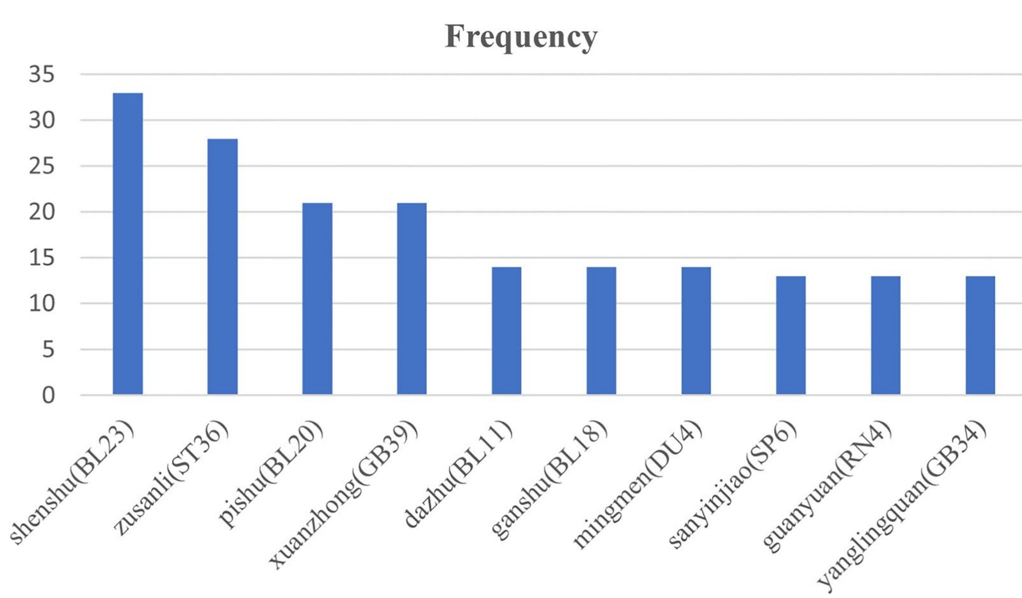

Fig. 3 The highest frequency acupoints adopted in these studies

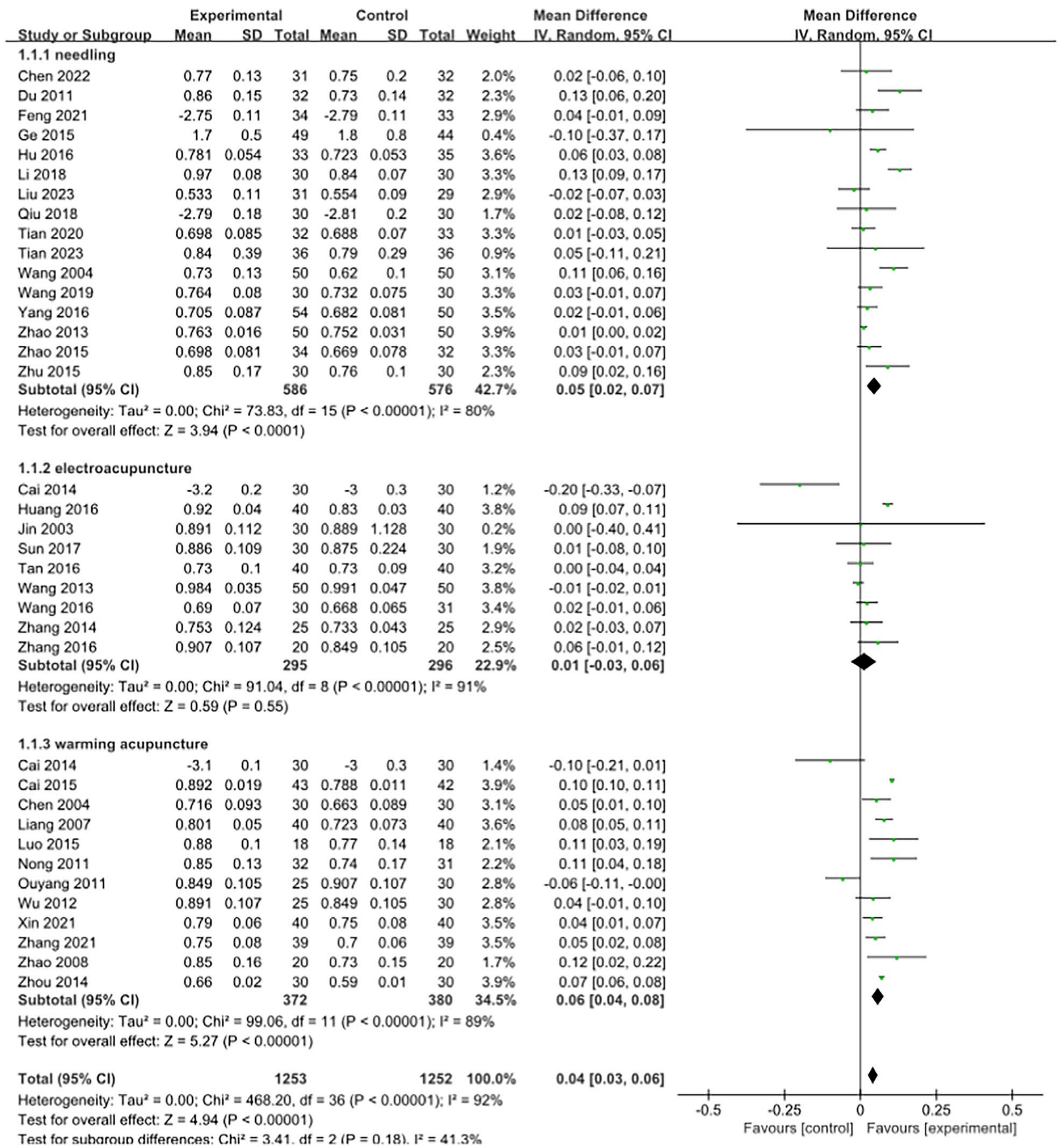

Fig. 4 Meta-analysis of bone mineral density acupuncture versus conventional medicine

the BMD of patients with OP (MD 0.05 [0.02–0.07], $P<0.001$, $I^2=80\%$), whether needling versus control group (MD 0.05 [0.02–0.07], $P<0.001$, $I^2=64\%$) or needling plus conventional medicine versus control group (MD 0.05 [0.00–0.09], $P<0.001$, $I^2=89\%$), respectively 11 [36, 38, 39, 44, 49, 53–55, 67, 69] and 5 [34, 37, 42, 61, 66] studies. The differences between subgroups were not significant ($P=0.96$), thus the two types of interventions did not appear to differentially affect the primary outcome. Secondly, a subgroup analysis of 9 studies [30, 40, 41, 51, 57, 59, 62, 63] indicated that there was no statistical significance for the BMD between the electroacupuncture groups and controls (MD 0.03 [−0.03–0.09], $P=0.03$, $I^2=97\%$). Finally, a subgroup analysis with 12 studies [30–33, 43, 45, 46, 59, 60, 64, 65, 68] found that warm acupuncture presented a significant improvement in BMD (MD 0.06 [0.04–0.08], $P<0.001$, $I^2=89\%$), whether warm acupuncture versus control group (MD 0.07 [0.02–0.13], $P<0.05$, $I^2=65\%$) or warm acupuncture plus conventional medicine versus conventional medicine (MD 0.05 [0.03–0.08], $P<0.001$, $I^2=93\%$), respectively 5 [30, 43, 45, 46, 65] and 7 [31, 32, 47, 59, 60, 64, 68] studies. The differences between subgroups were not significant ($P=0.47$), thus the two types of interventions did not appear to differentially affect the primary outcome.

Pain visual analog scale (VAS)

A total of 23 [30, 33, 35, 38, 41, 46, 48, 50–53, 56, 57, 59–62, 66] studies reported VAS after acupuncture treatment. Compared with the control group, meta-analysis found that acupuncture can effectively reduce the pain scores (SMD −1.79 [−2.29 to −1.29], $P<0.001$, $I^2=95\%$) (Fig. 5). We next performed subgroup analysis. Firstly, a subgroup analysis with 10 studies [25, 28, 40, 53, 56, 61, 67, 68] showed needling significantly improved the VAS of patients with POP (SMD −1.81 [−2.45 to −1.16], $P<0.001$, $I^2=95\%$), whether needling versus conventional me conventional medicine (SMD −1.94 [−2.52 to −1.37], $P<0.001$, $I^2=82\%$) or needling plus conventional medicine versus conventional medicine (SMD −1.50 [−2.62 to −0.38], $P<0.05$, $I^2=96\%$), respectively 7 [35, 38, 53, 54, 56, 67, 69] and 3 [50, 61, 66] studies. The differences between subgroups were not significant ($P=0.49$), thus the two types of interventions did not appear to differentially affect the primary outcome. Secondly, a subgroup analysis of 8 studies [30, 33, 41, 51, 52, 57, 62, 63] indicated that electroacupuncture can effectively improve the VAS of patients with POP (SMD −1.28 [−2.14 to −0.42],

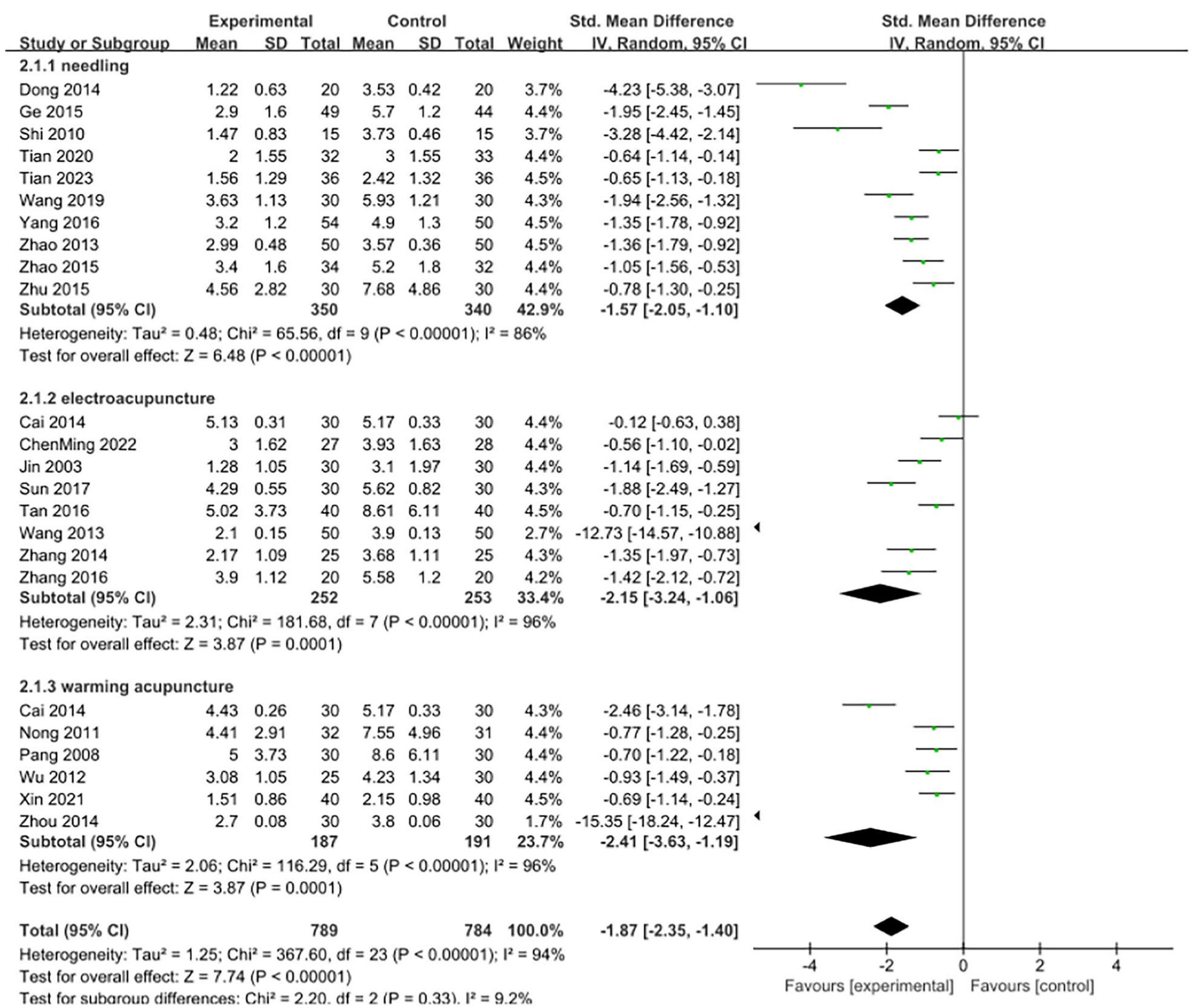

Fig. 5 Meta-analysis of VAS acupuncture versus conventional medicine

$P<0.05$, $I^2=100\%$), whether electroacupuncture versus conventional medicine (SMD −0.72 [−1.19 to −0.25], $P<0.05$, $I^2=94\%$) or electroacupuncture plus conventional medicine versus conventional medicine (SMD −1.53 [−1.90 to −1.15], $P<0.05$, $I^2=72\%$),. respectively 5 and 4 studies [33, 51, 57, 63]. The differences between subgroups were significant ($P=0.009$), thus the effect size for VAS is larger in electroacupuncture plus conventional medicine group. But both subgroups contain considerable statistical heterogeneity suggesting factors other than intervention type likely contribute to the observed heterogeneity. Finally, a subgroup analysis of 6 studies [30, 46, 48, 59, 68] proved that warm acupuncture presented a significant improvement in VAS (SMD −0.98 [−1.28 to −0.68], $P<0.001$, $I^2=85\%$), whether warm acupuncture versus control group (SMD −2.23 [−4.43 to −0.13], $P<0.05$, $I^2=80\%$) or warm acupuncture plus conventional medicine versus conventional medicine (SMD −0.98 [−1.29 to −0.67], $P<0.001$, $I^2=60\%$), respectively 3 [30, 46, 48] and 3 [59, 60, 68] studies. The differences between subgroups were not significant ($P=0.25$), thus the two types of interventions did not appear to differentially affect the primary outcome.

Clinical effectiveness rate

Twenty-eight articles reported the effective rate of acupuncture and meta-analysis results showed that the acupuncture significantly improved the clinical effectiveness (RR 1.24 [1.14–1.34], $P<0.001$, $I^2=81\%$) (Fig. 6) [33, 34, 36–38, 42–45, 48, 49, 52, 53, 55–57, 60, 61, 64, 65, 67, 68]. We next performed subgroup analysis. Firstly, 14 studies [24, 36–38, 42, 44, 49, 53, 55, 56, 61, 66, 67] reported the findings of needling therapy for POP. Compared with the control group, needling can effectively improve the clinical effectiveness of patients with POP (RR 0.23 [0.14–0.32], $P<0.001$, $I^2=76\%$), whether needling versus control group (RR 0.17 [0.04–0.31], $P<0.001$, $I^2=78\%$) or needling plus conventional medicine versus conventional medicine (RR 0.23 [0.14–0.32], $P<0.001$, $I^2=59\%$), respectively 10 [36, 38, 39, 44, 49, 53, 55, 56, 67, 69] and 4 [34, 37, 42, 61] studies. The differences between subgroups were not significant ($P=0.42$), thus the two types of interventions did not appear to differentially affect the primary outcome. Secondly, a subgroup analysis of 5 studies [33, 52, 57, 58, 62] indicated that electroacupuncture can effectively improve the clinical effectiveness of patients with POP (RR 0.22 [0.09–0.35], $P<0.001$, $I^2=67\%$). whether electroacupuncture versus control group (RR 0.13 [0.03–0.22], $P<0.05$, $I^2=0\%$) or electroacupuncture plus conventional medicine versus conventional medicine (RR 0.40 [0.10–0.70], $P<0.05$, $I^2=82\%$), respectively 4 [52, 57, 58, 62] and 2 [33, 57] studies. The differences between subgroups were not significant ($P=0.09$), thus the two types of interventions did not appear to differentially affect the primary outcome. Finally, a subgroup analysis of 9 studies [32, 43, 45, 46, 48, 60, 64, 65, 68] found that warm acupuncture presented a significant improvement on clinical effectiveness of patients with POP (RR 1.11 [1.01–1.22], $P<0.05$, $I^2=76\%$). whether warm acupuncture versus control group (RR 1.06 [0.98–1.16], $P=0.16$, $I^2=44\%$) or warm acupuncture plus conventional medicine versus conventional medicine (RR 1.11 [1.01–1.22], $P=0.20$, $I^2=90\%$), respectively 5 [43, 45, 46, 48, 65] and 4 [32, 60, 65, 68] studies. The differences between subgroups were not significant ($P=0.42$), thus the two types of interventions did not appear to differentially affect the primary outcome.

Level of estradiol (E_2)

A meta-analysis of 5 studies [32, 36, 39, 57, 65] suggested that the acupuncture group had a improvement in the level of E_2 compared to the control group (SMD 0.30 [0.09–0.52], $P=0.006$, $I^2=0\%$) (Fig. 7).

Other outcomes

There were only two studies reporting the ALP and ODI, respectively. Therefore, we performed a narrative synthesis for these two outcomes. Both studies showed that acupuncture has a superior effect over the conventional medicine in the ALP and ODI.

Sensitivity analysis

A method of one study excluded at a time was used to detect the source of heterogeneity and to assess whether the results could have been influenced. The results showed that there was no significant influence on the pooled MD, SMD or RR value.

Publication bias

Based on Egger's tests, there was not significant publication bias observed for BMD ($P=0.093$), VAS ($P=0.101$), clinical effectiveness rate ($P=0.309$) and E_2 ($P=0.95$). This was in accordance with the results of funnel plot. Details of the publication bias are in Supplementary Material (Figs. 2, 3, 4, 5 and 6 and Table 1).

Credibility of evidence

The credibility of the evidence was assessed by the GRADE system [27]. The summary of findings indicated that there was moderate certainty in the BMD and low certaintyin the VAS. In consideration of the high heterogeneities and high or unclear risks found in the included studies, we downgraded the quality of evidence. Results of this assessment are in Supplementary Material (Fig. 7).

Study or Subgroup	Experimental Events	Experimental Total	Control Events	Control Total	Weight	Risk Ratio M-H, Random, 95% CI
3.1.1 needling						
Chen 2022	26	31	19	32	2.9%	1.41 [1.02, 1.96]
Du 2011	26	32	18	32	2.7%	1.44 [1.02, 2.05]
Feng 2021	31	34	23	33	3.6%	1.31 [1.02, 1.68]
Ge 2015	43	49	29	44	3.7%	1.33 [1.05, 1.69]
Hu 2016	31	33	27	35	4.0%	1.22 [1.00, 1.49]
Li 2018	27	30	19	30	3.1%	1.42 [1.06, 1.91]
Liu 2023	27	31	18	29	3.0%	1.40 [1.02, 1.92]
Qiu 2018	28	30	23	30	3.8%	1.22 [0.98, 1.52]
Tian 2020	30	32	24	33	3.8%	1.29 [1.03, 1.62]
Wang 2004	41	50	29	50	3.4%	1.41 [1.08, 1.85]
Wang 2019	29	30	7	30	1.2%	4.14 [2.16, 7.95]
Yang 2016	51	54	45	50	4.8%	1.05 [0.94, 1.17]
Zhao 2015	32	34	27	32	4.3%	1.12 [0.94, 1.32]
Zhu 2015	27	30	23	30	3.7%	1.17 [0.93, 1.48]
Subtotal (95% CI)		**500**		**490**	**48.1%**	**1.30 [1.17, 1.44]**
Total events	449		331			
Heterogeneity: Tau² = 0.02; Chi² = 35.75, df = 13 (P = 0.0006); I² = 64%						
Test for overall effect: Z = 4.78 (P < 0.00001)						
3.1.2 electroacupuncture						
ChenMing 2022	19	27	4	28	0.7%	4.93 [1.92, 12.61]
Tan 2016	34	40	26	40	3.4%	1.31 [1.01, 1.70]
Wang 2013	40	50	35	50	3.8%	1.14 [0.91, 1.44]
Wang 2016	26	30	25	31	3.8%	1.07 [0.86, 1.34]
Zhang 2014	22	25	18	25	3.2%	1.22 [0.92, 1.62]
Subtotal (95% CI)		**172**		**174**	**14.9%**	**1.27 [1.01, 1.61]**
Total events	141		108			
Heterogeneity: Tau² = 0.04; Chi² = 12.59, df = 4 (P = 0.01); I² = 68%						
Test for overall effect: Z = 2.01 (P = 0.04)						
3.1.3 warming acupuncture						
Chen 2004	24	30	16	30	2.5%	1.50 [1.03, 2.19]
Liang 2007	37	40	34	40	4.4%	1.09 [0.93, 1.27]
Luo 2015	16	18	12	18	2.6%	1.33 [0.93, 1.92]
Nong 2011	32	32	30	31	5.0%	1.03 [0.95, 1.13]
Pang 2008	28	30	24	30	4.0%	1.17 [0.95, 1.43]
Xin 2021	38	40	31	40	4.2%	1.23 [1.02, 1.47]
Zhang 2021	37	39	31	39	4.3%	1.19 [1.00, 1.42]
Zhao 2008	20	20	20	20	4.9%	1.00 [0.91, 1.10]
Zhou 2014	30	30	30	30	5.1%	1.00 [0.94, 1.07]
Subtotal (95% CI)		**279**		**278**	**37.0%**	**1.11 [1.01, 1.22]**
Total events	262		228			
Heterogeneity: Tau² = 0.01; Chi² = 33.77, df = 8 (P < 0.0001); I² = 76%						
Test for overall effect: Z = 2.14 (P = 0.03)						
Total (95% CI)		**951**		**942**	**100.0%**	**1.23 [1.13, 1.34]**
Total events	852		667			
Heterogeneity: Tau² = 0.03; Chi² = 140.43, df = 27 (P < 0.00001); I² = 81%						
Test for overall effect: Z = 4.93 (P < 0.00001)						
Test for subgroup differences: Chi² = 4.65, df = 2 (P = 0.10), I² = 57.0%						

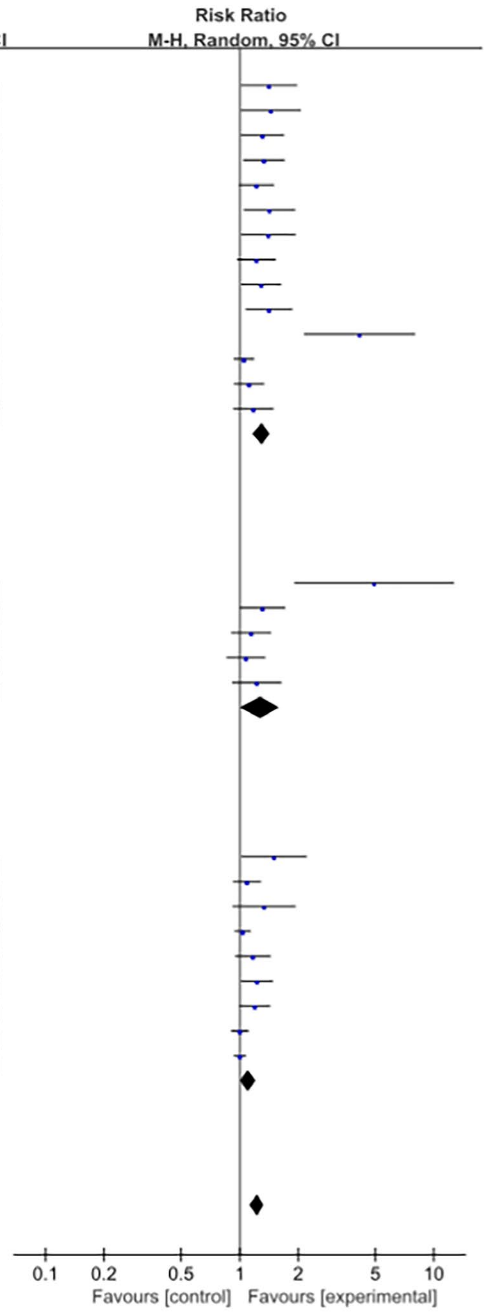

Fig. 6 Meta-analysis of clinical therapeutic effect acupuncture versus conventional medicine

Discussion

In our meta-analysis, we observed that acupuncture resulted in a increase in BMD compared to that in the control group. This is consistent with previous meta-analyses and trials of acupuncture as a stand-alone treatment for OP or in combination with other active treatments [17–20]. Additionally, this meta-analysis proved that acupuncture had a positive effect on reducing VAS scores compared to that in the control group. This is consistent with the fact that acupuncture is used as an analgesic therapy to relieve pain [70, 71]. The health insurance-funded German Acupuncture Randomized Trials and Acupuncture in Routine Care study programs found that acupuncture was superior to non-treatment [72, 73], but not superior to control acupuncture, which was performed with placebo needles [74]. Similarly, a

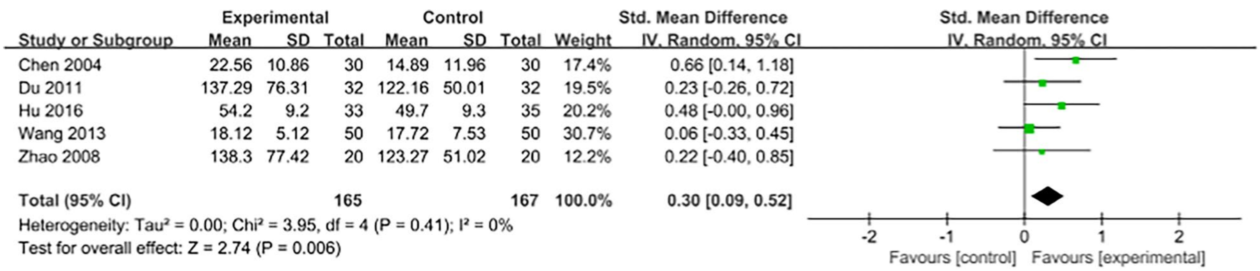

Fig. 7 Meta-analysis of ODI acupuncture versus conventional medicine

prospective, randomized, double-blind study on the treatment of pain in patients with hip osteoarthritis demonstrated comparable effects between verum acupuncture and control acupuncture [75, 76]. A high-quality meta-analysis including data from 29 randomized clinical trials showed that acupuncture was more effective than control acupuncture and no acupuncture in treating chronic pain in the axial skeleton [77]. A Cochrane meta-analysis of six randomized controlled trials, which were considered by the authors to be of high quality, concluded that acupuncture is more effective than placebo treatment and non-treatment in reducing pain and improving physical function among patients with low back pain [78].

Moreover, our study showed that acupuncture can enhance the level of E_2 compared to that of the control group. An animal experiment showed that acupuncture improves OP while increasing circulating estrogen levels, which may be closely related to postmenopausal extragonadal aromatization [16]. According to previous studies, ALP is recommended as a marker of bone turnover that can predict OP and osteoporotic fractures [80]. Current studies have suggested that bALP may be a useful, valid, and reliable tool for therapy monitoring in postmenopausal osteoporosis [81, 82]. The number of reported literature on these two indicators, ODI and ALP, is too small. Therefore, we did not perform a meta-analysis on them, and more studies focusing on these two indicators are needed to help us determine whether acupuncture has an ameliorative effect on these two indicators. In the future research, the prevalence of OP and related complications such as vertebral compression fractures is expected to increase due to aging population [83]. Therefore, there is a growing need for clinical predictors to prevent early OP, such as weight and genetic screening [84, 85].

Several systematic reviews and meta-analyses have investigated the use of acupuncture in treating OP. Most reported encouraging results, but many systematic reviews did not consider the impact of factors that could contribute to the high heterogeneity and the results, such as the type of OP (primary or secondary), acupuncture points for injection, treatment frequency and duration of treatment, type of outcome measure (clinician rated or self-reported), and personal characteristics (e.g. age, sex) [17–20]. Future studies should improve the methodology quality and be consistent in acupuncture frequency and duration of treatment.

Although limited superior effects of acupuncture were found in bone mineral density and visual analog scale scores, the enhancement of clinical effectiveness rate was encourging for clinical practice. Even modest increases in BMD over the long-term clinical course can significantly reduce fracture risk in OP patients [79] and diminish the patients' requirements for subsequent invasive treatments such as surgery. Furthermore, as an alternative or complementary therapy, acupuncture can decrease reliance on medications like analgesics and other drugs, thus reducing their associated side effects. Current results have showed sustained effects of acupuncture for pain reductions persisting for 3–6 months [80, 86]. Non-pharmacological therapies are the main active methods used in physical rehabilitation medicine. These therapies involve the development of personalized home-based exercise programs and the use of flexible trunk orthoses to improve posture. Finally, a meta-analysis demonstrated that acupuncture is beneficial in improving anxiety and depression, improving neurotransmitter levels in the brain, reducing serum inflammatory factors, and improving the ability to perform daily activities in patients with spinal cord injury [87]. In conclusion, acupuncture provides physiological and psychological benefits to patients and holds considerable clinical significance.

Limitations

The generalizability of the findings of this meta-analysis is limited by the lack of racial and ethnic diversity in the included studies; all participants were from China across all included trials, resulting in a homogeneous sample that is not representative of the general population. Moreover, the overall heterogeneity of the studies was high, which may be due to differences in sample size, study population, personal characteristics (e.g. age, sex), and experimental methods of individual studies. Finally, methodological limitations reduced confidence in the effect estimates in the current systematic review.

Conclusions

The findings of this review on the efficacy of acupuncture in treating POP are encouraging for its use in clinical practice as a alternative or complementary intervention for patients with POP. However, high-quality multicenter studies in different countries or regions should be conducted in the future.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13018-025-05513-9.

Supplementary Material 1.

Author contributions

Data curation: Tianyi Ma, TianTian Zhang, Liang Ou, Le Zhang. Writing—original draft: Tianyi Ma, TianTian Zhang Writing—review & editing: Tianyi Ma, Liang Ou, Jianjun Kuang. Methodology: Le Zhang, Liang Ou. Software: TianTian Zhang. Funding acquisition: Liang Ou, Jianjun Kuang. Supervision: Liang Ou, Haoming Zhao. Validation: Liang Ou, Haoming Zhao, Ke Liu. Visualization: Ke Liu.

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Availability of data and materials

No datasets were generated or analysed during the current study.

Declarations

Competing interests

The authors declare no competing interests.

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