



Efficacy and safety of acupuncture for pain relief: a systematic review and meta-analysis

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Abstract

Objective This study aims to evaluate the efficacy and safety of traditional acupuncture for pain relief based on rigorously designed RCTs with double-blind. The findings seek to provide valuable insights for clinical practice and inform future research.

Methods A literature search was conducted in PubMed, Web of Science, Cochrane Library, and Embase databases for randomized controlled trials on traditional acupuncture for pain management using a double-blind design, published from database inception to November 22, 2023. The Risk of Bias 2 (RoB2) tool was used to assess potential biases in the included studies, followed by a comprehensive analysis to evaluate efficacy and safety.

Results The findings show a significant positive effect on pain improvement, evidenced by changes in visual analog scale scores (mean difference 0.97 [95% confidence interval (CI) 0.66–1.27]). Safety analysis showed no significant differences in adverse reactions between the acupuncture and control groups (relative risk 1.40 [95% CI 0.52–3.74]), with no serious adverse effects reported.

Conclusion Traditional acupuncture is effective and safe in pain management. This suggests that acupuncture can be a valuable approach in clinical practice. Future studies should explore optimal treatment durations and frequency, using larger sample sizes for more comprehensive insights.

Keywords Double-blind · Traditional acupuncture · Pain · Systematic reviews · Meta-analyses

Introduction

According to the International Association for the Study of Pain (IASP), pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage [1]. Globally, millions of individuals suffer from acute and chronic pain annually [2, 3], making it a significant public health challenge [4]. Pain is a common symptom

experienced in several diseases [5], including cancer [6], arthritis [7, 8], neurodegenerative disorders [9], chronic heart failure [10], chronic obstructive pulmonary disease [11], chronic kidney disease [12], and liver diseases [13].

Acupuncture is a traditional medical technique that originated in China [14], which works by stimulating specific body areas (known as acupoints) found along meridian channels (the pathways through which vital life energy, known as “qi” flows) to regulate physiological functions [15, 16]. It is a widely recognized technique in the management of pain and has gained extensive application in medical practice globally. Since pain assessment is a subjective measure, there is uncertainty about the reliability of outcomes especially following acupuncture treatment [17]. Although subjective bias is addressed using double-blind randomized controlled trials (RCTs) [18, 19], double-blind is quite challenging to implement in traditional acupuncture RCTs [20].

The most recent meta-analysis provided supportive evidence of the positive therapeutic effects of acupuncture in managing acute pain [21]; however, the RCTs included were

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not double-blinded, which potentially affects the quality of the results. The effectiveness and safety of acupuncture for pain relief, as assessed by rigorously designed RCTs with double-blind, remain uncertain. Therefore, our study aims to systematically assess the efficacy and safety of traditional acupuncture for pain management using double-blinded RCTs. This study will guide current practice and future research.

Methods

Protocol and registration

This study was performed following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (i.e., “PRISMA”) guidelines [22]. This study was registered with the International Prospective Register of Systematic Reviews (i.e., “PROSPERO”) database with accession no. CRD42024500737. This study is a secondary analysis

including published literature; therefore, no ethical approval was required.

Database and search strategies

A systematic search was performed in 4 electronic databases (PubMed, Web of Science, Embase, and Cochrane Library) using the MESH terms “acupuncture” and “pain,” to identify articles published from database inception up to November 22, 2023. Relevant studies that investigated the use of acupuncture for pain management using double-blind designs were retrieved.

Inclusion criteria

Studies were included based on the following criteria: patients ≥ 18 years of age experiencing pain from any disease, intervention measures included traditional acupuncture (using metallic needles inserted into specific acupuncture points on the body and using manual techniques to regulate

Fig. 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of the study selection process

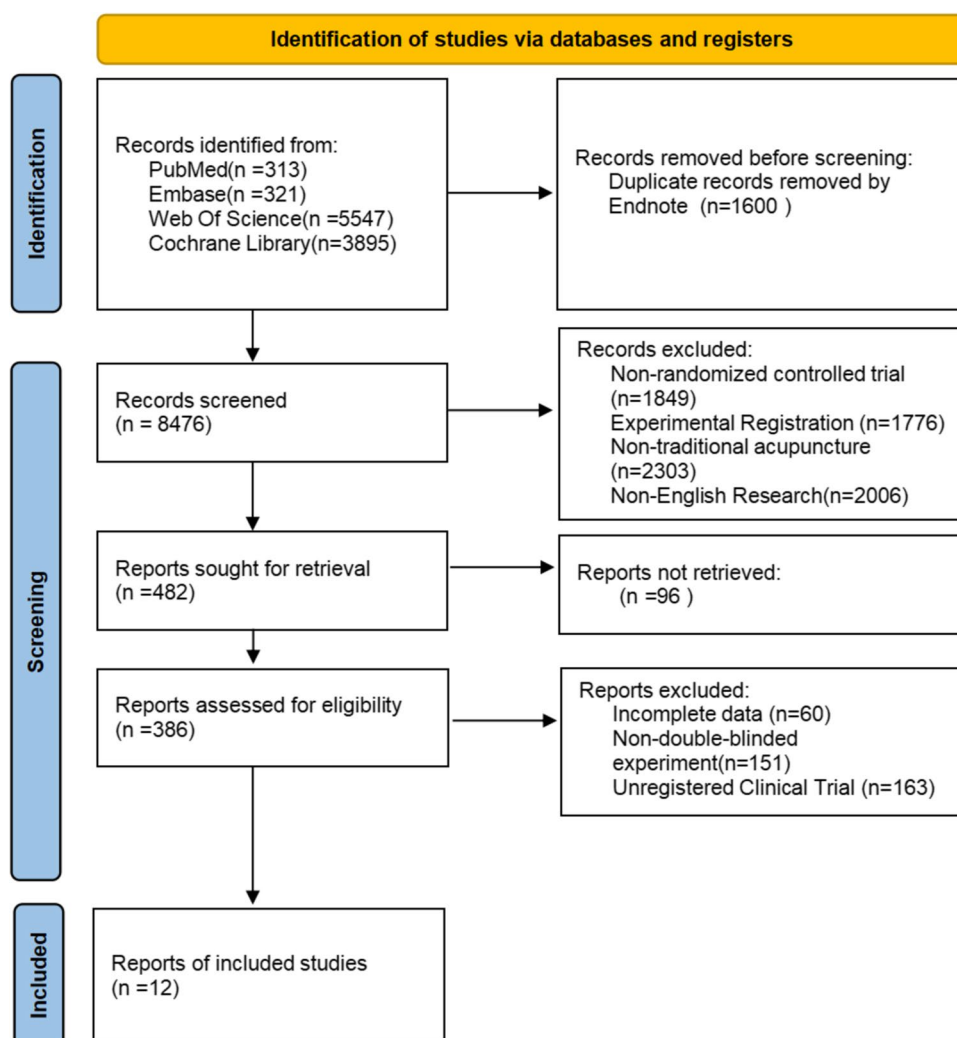


Table 1. Characteristics of the included studies

Author	Year	ICD-11*	Experimental Group	Number of intervention group	Control group	Number of control group	Methods of follow-up	Duration of follow-up	Pain Scale	Adverse reactions	Nature of pain
Yoshi F. Shen	2009	15	Traditional acupuncture	16	Sham acupuncture	12	Assess by experts	-	VAS	-	Long
Hasegawa, T. M.	2014	15	Traditional acupuncture	40	Sham acupuncture	40	Assess by experts	baseline(D0) days 3(D3) days 7(D7) days 14(D14) days 21(D21) days 28(D28)	VAS	Not occurred	Short
Liao, H. Y.	2017	8	Traditional acupuncture	28	Sham acupuncture	20	Patient self-recording	Immediately	VAS	-	Short
Min-yi Zhao	2017	16	Traditional acupuncture	43	Sham acupuncture	45	Patient self-recording	After treatment: 30min	VAS	Not occurred	Long
Huang, Z.	2019	15	Traditional acupuncture	23	Sham acupuncture	23	Assess by experts	1week 2week 3week 4week 16week 18week	VAS	Occurred	Long
de Salles-Neto, F. T.	2020	15	Traditional acupuncture	16	Sham acupuncture	16	Assess by experts	Immediately 1 week 1 month 2 week	VAS	Occurred	Long
Lam, W. C.	2021	15	Traditional acupuncture	42	Sham acupuncture	41	Assess by experts	4 week 6 week 10 week After surgery:	VAS	Occurred	Long
Lv, J. Q.	2021	8	Traditional acupuncture	58	Sham acupuncture	59	Assess by experts	24h 48h 72h	VAS	Occurred	Short
Zhang, X.	2021	16	Traditional acupuncture+Normal saline	39	Sham acupuncture+Lornoxicam	41	Patient self-recording	Completion of treatment: 0min 5min 10min 15min 20min 40min T1(0 h after entering the ward) T2(0.5 h after entering the ward) T3(6 h after entering the ward) T4(24 h after entering the ward)	VAS	Occurred	Short
Hou, J.	2022	16	Traditional acupuncture	23	Sham acupuncture	21	Assess by experts	4 week 16 week 28 week	VAS	Not occurred	Short
Jiao, R. M.	2022	14	Traditional acupuncture	50	Sham acupuncture	50	-	Menstrual cycle 1-3 cycle 4-6	VAS	Occurred	Short
Liu, L.	2022	8	Traditional acupuncture+placebo naproxen	86	Sham acupuncture+Naproxen	84	Patient self-recording	Menstrual cycle 1-3 cycle 4-6	VAS	Occurred	Long

Abbreviation:

Table 1. (continued)

*:8:Neurological diseases;14:Diseases of the skin;15:Diseases of the musculoskeletal system or connective tissue;16:Diseases of the genitourinary system
VAS: Visual Analogue Scale

TABLE 1-1 Characteristics of the included studies

Author	Year	Type of needle	Acupoint	Reasons for acupoint selection	Size of needle	Angle of needle	Depth of needle	Duration of intervention	The details of De-qi
Yoshi f. Shen	2009	-	Hegu li4(left hand)	-	-	-	10-20mm	20min	Not required
Hasegawa, t. M.	2014	Disposable stainless steel needles,(suzhou huanqiu acupuncture medical appliance co)	Basic Point: D	Yamamoto's new scalp acupuncture(Y NSA)	0.20×13mm	15°	0.3-0.5cm	30 min	-
			Basic Points: D1–d6						
			Basic Point: H						
			Basic Point: I						
			Y Point: Bladder						
			Y Point: Kidney						
			Y Point: Liver						
			Diagnostic Points Of Cervical Region:Kidney						
			Diagnostic Points Of Cervical Region:Bladder						
			Diagnostic Points Of Cervical Region:Liver						
Liao, h. Y.	2017	Disposable needles measuring(yu kuang, taipei, taiwan)	Baihui(gv-20)	-	0.25×44mm	-	Based on the excitation of de-qi	20min	Each acupoint was stimulated to elicit de-qi
			Sishencong(ex-hn1)						
			Quchi(li11)						
			Hegu(li4)						
			Neiguan(pc6)						
			Waiguan(te5)						
			Yanglingquan(gb34)						
			Zusanli(st36)						
			Sanyinjiao(sp6)						
			Taichong(lr3)						
			Additional acupoints were added according to symptoms						
			Disposable stainless acupuncture with guide tubes						
			(zhongyan taihe, wuxi jiajian medical instrument co ltd, jiangsu, china)						
			Disposable hwato needles						
			Dachangshu(bl25)						
			Shenshu(bl23)						
			Weizhong(bl40)						
			Chengshan(bl57)						

Table 1. (continued)

De salles-neto, f. t.	20	Disposable stainless spiral cable needles (dong bang®, korea)	Hegu(li4) Yanglingquan(gb34) Zusanli(st36) Quanliao(si18) Tinggong(si19) Jiache(st6) Xiaguam(st7) Fengchi(gb20)	Previous research	Distal points: 2.0cm×3.0cm×0.25mm facial points:2.0cm×1.5cm×0.20mm	-	-	20min	Rotate index and thumb at 3-5 rpm, alternating clockwise and counterclockwise, until de-qi is achieved
Lam, w. C.	20	Disposable needles(mo cm, hong kong)	-	-	0.30×40 mm	0°-10°	10-20mm	30min	-
Lv, j. Q.	20	Disposable stainless steel needles (wuxi jiajian; made in jiangsu, china)	P6 acupoint	Meridian theory, previous research	0.25×25 mm	90°	20 mm	30min	Downward pressure and upward lifting and rotation of the needle to achieve deqi (sensation of pain, numbness, expansion, or radiation)
Zhang, x.	20	-	Sanyinjiao(sp6) yinlingquan(sp9)	The nomenclature and location of acupuncture points described in the national gb/ t12346-2006 acupoint standard	-	90°	-	20min	Sense of de-qi:Sour,numb,swelling up,or painful
Hou, j.	20	Needle(hua tuo brand, suzhou medical products co. Ltd.)	Lower 1:Near achilles tendon, Lower 2:Near medial tibia border, Lower 3:1cm medially from anterior crest tibia	Previous research	0.25×25 mm	30°	0.2mm	24h	-
Jiao, r. M.	20	Disposable acupuncture needles(hu atuo brand; suzhou medical appliance, suzhou,	Dazhui(cv14) Bilateral acupointsof quchi(li11) Hegu(li4) Zusanli(st36) Neiting(st44)	The guidelines for av treatment in china (revised version 2014); consensus of experienced acupuncturists	0.30×40 mm	10-15°	CV14: 30-40mm others: 25-30mm	30 min	Slight lifting, thrusting, and twisting manipulations to produce a sensation of de-qi (characteristic needling sensation of sourness, numbness, swelling and heaviness)

overall physical well-being), control measures involving sham acupuncture or any other intervention that could successfully implement a double-blind design, study outcome measures included any arbitrary pain rating scales, such as the visual analog scale (VAS) and/or numerical pain rating scale (NPRS), and study design was a double-blind RCT.

Exclusion criteria

Duplicate studies, unregistered studies, inaccessible studies or studies registered solely as experimental trials, studies with incomplete outcome data or where outcome indicators could not be combined, and retracted studies were excluded.

Literature screen

After retrieving literature, duplicate studies were excluded using Endnote X9.3.3 (Clarivate, London, UK). Two independent researchers reviewed the titles and abstracts.

Furthermore, studies were screened based on the inclusion and exclusion criteria, and full texts were obtained for the remaining articles. If the original text was unavailable online, the author(s) were contacted.

Data extraction

Two researchers independently extracted the following data: author, publication year, article title, disease code (based on the *International Classification of Diseases, 11th Revision* [ICD-11] code[23], intervention measures in the acupuncture group, intervention measures in the control group, sample size, acupuncture points used, needle size, needle insertion angle, needle insertion depth, duration of acupuncture treatment, details of de qi, follow-up method, follow-up period, adverse events, and type of pain measurement scale used for the outcomes. Following data extraction, data were cross-checked for accuracy, and any discrepancies were discussed and resolved.

Table 1. (continued)

		jiangsu, china)							
			Standard Points:Gv20 (Baihui), Gv24 (Shenting), Gb13(Benshen), Gb8 (Shuaigu), Te20 (Jiaosun),Gb20 (Fengchi) Shaoyang Headache:Te5 (Waiguan),Gb34(Yangl ingquan) Yangming Headache:Li4 (Hegu),St44 (Neiting) Taiyang Headache: Bl60 (Kunlun),Si3 (Houxi) Jueyin Headache:Lr3 (Taichong),Gb40 (Qixu) Nausea And Vomiting: Pc6 (Neiguan) Dysphoria And Susceptibility To Rage:Lr3 (Taichong) Premenstrual Conditioning: Ki12 (Dahe), Cv3(Zhongji),St29 (Guilai)	Previous research	Head: 0.25×25 mm limb and abdominal:0.3× 40mm	-	10-15mm	30min	Using the rotation method to produce de-qi (the doctor feels tension around the needle and the patient feels numbness, bloating, pain and heaviness around the needle point)
Liu, L.	20 22	Disposable steel needles (hwatoneed les, made in suzhou, china)							

TABLE 1-2 Characteristics of the included studies (Continued)

*:8: neurological diseases; 14: diseases of the skin; 15: diseases of the musculoskeletal system or connective tissue; 16: diseases of the genitourinary system VAS Visual Analogue Scale

Risk of bias

The quality of the included studies was assessed independently by 2 researchers. All RCTs were evaluated using the Revised Cochrane risk-of-bias tool for randomized trials (RoB 2) [24]. Five domains were evaluated: D1 (risk of bias arising from the randomization process), D2 (risk of bias due to deviations from the intended interventions), D3 (risk of bias due to missing outcome data), D4 (risk of bias in the measurement of the outcome), and D5 (risk of bias in the selection of reported results). Based on this evaluation, each study was classified as “low risk,” “high risk,” or “some concerns.”

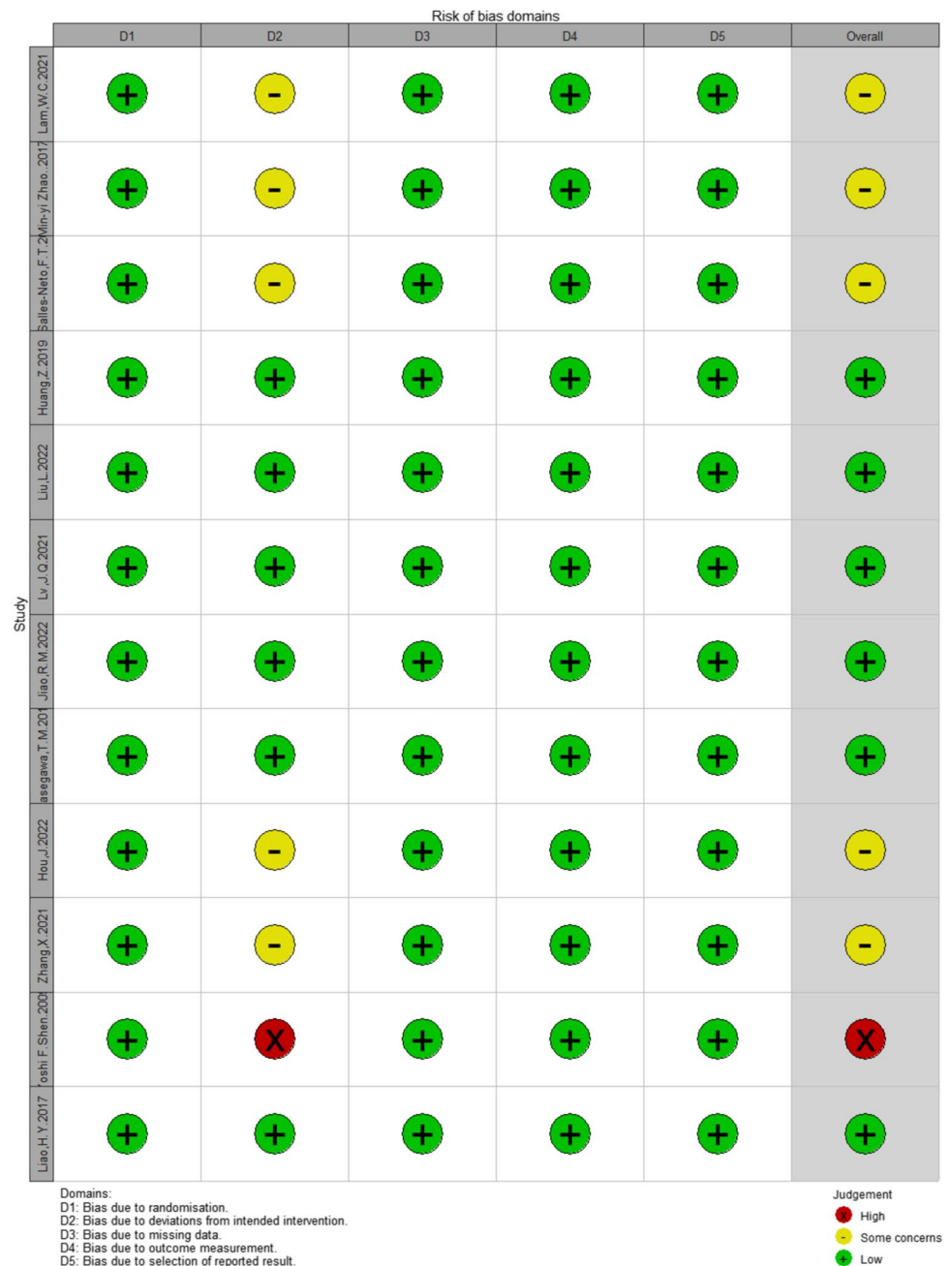
Statistical methods

Data analysis was performed in R Studio version 4.2.2 [25, 26]. Furthermore, data transformation was performed using the method described by Shi et al. [27]. In this method, the median-mean conversion was based on a study by Luo et al. [28], and the conversion of range and quartile-standard

deviation was based on the algorithm reported by Wan et al. [29]. Conversion of 95% confidence interval (CI) and standard deviation was performed using the following equation:

$$CI = \bar{x} \pm Z \times \frac{S}{\sqrt{n}}$$

The conversion of pre- and post-intervention mean and standard deviation was performed following the guidelines outlined in the Cochrane Handbook 6.5.2.8 [30, 31]. Mean difference (MD) and risk ratio (RR) with their corresponding 95% CI were used to assess the effectiveness and safety of acupuncture across the included studies. It was further illustrated using forest plots. The heterogeneity of the combined results was quantified using the I^2 statistic, with the $I^2 > 50\%$ indicating significant heterogeneity. A fixed-effects model was applied when no considerable heterogeneity was observed among studies. Conversely, a random-effects model was adopted when substantial heterogeneity was observed. In case of significant heterogeneity, meta-regression, subgroup, and sensitivity analyses were performed

Fig. 2 Risk of bias in studies included in the systematic review

to identify the potential sources. Furthermore, publication bias was assessed using funnel plot analysis.

Results

Literature screening

The PRISMA flow diagram clearly illustrates the study selection process (Fig. 1). The literature search performed across 4 electronic databases yielded 10,076 articles. A total of 1600 duplicates were automatically removed using

EndNote software. After the initial screening of titles and abstracts, 482 articles were retained for further evaluation. Following a thorough assessment of the full texts, 12 studies were ultimately included in the analysis [32–43].

Study characteristics

Table 1 summarizes the basic characteristics of the included studies. Among the 12 included studies based on the ICD-11 codes, 3 focused on neurological disorders, 1 on skin diseases, 5 on musculoskeletal or connective tissue disorders, and 3 on genitourinary system diseases. Half of the studies examined

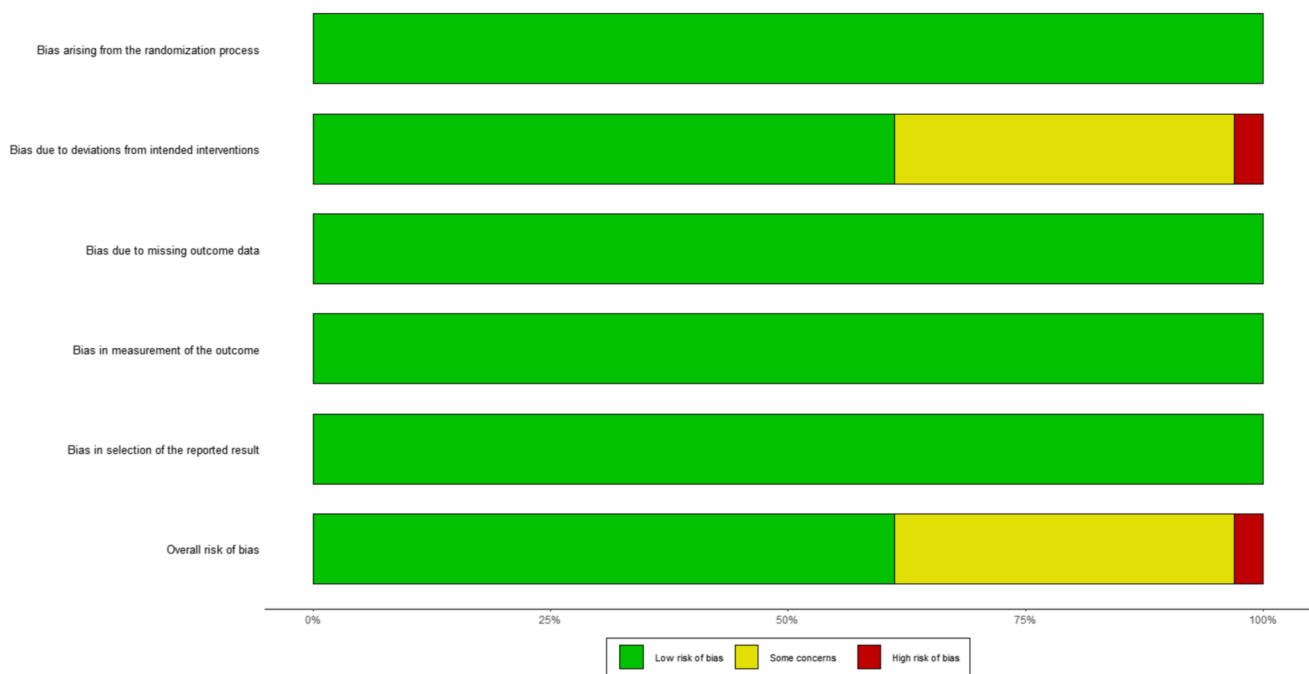


Fig. 3 Overall risk of bias for each category presented as a percentage

chronic pain ($n=6$), while the remaining studies examined acute pain ($n=6$). All of the included studies used a VAS to assess pain intensity. In addition, 2 studies lacked complete information on adverse events in either of the study groups, and 7 studies gave a detailed report on the occurrence of adverse events. Three studies reported no occurrence of adverse events.

Risk of bias

The risk of bias for the 12 included studies was assessed using the RoB2 tool. Individual study bias assessments and an overall summary are illustrated in Figs. 2 and 3. All studies had a low risk of bias in the domains of the randomization process, missing outcome data, measurement of outcome, and selection of reported results. However, in the domain of deviations from the intended interventions, 5 studies [35, 37, 38, 40, 41] were rated as having “some concerns,” mainly regarding incorrect intention-to-treat (ITT) analysis, and 1 [32] was classified as high risk due to insufficient evidence supporting the use of ITT analysis.

Analysis of effectiveness

The overall effect sizes of all included studies are shown in Fig. 4. Due to significant heterogeneity, a random-effects model was employed. All included studies used the VAS as the outcome measure. The acupuncture group demonstrated a larger overall improvement in VAS scores compared to the control group, with an MD of 0.97 (95% CI 0.66–1.27).

This indicates that acupuncture had a statistically significant impact on pain relief.

Analysis of safety

Safety analysis was conducted on 9 studies (Fig. 5) that provided complete reports on adverse reactions in both the acupuncture and control groups. The study by de Salles-Neto et al. [37] was excluded due to the lack of group-specific occurrence of adverse reactions. The analysis found no significant difference in the occurrence of adverse reactions between the acupuncture and control groups, with an RR of 1.40 (95% CI 0.52–3.74), indicating a similar likelihood of adverse reactions between the two groups. Notably, no serious adverse effects were reported in any of the trials.

Sensitivity, subgroup analyses, and meta-regression

The sensitivity analysis excluded individual studies to assess the robustness of the results. However, no substantial changes were observed in the MD or its corresponding 95% CI (Fig. 6), which indicates that the results were robust. We conducted a meta-regression analysis to study the impact of various factors on estimating the treatment effects. According to the meta-regression results (Table 2), the effect sizes for disease classifications ICD11-8 (nervous system) (coefficient = 0.6223, $p < 0.05$) and ICD11-16 (genitourinary system) (coefficient = 1.671, $p < 0.001$) are notably higher

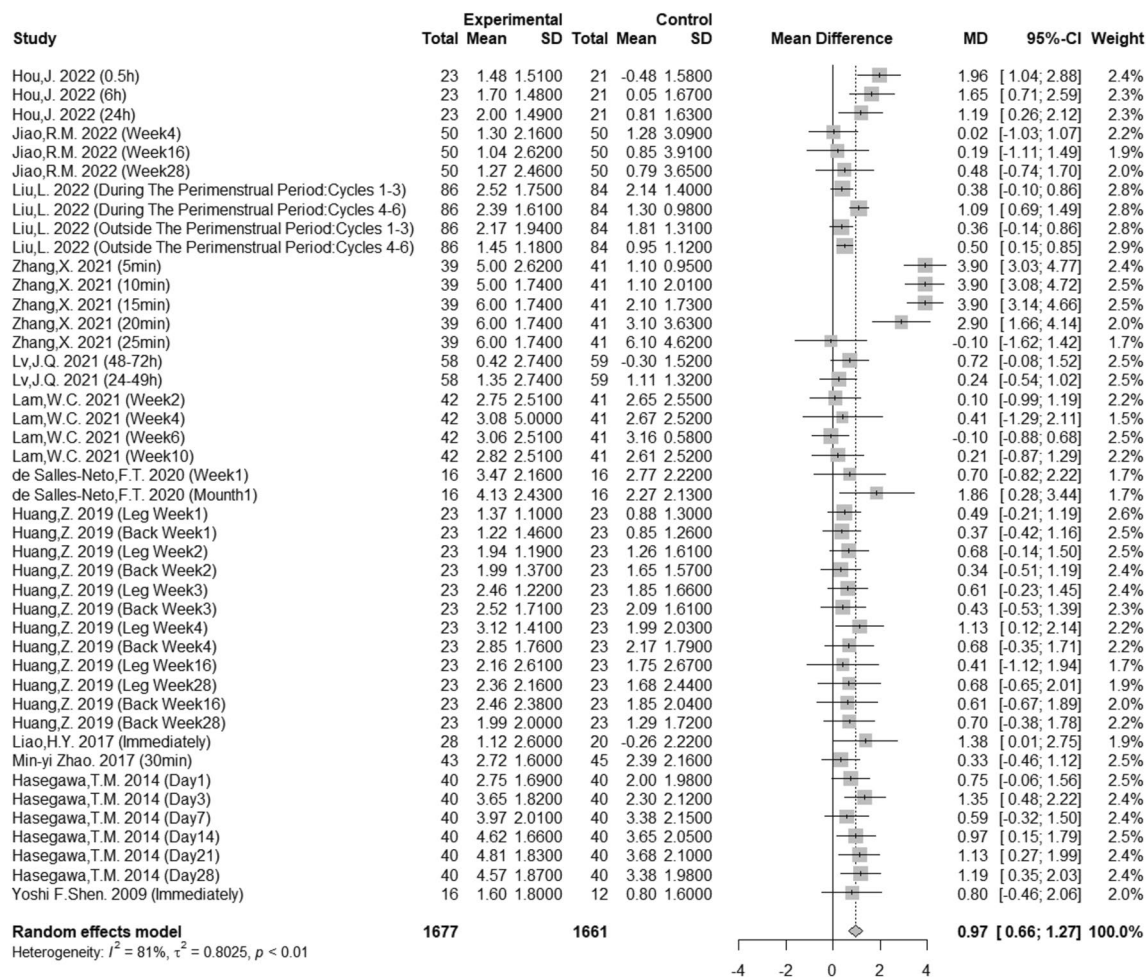


Fig. 4 Forest plot of the overall effectiveness of traditional acupuncture in pain management

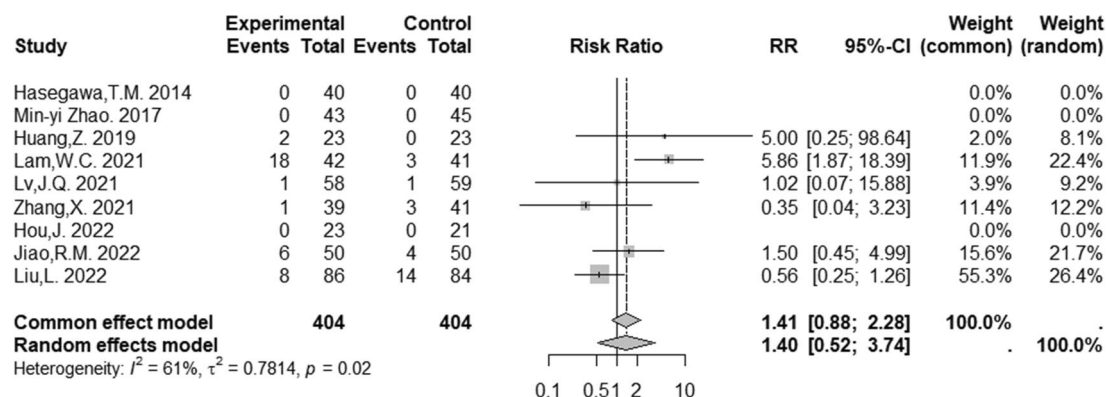
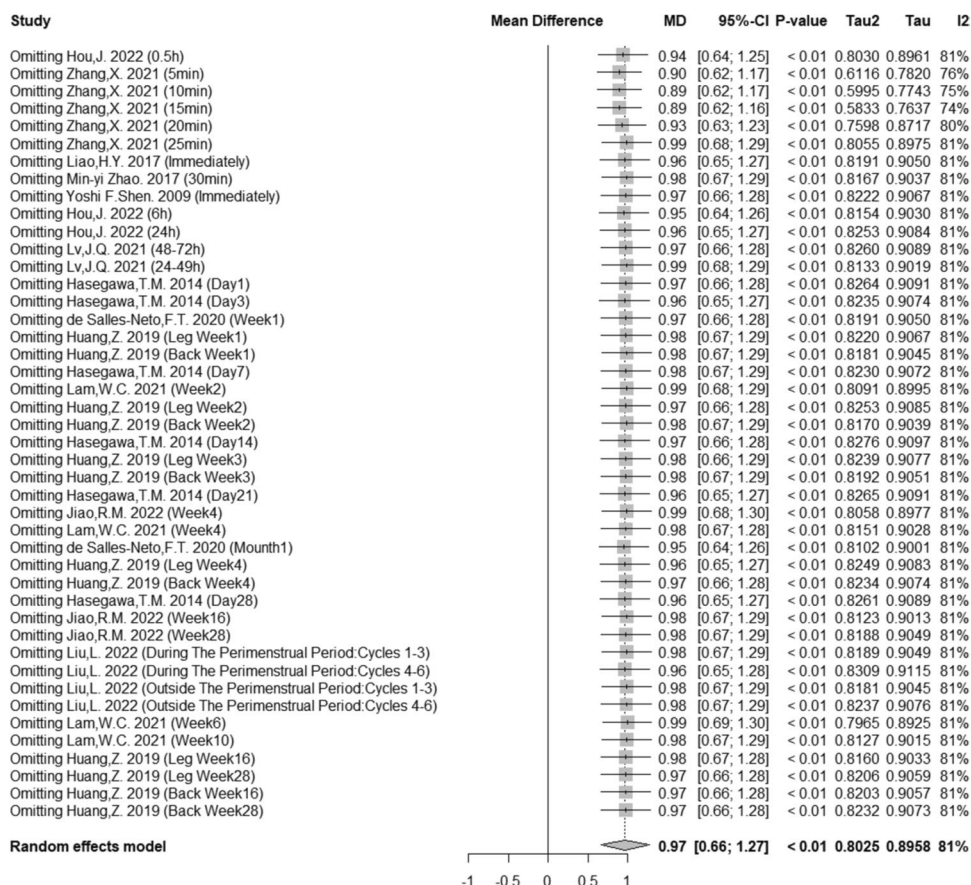


Fig. 5 Safety analysis of traditional acupuncture for pain management

than the overall effect size. In contrast, no significant differences in effect sizes were observed for ICD11-14 (musculoskeletal or connective tissue) and ICD11-15 (genitourinary system). Considering the duration of pain, acupuncture demonstrates significant therapeutic effects for both long-term

pain (coefficient = 0.5529, $p < 0.01$) and short-term pain (coefficient = 0.9115, $p < 0.01$). Analysis of duration of treatment reveals that the subgroup with treatment duration of less than 30 min has the highest regression coefficient (2.2791, p -value < 0.001). Conversely, the regression

Fig. 6 Sensitivity analysis**Table 2** Meta-regression analysis of effect size estimates by ICD-11 classification, pain duration, and treatment timing

Subgroup	Coefficient	SE	Z-value	P-value	CI lower	CI upper
ICD-11						
8 (nervous system)	0.6223	0.2613	2.382	0.0172*	0.1103	1.1344
14 (skin)	-0.4022	0.5581	-0.7207	0.4711	-1.4962	0.6917
15 (musculoskeletal system or connective tissue)	0.0507	0.3062	0.1656	0.8685	-0.5495	0.6509
16 (genitourinary system)	1.671	0.3678	4.5434	<0.001***	0.9501	2.3918
Pain						
Long	0.5529	0.1882	2.9375	0.0033**	0.184	0.9218
Short	0.9115	0.2789	3.268	0.0011**	0.3648	1.4581
Time						
< 30 min	2.2791	0.2793	8.1616	<0.001***	1.7318	2.8265
1-3 days	-1.3142	0.4238	-3.101	0.0019*	-2.1448	-0.4835
1 month	-1.4147	0.4549	-3.1098	0.0019*	-2.3063	-0.5231
1 week	-1.7634	0.4919	-3.585	0.0003**	-2.7275	-0.7993
2-6 months	-1.8091	0.3626	-4.9898	<0.001***	-2.5197	-1.0985
2 weeks	-1.7349	0.4845	-3.5805	0.0003**	-2.6846	-0.7852
3 weeks	-1.5495	0.5353	-2.8948	0.0038**	-2.5986	-0.5004

Notes: <0.001***, <0.01**, <0.05*

coefficients for the 1-3 days, 1 week, 2 weeks, 3 weeks, and 2-6 months subgroups are -1.3142, -1.7634, -1.7349, -1.5495, and -1.8091, respectively, with *p*-values of less than

0.05 across all groups. This indicates that the effect sizes for these time subgroups are significantly smaller compared to other subgroups.

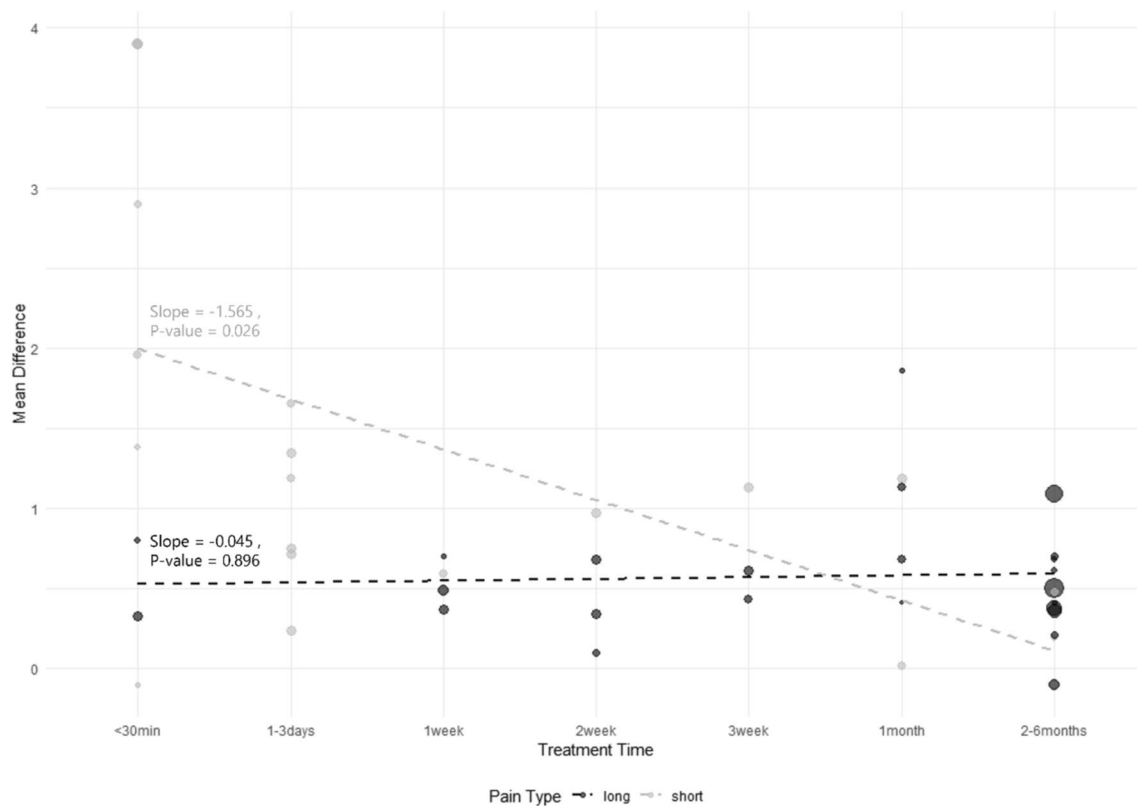


Fig. 7 Meta-regression bubble plot of pain nature and treatment duration

Having observed disparities in the impact of treatment duration on treatment outcomes from the meta-regression analysis, we created a meta-regression bubble plot examining the correlation between treatment duration and the type of pain, as depicted in Fig. 7. The regression outcomes indicate the absence of a linear relationship ($p > 0.05$) between the efficacy of traditional acupuncture treatment for chronic pain and the duration of treatment. Conversely, for individuals suffering from acute pain, the treatment effectiveness diminishes as the duration increases ($p < 0.05$).

To further explore the sources of heterogeneity, subgroup analyses were performed employing the following subgroups: the total duration of acupuncture treatment, the nature of pain, and disease classification according to ICD-11.

The subgroup analysis based on the total duration of acupuncture treatment revealed distinct patterns. All groups exhibited lower levels of heterogeneity except for the group with a total duration of less than 30 min, which showed high heterogeneity. Moreover, results from each group demonstrated the superiority of acupuncture for pain relief (Fig. 8).

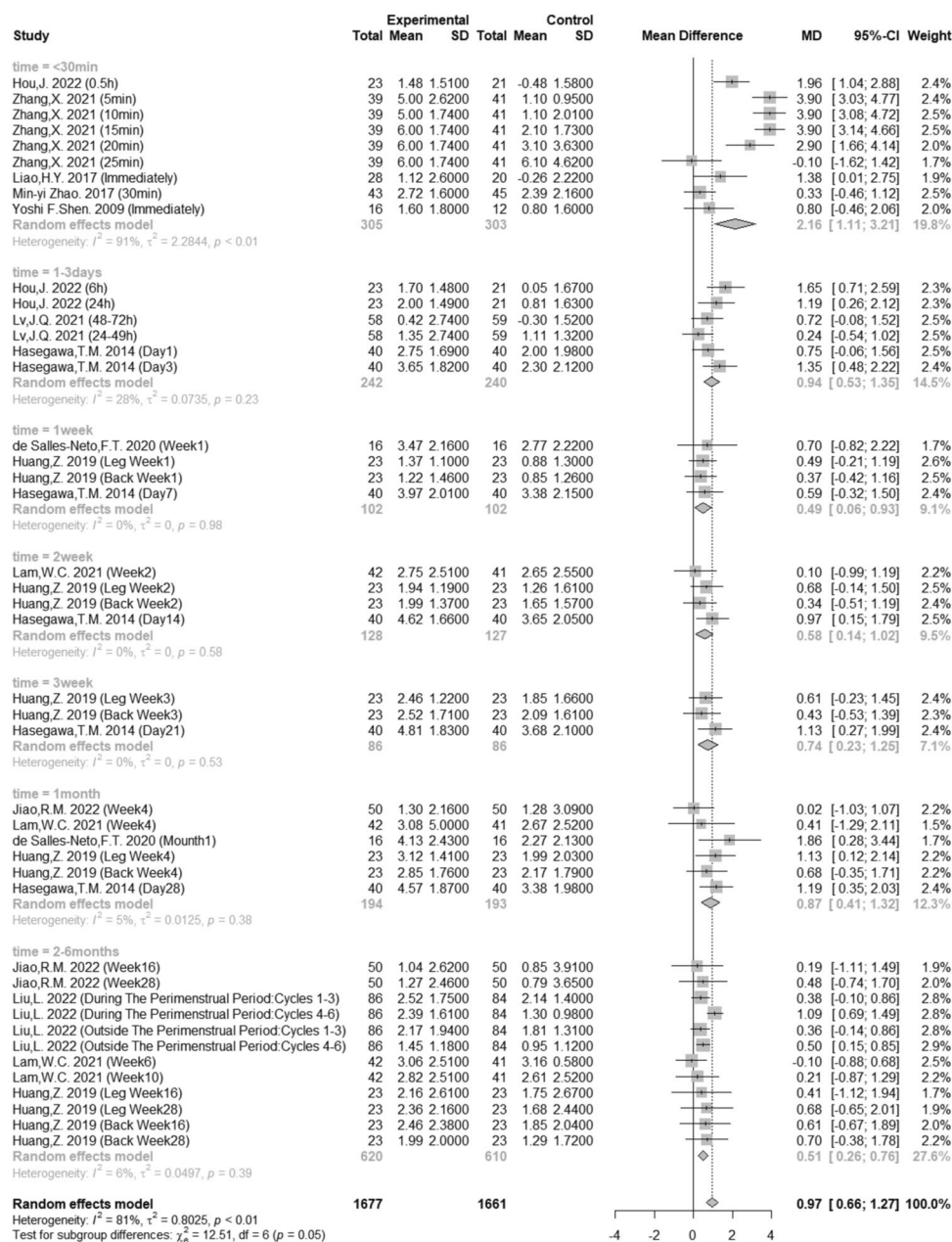
The subgroup analysis based on the nature of pain revealed distinct patterns. Studies focusing on chronic pain exhibited no significant heterogeneity, whereas studies investigating acute pain exhibited higher levels of heterogeneity.

However, both groups consistently demonstrated the superiority of acupuncture in relieving pain (Fig. 9).

The subgroup analysis based on disease classification according to ICD-11 revealed that studies investigating genitourinary system diseases had relatively high heterogeneity, whereas in other groups, heterogeneity was insignificant. Notably, while studies on skin diseases showed no significant effect of acupuncture, all other subgroups reinforced the superiority of acupuncture in relieving pain (Fig. 10). These subgroup analyses aimed to identify the potential sources of heterogeneity and provide insights into the differential effects of acupuncture in different contexts. The findings suggest that factors such as the total duration of acupuncture treatment, the nature of acute pain, and disease classification according to ICD-11 may have influenced the observed heterogeneity. Despite these variations, the overall findings consistently support the superior efficacy of acupuncture for pain relief.

Publication bias

Egger's test was conducted to assess publication bias. The results indicated a t -value of 0.77 with 42 degrees of freedom, and a p -value of 0.445, suggesting no significant publication

Fig. 8 Forest plots of the subgroups grouped according to total treatment time

bias. Additionally, a funnel plot was generated to visually assess potential publication bias (Fig. 11). The funnel plot displayed no obvious asymmetry between the effect sizes (i.e., mean differences) of the studies and their corresponding uncertainties (i.e., standard errors), further supporting the findings of Egger's test. Therefore, the results of the meta-analysis were not significantly affected by publication bias.

Discussion

Our study systematically evaluated the effectiveness and safety of traditional acupuncture for pain management in trials using a double-blind design. The use of a double-blind

methodology is crucial in RCTs because it ensures that both the study participants and investigators are unaware of who receives the actual treatment or placebo. This helps reduce bias and expectancy effects and ensures the validity and reliability of the findings [44, 45]. This design is important for evaluating medical interventions, particularly alternative therapies such as acupuncture [46].

Our results demonstrated that traditional acupuncture has promising therapeutic effects in pain relief. This is consistent with a study conducted in 2017 by Xiang et al. [21]. Furthermore, in some studies, acupuncture has shown profound analgesic effects and was proposed for surgical anesthesia [47, 48].

Notably, previous studies primarily focused on short-term treatment outcomes; however, our study highlighted

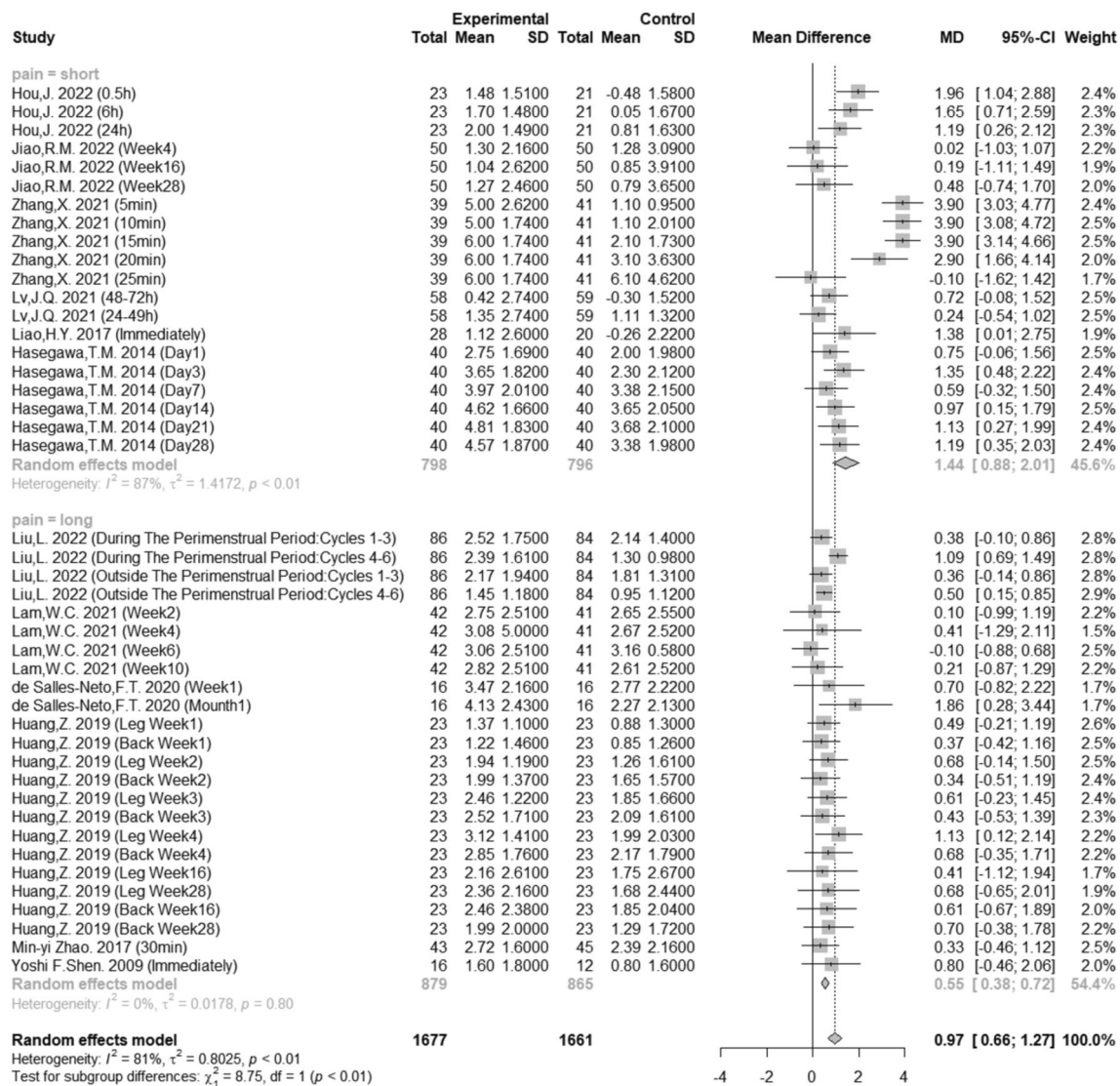


Fig. 9 Plots of subgroup forests according to disease type

the short and long-term treatment outcomes, emphasizing the efficacy of traditional acupuncture for acute and chronic pain. Moreover, the subgroup analysis indicated that short-term pain relief was more effective than long-term pain relief. This observation may be attributed to adaptive changes in the central nervous system resulting from prolonged pain, including enhanced pain signaling, neurotransmitter alterations, and synaptic plasticity [49, 50]. Such neural adaptations may cause individuals with chronic pain to be less responsive to acupuncture compared to individuals with acute pain. However, it is important to note that this is a speculative hypothesis based on limited sample data, which warrants further investigation in future studies.

Additionally, in subgroup analysis based on ICD-11, traditional acupuncture was effective in various diseases, including

those related to the nervous, musculoskeletal, connective tissue, and genitourinary systems, except for pain associated with dermatological conditions. A possible explanation could be that pain caused by acne is primarily attributed to microbial-induced inflammation [51, 52]. Acupuncture can modulate pain through the adjustment of neural transmission [53]; however, established inflammatory responses may not directly inhibit inflammatory processes or reduce the release of inflammatory mediators. Since these findings are based on a single study, the results may be influenced by the sample size and selection of acupuncture points, such as Dazhui (CV14), bilateral acupoints of Quchi (LI11), Hegu (LI4), Zusanli (ST36), and Neiting (ST44); future research with larger sample sizes and different acupuncture point selections is required to validate these findings.

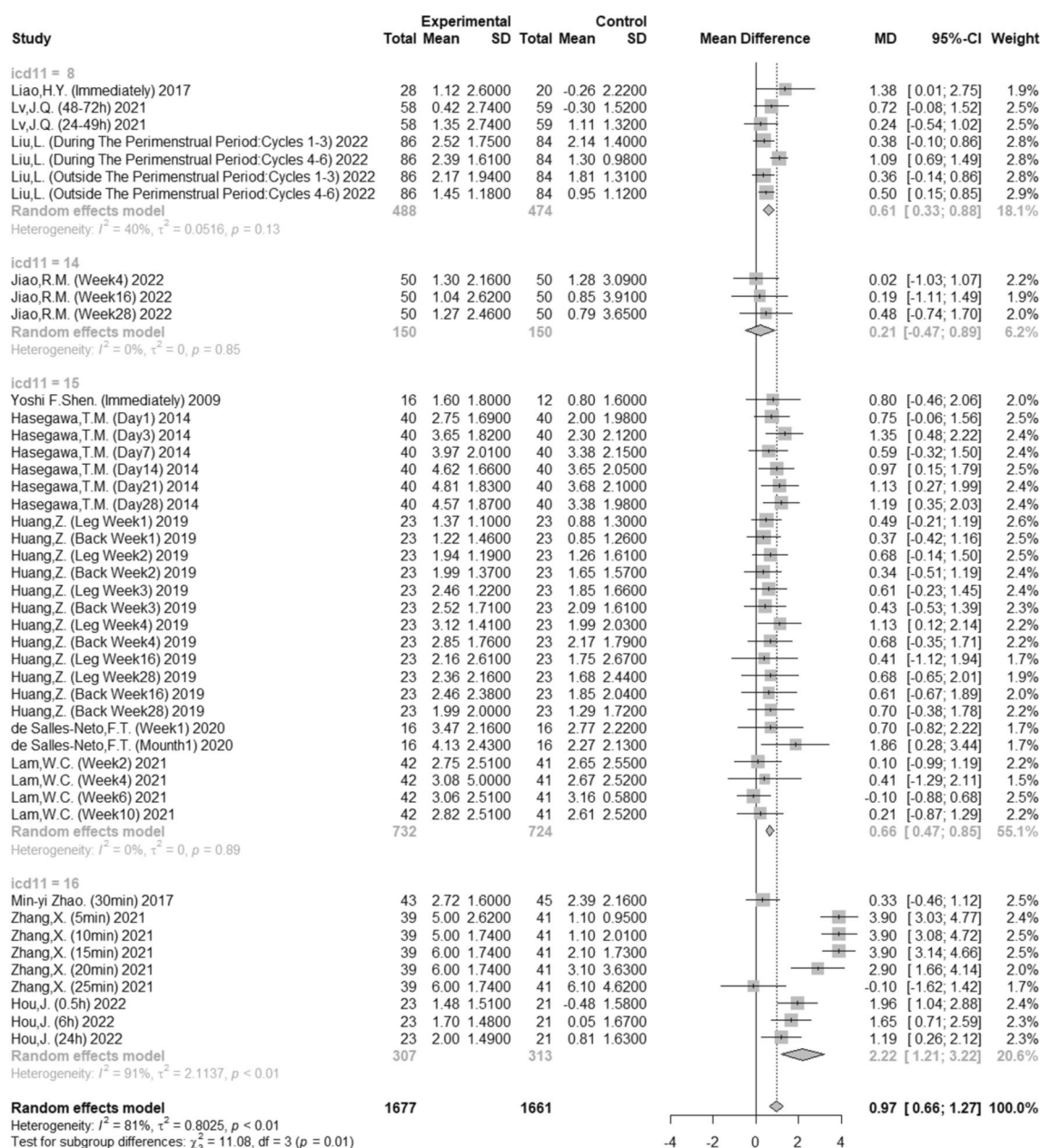
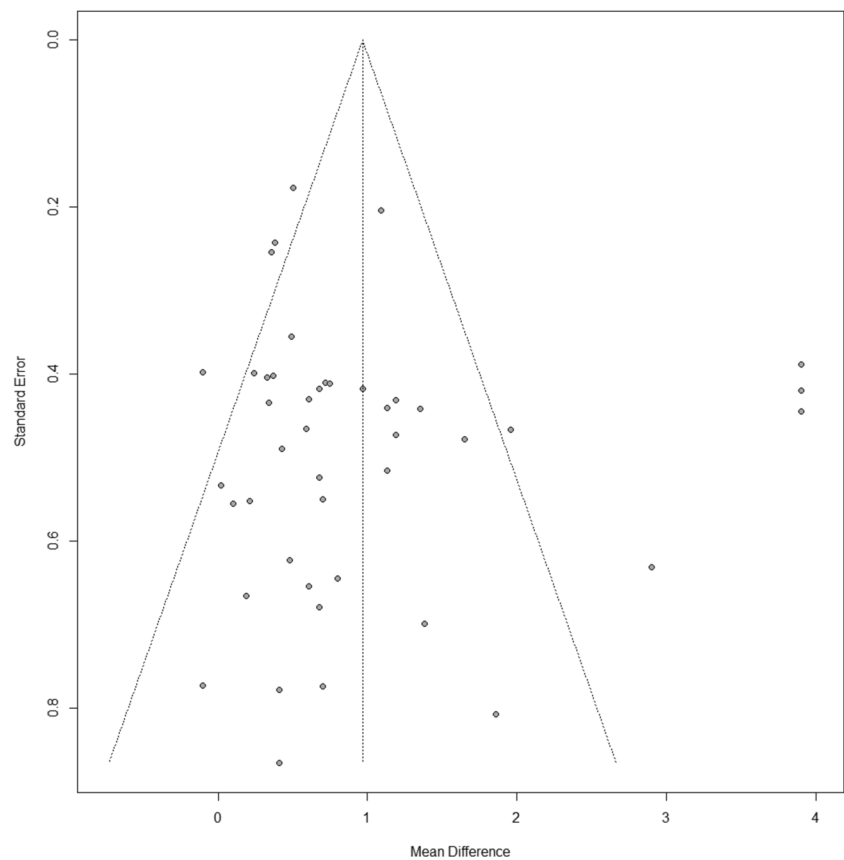


Fig. 10 Plots of forest subgroups according to the *International Classification of Diseases, 11th Revision (ICD-11)* classification

Furthermore, meta-regression analysis reveals a gradual decline in the efficacy of traditional acupuncture treatment for acute pain with longer treatment duration. This trend can potentially be attributed to the adaptability of treatment approaches and patient responses. Initially, patients may respond positively to acupuncture; however, this response tends to diminish over time, indicating the necessity for adjusting treatment adaptability, frequency, and intensity for acute pain management. Moreover, the diverse nature of acute pain might necessitate flexible treatment strategies for personalized adjustments tailored to individual patient

needs [54]. In the case of chronic pain patients, our findings suggest a relatively stable treatment effect irrespective of treatment duration. This finding underscores a fundamental principle in chronic pain care: sustained long-term treatment consistency may be more beneficial in managing chronic pain compared to short-term intensive interventions [55]. This trend likely correlates with patient responsiveness to treatment and the personalization of their treatment plans. These findings hold direct implications for clinical practice. In treating acute pain, physicians are advised to closely monitor treatment efficacy and be prepared to adjust

Fig. 11 Funnel plot

treatment plans based on individual patient responses. This flexibility can optimize treatment outcomes and prevent the progression of pain into a more refractory chronic state. In managing chronic pain, our study advocates for long-term, consistent treatment strategies. This suggests the provision of continual support and treatment for patients rather than solely intervening during exacerbations. Such an approach may be more effective in managing pain and improving a patient's overall quality of life.

There were no significant differences in adverse event occurrence between the acupuncture and control groups, and no reports of serious adverse effects were documented in these trials. Previous studies also demonstrated the safety of acupuncture [56, 57]. This further confirms its safety profile. However, although there was no significant difference in adverse reactions between the acupuncture group and the control group, both groups still experienced mild adverse effects such as skin bleeding, local numbness, nausea, palpitations, indigestion, and drowsiness. Future research should pay more attention to the long-term effects and potential risks of these adverse reactions.

Strengths and limitations

A key strength of this study lies in the inclusion of double-blind randomized controlled trials, which hold high

methodological rigor and credibility. The double-blind design effectively minimizes bias by ensuring that neither the participants nor the researchers or data analysts are aware of the intervention allocation, thereby enhancing the reliability of the findings. Furthermore, our comprehensive bias assessment confirms the absence of publication bias. This confirms the robustness of our meta-analysis results, as publication bias can often lead to an overestimation of treatment effects. The inclusion of high-quality studies allows us to provide a more accurate and reliable evidence base for the clinical effectiveness of the interventions under investigation.

This systematic review and meta-analysis also had several limitations. First, this study only included articles published in English, which might exclude important regional studies that could offer valuable insights into specific populations or interventions. This could limit the reliability and global applicability of our findings. Additionally, the number of included studies was limited, and most studies had small sample sizes, which may affect the generalizability of the results. Third, although the included studies were double-blind design, complete blinding remains challenging due to the nature of acupuncture treatment. For example, the procedures in acupuncture make it difficult to blind the treatment providers. Therefore, future studies should explore innovative methods to simulate the

sensation of acupuncture and ensure the effectiveness of blinding. To enhance the investigation into the efficacy and safety of traditional acupuncture, future studies should incorporate research published in various languages, include larger sample sizes, and extend follow-up periods.

Conclusion

This study aimed to evaluate the effectiveness and safety of traditional acupuncture in pain management through double-blinded clinical trials. The results revealed a significant improvement in the acupuncture group compared to the control group, as shown by VAS scores. Furthermore, the safety analysis indicated that acupuncture is a relatively safe treatment option. Therefore, acupuncture can be regarded as a safe and effective method of managing pain, providing valuable insights for clinical practice. Future research should involve larger sample sizes to determine the optimal duration and frequency of acupuncture treatments for enhanced pain management outcomes.

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Author contribution CJ and LL: study design and writing; CQ and HM: data collection, data analysis, and writing; HN, MW, and YS: data collection and data analysis; OOM: writing.

Conghua Ji and Lihong Li: Study design, Writing; Chu Qin and Huan Ma: Data collection, Data analysis, Writing; Minyan Wang, Yun Shi and Haojie Ni: Data collection, Data analysis; Oscar Onayi Mandizadza: Writing.

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No datasets were generated or analysed during the current study.

Declarations

Ethical approval Not applicable.

Conflict of interest The authors declare no competing interests.

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