Journal of Orthopaedic Surgery and Research

SYSTEMATIC REVIEW

Open Access

Therapeutic effects of different acupuncture methods on chronic nonspecific low back pain: A network meta-analysis

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Abstract

Background Low back pain has become a globally challenging health problem, and about 90% of cases are nonspecific. Due to the risks associated with opioid use and the limited effectiveness of drug treatment, acupuncture and other non-drug methods have become the first-line treatment for this disease. However, the best acupuncture method has not yet been determined. In this study, the effects of different acupuncture methods on chronic nonspecific low back pain (CNLBP) were compared by network meta-analysis, aiming at identifying the best option and providing a basis for precise treatment of CNLBP.

Methods Clinical randomized controlled trials (RCTs) on acupuncture in the treatment of NSLBP were searched in eight databases including PubMed, Embase, Cochrane Library, Web of Science, Sinomed, CNKI, Wanfang Data and VIP from the inception of databases to January 21, 2024. The Cochrane risk-of-bias tool 2.0 (RoB 2.0) and Stata 15.0 (Stata Corp, College Station, Texas, USA) were used to evaluate the literature quality and meta-analysis, and the evidence quality was assessed based on GRADE guidelines. This systematic review was registered at the International Prospective Register of Systematic Reviews.

Results A total of 27 articles were included, involving 2579 patients. The results of the network meta-analysis showed that the top three treatment schemes were warm needle acupuncture, intensive silver needle therapy and meridian-sinew theory-based treatment. In terms of relieving pain, the top three treatments were electrical warm needling, intensive silver needle therapy and warm needle acupuncture. In improving mobility, the top three were meridian-sinew theory-based treatment, routine acupuncture and electroacupuncture.

Conclusion For CNLBP patients, warm needle acupuncture, electrical warm needling and meridian-sinew theory-based treatment are mainly recommended. If patients have significant pain, electroacupuncture is strongly suggested. On the contrary, for patients with decreased joint mobility, meridian-sinew theory-based treatment is advocated.

Keywords Chronic nonspecific low back pain, Acupuncture, Network meta-analysis, Meridian-sinew, Warm needle acupuncture

Introduction

Low back pain (LBP) is a common clinical complaint and symptom, with an annual incidence of 22–65% worldwide [1]. It is a major global public health problem, which has been identified as one of the main causes of disability globally. In 2019, LBP ranked the ninth cause of

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Disability-Adjusted Life Years (DALYs) and was the leading cause of Years Lived with Disability (YLDs), accounting for 2.5% of the total DALYs and 7.41% of total YLDs, respectively [2]. About 90% of LBP patients are diagnosed as nonspecific type, which cannot be attributed to specific and recognizable pathology (such as infection, tumor, osteoporosis, fracture, structural deformity, nerve root disorders, or cauda equina syndrome) [3]. Nonspecific low back pain (NSLBP) age of onset is mostly between 40 and 69 years old, and the incidence rate is higher in women than in men [4]. According to the course of the disease, low back pain is divided into three subtypes: acute (duration < one and a half months), subacute (duration ≥ one and a half months but < 3 months), and chronic NLBP (duration > three months) [5]. In the United States, Canada and Australia, it is one of the top ten reasons for emergency department visits, and 4–5% of visits are for low back pain [6]. In China, the incidence of NSLBP is higher than that of type 2 diabetes and primary hypertension, and its treatment cost is also higher than that of cardiovascular and cerebrovascular diseases, osteoarthritis and other diseases [7]. With the population growth and aging, low back pain has caused an increasing burden. How to effectively treat it and reduce the treatment expenses has become an urgent problem that needs to be solved.

At present, the common therapies of NSLBP are drug therapy and non-drug therapy. Regarding drug therapy, clinical practice guidelines generally follow the WHO analgesic ladder, including acetaminophen, non-steroidal anti-inflammatory drugs, muscle relaxants, and opioids. According to the first-class evidence published in relevant research, only baclofen, duloxetine, nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids have been proved to improve the pain and dysfunction of patients with low back pain. Muscle relaxants and NSAIDs can effectively alleviate pain and dysfunction in about a week. The combination of NSAIDs and acetaminophen can improve symptoms better than the single use of NSAIDs. However, the effects of NSAIDs and gabapentin in relieving pain and improving dysfunction are controversial [8–11]. In addition, there are some risks in using these drugs. For example, acetaminophen has been proved to be ineffective, elderly patients are advised to use non-steroidal anti-inflammatory drugs with caution, the evidence of muscle relaxants is of extremely low quality, and opioids are addictive and have higher odds of relapse after drug withdrawal. The safety and effectiveness of other intravenous drugs have also been proved to be controversial [12–14]. As for non-drug therapy, current studies are mainly focused on sports, massage and acupuncture. Acupuncture therapy is recommended in various guidelines for treating low back pain [15–18] and is covered by the American Medical Association (AMA) Health Insurance Proposal [19]. In 2020, the North American Spine Society (NASS) published a new edition of evidence-based medicine guidelines for low back pain, and acupuncture was recommended as a cost-effective therapy [20].

Acupuncture has a history of thousands of years. It is a treatment method of traditional Chinese medicine (TCM), during which needles are inserted into the body to regulate spinal cord signals, thus affecting the transmission of pain. It has obvious advantages in treating low back pain, promoting the blood circulation of meridians and central analgesia, relieving pain, promoting rehabilitation and avoiding side effects of drugs [21]. Although there are a variety of acupuncture methods (including acupoint acupuncture, acupoint moxibustion, acupoint and application), the therapeutic effect and safety of these methods are still controversial. NASS recommends that acupuncture can relieve pain and dysfunction, but current evidence and conclusions are contradictory. Current meta-analyses on acupuncture for the treatment of chronic NSLBP mainly focus on treatment efficacy and different acupuncture methods. Related network meta-analyses have only compared standardized acupuncture with individualized acupuncture, and other acupuncture methods have not been discussed thoroughly. It is only proved that individualized acupuncture and standard acupuncture combined with transcutaneous electrical nerve stimulation have the best effect in improving pain and quality of life [22]. Therefore, this network meta-analysis included RCTs of the relative efficacy of different acupuncture regimens in the treatment of chronic NSLBP to comprehensively evaluate and rank the therapeutic effects of these acupuncture regimens, in order to investigate the optimal acupuncture therapy and provide a reference for accurate treatment programs.

According to different needling techniques, acupuncture therapy can be divided into warm acupuncture, electroacupuncture, acupoint catgut embedding, scalp acupuncture, ear acupuncture, and moxibustion (thermal moxibustion). Different acupuncture methods have different therapeutic effects and safety profiles. Currently, there is no evidence-based medical evidence on the optimal acupuncture modality for the treatment of chronic non-specific low back pain. Given the lack of head-to-head comparative trials of acupuncture modalities, this network meta-analysis of RCTs on the relative efficacy of different acupuncture treatments in patients with chronic NSLBP aimed to comprehensively evaluate and rank their therapeutic effects, thus determining the optimal acupuncture

therapy and providing a reference for precise acupuncture programs.

Methods

This systematic review and meta-analysis is reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement [23] and was registered at International Prospective Register of Systematic Reviews (No. CRD42023425975; Registration Date, 23/01/2024).

Retrieval strategy

Randomized-controlled trials (RCTs) of acupuncture in NLBP were searched in PubMed, Embase, Cochrane Library, Web of Science, Sinomed, CNKI, Wanfang Data and VIP from the inception of databases to January 21, 2024 by two researchers (Kaixuan Zhang and Leichao Wang). Each database was searched using medical subject headings (MeSH) and text words. The following search terms were employed: Low Back Pain (Topic), Acupuncture (Topic), Electroacupuncture (Topic), ear needle (Topic), warm needle acupuncture (Topic), catgut embedding therapy (Topic), or Moxibustion (Topic), and clinical randomized controlled trial (Topic) and Non-specific Low Back Pain (Should – Search within the topic) and Preprint Citation Index (Exclude – Database). The specific search strategy is described in Additional file 1. This paper has additionally retrieved references from others.

Inclusion and exclusion criteria

Inclusion criteria

The purpose of this study is to conduct a network meta-analysis on RCTs of different acupuncture treatments for chronic NSLBP patients. The specific literature inclusion criteria are as follows. The study followed the PICOS (Population, Intervention, Comparator, Outcome, Study type) search design. The inclusion criteria were as follows:

(1) Patient: Subjects meeting the diagnostic criteria of nonspecific low back pain, regardless of age or sex.
(2) Intervention involving various acupuncture methods, including but not limited to warm needle acupuncture, electroacupuncture, acupoint catgut embedding, scalp acupuncture, ear acupuncture, and moxibustion (heat-sensitive moxibustion). These acupuncture methods can be applied alone or in combination with conventional drugs (such as non-steroidal anti-inflammatory drugs, opioid analgesics and paracetamol), and the selection of acupoints, operation, treatment time and treatment sessions are not limited.
(3) Control treatment involving conventional drugs (such as non-steroidal anti-inflammatory drugs, opioid analgesics, paracetamol), conventional care (such as waiting for treatment, bed rest, warm compress), placebo needling (sham acupuncture or other placebo treatment), or other acupuncture methods (the same as the intervention group).
(4) Outcomes involving therapeutic indicators (such as total effective rate and recovery rate) and with data support (such as Visual Analog Scale, Oswestry Disability Index, and Roland-Morris Disability Questionnaire);
(5) Study type: RCTs.

Exclusion criteria

Exclusion criteria were as follows: (1) Articles with inaccessible full text or unavailable statistical data; (2) Animal experiments (such as pharmacological or pharmacokinetic studies). (3) Studies written in languages other than English and Chinese. (4) Studies on acupuncture combined with traditional Chinese herbs, massage, transcutaneous electrical nerve stimulation and acupoint embedding therapy for low back pain.

Data extraction

The article screening, data extraction, and cross-validation were completed by two independent researchers (Yu Fu and Ziwei Liu) according to the research objectives and inclusion criteria. Differences were resolved by consulting a third researcher (Xingxing Lin). Basic characteristic table was designed according to the included articles, which mainly includes: ① The basic information of the included studies, including the author's name and publication time; ② Basic characteristics of the subjects, including the number and gender composition of patients in the treatment group and the control group; ③ Intervention measures; ④ Primary outcomes; ⑤ Response rate, mean and standard deviation (SD). The corresponding author was inquired about the missing information by email or telephone.

Document quality evaluation

In this process, two researchers (Kaixuan Zhang and Ziwei Liu) used the risk-of-bias assessment tool recommended by Cochrane Handbook 5.1.0 to evaluate the risk of bias of the randomized controlled trials [24]. This process was evaluated by two researchers respectively, and disputes were decided by the corresponding author of this study. The content of the evaluation

includes the generation of random sequence, distribution concealment, blinding of the participants and investigators, blinding of outcome evaluation, incomplete outcome data, selective publication, and other biases. A high risk of bias is considered if the above criteria are not met. Each item is evaluated as "low risk of bias", "uncertainty risk of bias" or "high risk of bias". Meanwhile, the risk of bias figure was plotted with Review Manager 5.2.

Statistical analysis

Statistical analysis was carried out using Stata 15.0 (Stata Corp, College Station, Texas, USA). Stata is an integrated statistical software that can be used to manage and analyze data and design professional charts. The network meta-analysis of the random effects model was performed by frequency method, which combines direct and indirect evidence by using the inverse variance method. That is, taking the reciprocal of a study variance as the weight, calculating the weighted average of each study effect, and the variance of the overall effect is the reciprocal of the sum of weights. Firstly, a meta-analysis was conducted, and a network topology was drawn to directly compare different intervention measures. When there is a closed loop in the evidence network, the node splitting analysis is performed to check the consistency, and p-values more than 0.05 indicate that there is no significant inconsistency between direct comparison and indirect comparison. If the p-value is less than 0.05, it is considered that there is local inconsistency and the results must be handled with caution [25].

In this study, due to inconsistent measurement methods for outcome indicators, such as trichotomy and quartering for evaluating the total effectiveness, odds ratio (OR) was used to represent the continuous variables, and standardized mean difference (SMD) was used to represent continuous variables. Effect sizes were provided with a 95% confidence interval (CI). When 95% CI of OR does not contain 1 or 95% CI of MD does not contain 0, it is considered that the difference between the two intervention measures is statistically significant.

In this study, the surface under the cumulative ranking (SUCRA) curve was used for probability ranking, the ranking results of various interventions were obtained and the cumulative probability chart was drawn. The area under the curve presented the pros and cons of the curative effect of each intervention. A large area means that the therapy is more likely to be the best treatment, and vice versa [26]. The publication bias of the included articles was evaluated using a funnel plot. Asymmetry in the funnel plot indicates publication bias in the included articles [27]. Finally, the evidence quality of the outcome indicators was evaluated using the GRADEpro GDT tool, and the evidence quality of RCTs was considered as "high" by default. The evidence quality level of the outcome indicators was evaluated from five aspects (bias risk, inconsistency, indirectness, inaccuracy and publication bias) [20].

Results

Search results

According to the pre-established literature retrieval strategy and collection method, a total of 2691 articles were obtained by computer retrieval, and 1783 related documents were obtained after eliminating 908 duplicates. According to the established criteria for inclusion and exclusion of articles, we read the titles and abstracts one by one on Endnote for document management, further excluded 1759 studies inconsistent with the inclusion criteria, and finally included 27 documents [28–54]. The flowchart is shown in Fig. 1.

Basic characteristics of the included studies

There were 2579 patients in 27 studies, all over 30 years old. There was no statistical difference in baseline data between the two study groups in each study. The intervention measures included routine acupuncture, electroacupuncture, meridian-sinew theory-based treatment, warm needle acupuncture, fire needling, intensive silver needle therapy, electrical warm needling and auricular point application in the experimental group, and placebo needling, Western medicine (including diclofenac sodium, celebrex, loxoprofen sodium, acetaminophen and flurbiprofen gel for external use) and routine nursing in the control group. One of these articles is a three-arm experiment, the rest are two-arm experiments. One study is in a foreign language, and the rest are all in Chinese. In these studies, the outcome variables include VAS, ODI, RMDQ, JOA, overall response rate and recovery rate. The basic characteristics of the included articles are shown in Table 1.

Document quality evaluation results

Among the 27 articles, 18 articles mentioned allocation by computer or random number table, and 2 articles involved allocation according to the order of treatment. There were 5 studies that used envelope for allocation concealment, 8 studies reported the blinding of participants and personnel, 21 reported the blinding of result evaluation, 9 RCTs reported the follow-up results of subjects, and 1 RCT did not show selective reporting. Except for these, other biases in all studies are unclear. The specific results for bias risk assessment are shown in Fig. 2.

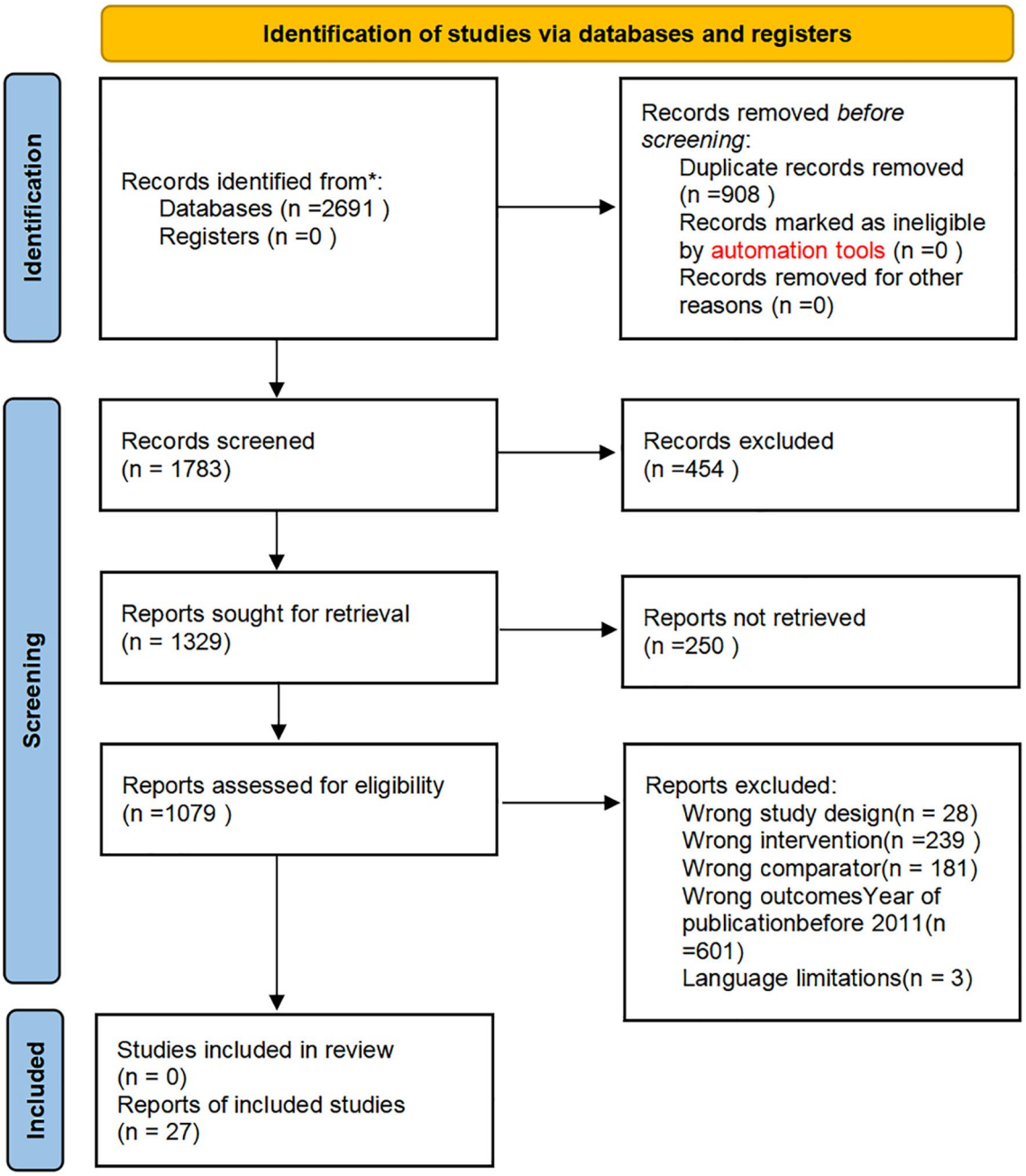

Fig. 1 Flowchart of literature screening

Inconsistency test

P value was obtained by fitting inconsistency analysis. The overall response rate, recovery rate, ODI, JOA, RMDQ and VAS was 0.3902, 0.3642, 0.0643, 0.0527, 0.0825, and 0.0748, respectively. The above results show that the p-values were all greater than 0.05, which shows that the direct comparison and indirect comparison of various acupuncture treatments for CNLBP patients yielded consistent results. Node-splitting method was used to test local inconsistency, and the results showed that there was no statistical difference in overall response rate, ODI, JOA and RMDQ ($P > 0.05$), and there was no local inconsistency.

Network meta-analysis results of response rate

Overall response rate

Nineteen RCTs [28, 29, 31–33, 35, 36, 38–42, 45, 48–51, 54] reported the overall response rate, involving six

Table 1 Basic characteristics of the included documents

Authors published years	baseline data(M/F)					Intervention		Control		Main Outcome	Primary Outcome	Follow-up time
	Country	sample	mean age, years	Gender	Diease type	Intervention group	Intervention	Control group	Intervention			
Chen et al. 2012.6	China	180	53.1	73/107	NLBP	MMA	Needle-knife release through tendon layer	TA	Needling at bilateral Shenshu, bilateral Dachangshu, bilateral Weizhong (or Chengshan), bilateral Kunlun, bilateral Fuliu and Ashi acupoints	Clinical effects ODI	Intervention on group 94. 4% control group 91.1% inter-group*p* comparison, $P > 0.05$ Intervention group, Control group, intra-group comparison before and after treatment ($P < 0.01$) inter-group comparison after treatment ($P < 0.05$)	
Liu et al. 2012.12	China	158	47.8/45.8	33/125	CNLBP	TA	Needling at Yaoyangguan, Xuanzhong, Houxi and Shenmai acupoints	PN	Needling at the skin vertically and shallowly at the same position, so that the needle can stand upright at the acupoint without toppling, without any manipulation	Clinical effects ODI VAS	Intervention group65.9%, Control group13.1% The ODI score of the intervention group was better than that of the control group The VAS score of the intervention group was lower that of the control group ($P < 0.05$)	4 weeks
Chen et al. 2015.1	China	120	56.60/57.45	66/54	NLBP	FN	HE's fire needling at bilateral Shenshu, Dachangshu and Ashi acupoints	TA	Needling at bilateral Shenshu, Dachangshu, Xuanzhong, Shenmai, Kunlun and Huantiao acupoints	Clinical effects ODI VAS	Intervention group 75. 0%, Control group 41. 7%; The clinical effects of the intervention group were significantly better than those of the control group ($P < 0.01$) After treatment, the scores of both groups were significantly lower than those before treatment. ($P < 0.05$ or $P < 0.01$), with a more pronounced improvement in the intervention group ($P < 0.01$)	
Li et al. 2017.6	China	60	42.1/41.9	34/26	CNLBP	TA	Needling at Ashi acupoint	EA	Electroacupuncture at bilateral Jiaji, Shenshu, Dachangshu and Huantiao acupoints	Clinical effects ODI VAS	The clinical effects of the intervention group in each time point were better than those of the control group ($P < 0.05$) After treatment, the scores of both groups were improved compared with those before treatment, ($P < 0.05$), with a more pronounced improvement in the intervention group ($P < 0.05$)	6 months
Ye et al. 2017.9	China	130	60.77/60.05	33/97	CNLBP	EA	Electroacupuncture at Shenshu, Qihaishu, Dachangshu, Huantiao, Yanglingquan, Weizhong, Chengshan, Kunlun and Ashi acupoints on the affected side	WM	Oral Celebrex Capsule (Pfizer Pharmaceuticals LLC, drug approval No. J20120063)	Clinical effects VAS	The clinical effects of the intervention group (93. 85%) were significantly better than those of the control group (80.00%) ($P < 0.05$) The VAS score of the intervention group was significantly lower than that of the control group ($P < 0.01$)	2 weeks, 4 weeks
Ren et al. 2017.9	China	75	52.4/53	28/47	NLBP	MMA	Needle-knife release through tendon layer	TA	needling at Ashi, Fuliu, Kunlun, Weizhong, Dachangshu and Shenshu acupoints	Clinical effects VAS	Intervention group 78.95%, Control group 10.81% ($P < 0.05$) Intervention group 3.0 ± 0.7, Control group 4.2 ± 1.2 ($P < 0.05$)	

Table 1 (continued)

Authors published years	baseline data(M/F)					Intervention		Control		Main Outcome	Primary Outcome	Follow-up time
	Country	sample	mean age, years	Gender	Diease type	Intervention group	Intervention	Control group	Intervention			
Wang et al. 2017.9	China	118	66.3/66.5	68/50	NLBP	MMA	Needle-knife release through tendon layer	TA	Needling at Tianying, Dachangshu (bilateral), Shenshu (bilateral), Weizhong (bilateral), Fuliu (bilateral) and Kunlun (bilateral) acupoints	ODI VAS	Both indicators of the intervention group were superior to those of the control group ($P<0.05$)	
Wang et al. 2018.9	China	96	57.6/56.4	51/45	CNLBP	FN	HE's fire needling at bilateral Shenshu, Dachangshu and Ashi acupoints	TA	Needling at bilateral Shenshu, Dachangshu, Hangzhong, Kunlun and Huantiao acupoints	Clinical effects ODI VAS	The clinical effects of the intervention group (75.00%) were significantly higher than those of the control group (41.67%) ($P<0.01$) After treatment, the scores of the intervention group was significantly lower than those of the control group ($P<0.01$)	
Zhang et al. 2018.8	China	80	37/39	39/41	CNLBP	FN	Fire peck needling at Jiaji, Ashi, Shenshu (bilateral), Mingmen, Yaoyangguan and Weizhong (bilateral) acupoints	WM	Oral paracetamol tablets (Nanjixue®, specification: 0. 5 g /tablet, Sinopharm Group Guangdong Medi-World Pharmaceutical Co.,Ltd.)	ODI VAS	Compared with before treatment, the scores of each time point in the two groups were significantly improved after treatment ($P<0.05$).Comparison between the two groups after 2 weeks of treatment ($P>0.05$) After treatment, the scores of the intervention group were lower than those of the control group ($P<0.05$)	2 weeks, 4 weeks
Lai et al. 2019.1	China	126	49.38/52.26/51.67	66/60	NLBP	EA/EN	Electroacupuncture at waist Shenshu, Qihai, Dachangshu, Yaoyangguan, Mingmen and Ashi acupoints	WAM	Warm needle acupuncture at Shenshu, Dachangshu and Ashi acupoints	Clinical effects VAS JOA	Compared with before treatment, the VAS score of the two groups decreased ($P<0.05$) and JOA increased after treatment ($P<0.05$). Inter-group comparison: The intervention group was superior to the control group ($P<0.05$)	
Yin et al. 2019.12	China	60	44.46/43.13	36/24	CNLBP	TA	Needling at Shiqizhui, Yaoyangguan, Huantiao, Liang Qiu, Zusanli, Fenglong and Jiexi acupoints	WM	Diclofenac Sodium Dual Release Enteric-coated Capsules(Dufenac®, Temmler Ireland Ltd., drug approval No. H20170098) 75 mg	clinical effects ODI VAS JOA	Intervention group83.33%, Control group 80.00%, $P=0.739$ The ODI score of the intervention group (11.67 ± 2.66) was lower than that of the control group(20.67 ± 2.110 ($P<0.01$) The VAS score was lower in the intervention group (2.07 ± 0.78) than that in the control group (2.57 ± 1.04) ($P<0.05$) The JOA score was higher in the intervention group (23.07 ± 1.280) than in the control group (22.17 ± 1.23) ($P<0.01$)	
Josielli et al. 2020.3	Brazil	66	49/46	24/42	CNLBP	EA	electroacupuncture	TA	hand acupuncture	RMDQ	After treatment, the pain intensity and disability degree improved; However, no difference was observed between groups	3 months

Table 1 (continued)

Authors published years	baseline data(M/F)					Intervention		Control		Main Outcome	Primary Outcome	Follow-up time
	Country	sample	mean age, years	Gender	Diease type	Intervention group	Intervention	Control group	Intervention			
Chu et al. 2020.7	China	68	36.58/35.45	41/27	CNLBP	MMA	Needling at knotted meridian focal points based on the meridian-sinew theory	TA	Needling at Shenshu, Dachangshu, Ashi (waist tenderness point) and Weizhong acupoints	Clinical effects ODI VAS	Intervention group97. 06%, Control group 85. 29% ($P<0.05$) Both scores of the two groups decreased compared with those before treatment, and the decrease of the intervention group was more prominent ($P<0.05$)	
Lin et al. 2020.12	China	60	56.48/50.14	26/34	NLBP	MMA	Needling at bilateral Qihaishu and Pishu acupoints	TA	Needling at bilateral Weizhong, Jizhong, Yaoyangguan, Shenshu, Dachangshu and Ashi acupoints	Clinical effects ODI VAS JOA	All these indicators of the intervention group were superior to those of the control group (P < 0. 05)	Before treatment, after the first treatment and after the fifth treatment
Wang et al. 2020.3	China	68	35.88/35.41	38/30	NLBP	MMA	Needling at knotted meridian focal points based on the meridian-sinew theory	TA	Needling at Shenshu, Dachangshu and Weizhong acupoints	Clinical effects ODI VAS	The clinical effets of the intervention group were better than those of the control group ($P<0. 05$) After treatment, the scores of both groups were significantly reduced ($P<0. 05$), with more pronounced reduction in the intervention group ($P<0. 05$)	
Xu et al. 2020.1	China	60			NLBP	MMA	Needle-knife release through tendon layer	TA	Needling at Sanjiaoshu, Shenshu, Qihaishu, Ashi and Weizhong acupoints	VAS	The scores of patients in the two groups were significantly improved ($P<0.01$), with a more prominent improvement in the intervention group ($P<0.01$)	
Zhang et al. 2020	China	76	44.3/42.9	21/55	CNLBP	TA	Needling at Shenshu, Weizhong, Jiaji, Ashi, Ciliao and Yaoyan acupoints	CC	Hot compress	Clinical effects	Four weeks after treatment, the effective rate of the intervention group was 100%, and the marked effective rate was 78.9%, which was significantly better than that of the control group, with the effective rate of 86.8% and the marked effective rate of 39.5% (P < 0.05)	2 weeks, 4 weeks
										ODI VAS JOA	There was no statistical difference between the two groups before treatment ($P>0.05$). The VAS and ODI scores of the two groups decreased significantly after 2 weeks and 4 weeks of treatment ($P<0.05$). The JOA score increased significantly after 4 weeks of treatment ($P<0.05$). However, the VAS, ODI and JOA scores of the intervention group were better than those of the control group ($P<0.05$)	

Table 1 (continued)

Authors published years	baseline data(M/F)					Intervention		Control		Main Outcome	Primary Outcome	Follow-up time
	Country	sample	mean age, years	Gender	Diease type	Intervention group	Intervention	Control group	Intervention			
Zhang et al. 2020	China	61	51.9/52.4	31/30	CNLBP	EA	Electroacupuncture at bilateral Shenshu, Dachangshu, waist Jiaji, Ashi, Huantiao, Weizhong, Chengshan and Taixi acupoints	WM	Pharmaceuticals LLC, drug approval No. J20140072, 0.2 g/capsule)	clinical effects	The clinical effects of the intervention group were better than those of the control group($P < 0.05$)	
										VAS	The VAS score of the intervention group was significantly lower than that of the control group ($P < 0.05$)	
Deng et al. 2021.12	China	60	47.3/47.26	33/27	CNLBP	ISN	intensive silver needling at waist tenderness point	MMA	needle-knife release through tendon layer	ODI	After treatment, the scores of both groups were lower than those before treatment ($P < 0.05$). Two months after treatment, the scores of the intervention group were significantly improved compared to those of the control group ($P < 0.05$)	14 days, 2 months
										VAS		
Lin et al. 2021.10	china	180		89/91	NLBP	MMA	needling at knotted meridian focal points based on the meridian-sinew theory	TA	neediling at Dachangshu, Weizhong and Yaoyan acupoints	VAS	During and after treatment, the scores of both groups were significantly improved ($P < 0.01$). Among them, the indicators of the intervention group after treatment were better than those during treatment ($P < 0.01$). During and after treatment, the indicators of the intervention group were significantly improved compared to those of the control group ($P < 0.01$)	20 days, 40 days
										RMDQ		
Zeng et al. 2022.6	China	60	30/30.4	30/30	NLBP	TA	Neediling	EA	Electroacupuncture at Shenshu, Dachangshu, Mingmen, Huantiao and Weizhong acupints	Clinical effects	The clinical effects of the intervention group (86.67%, 26/30) were better than those of the control group (76.67%, 23/30) ($P < 0.05$)	2 weeks
										VAS	After treatment, the VAS score of the two groups was significantly improved ($P < 0.05$), and the intervention group was significantly better than the control group in improving the VAS score ($P < 0.05$)	
										RMDQ	After treatment, the scores of both groups were significantly improved ($P < 0.05$), with a more pronounced improvement in the intervention group ($P < 0.05$)	
										ODI		
Yang et al. 2022.2	China	115	34.68/34.67	69/46	CNLBP	TA	Neediling at Fengfu, Baihui, Yaoyangguan and Xuanshu acupoints	WM	Oral Loxoprofen Sodium Tablets (Disha Pharmaceutical Group Co. Ltd.)	Clinical effects	The clinical effects of the intervention group (86. 21%) were significantly higher than those of the control group (63.16%) ($P < 0. 05$)	2 weeks
										ODI	The JOA and ODI scores of both groups were significantly increased and decreased. The JOA score of the intervention group was significantly higher than that of the control group, and the ODI score was significantly lower than that of the control group ($P < 0.05$)	
										JOA		

Table 1 (continued)

Authors published years	baseline data(M/F)					Intervention		Control		Main Outcome	Primary Outcome	Follow-up time
	Country	sample	mean age, years	Gender	Diease type	Intervention group	Intervention	Control group	Intervention			
Gai et al. 2022.6	China	72	45.34/45.25	41/232	NLBP	TA	Neediling at Ashi, Weizhong, Shenshu, Ciliao and Jiaji acupoints	CC	Hot compress	ODI/VAS/JOA/clinical effects	After treatment, the JOA and total effective rate were higher in the intervention group than those in the control group (P < 0.05). After treatment, the ODI and VAS scores were lower than those of the control group (p < 0.05)	
Zhang et al. 2022.1	China	78	47.51/46.76	36/42	CNLBP	AA	auricular point application	CC	routine nursing	VAS	The VAS score was lower in the intervention group than in the control group (*P* < 0.05)	
Wang et al. 2022.2	China	210	42.39/43.56	98/112	NLBP	ISN	Intensive silver needling at waist tenderness point	TA	Neediling at Dachangshu, Weizhong, Mingmen and Yaoyan acupoints	Clinical effects	The clinical effects in the intervention group were significantly higher than those in the control group (*P* < 0.05)	2 weeks, 4 weeks
										VAS	The scores were all improved in both groups, and both indicators of the intervention group were better than those of the control group (*P* < 0.05)	
										JOA		
Long et al. 2023.11	China	82	48.2/47.3	48/34	CNLBP	EA	electroacupuncture at bilateral L4, L5 and S1 of Huatuo Jiaji, Yaoyangguan and Yaoshu acupoints	TA	neediling at Shenshu, Dachangshu, Yaoyangguan, Weizhong and Ashi acupoints	VAS	Before treatment, the comparison of the VAS score between the two groups was *P* = 0.854. After 1, 2 and 3 weeks of treatment, the VAS score of the intervention group was lower than that of the control Group (*P* < 0.05)	1 week, 2 weeks, and 3 weeks
										JOA	Before treatment and after 1, 2 and 3 weeks of treatment, the JOA score was not comparable (*P* > 0.05). After 1, 2 and 3 weeks of treatment, the JOA score was higher than that before treatment (*P* < 0.05)	
Zhang et al. 2023.1	China	60	47.1/46.3	24/36	NLBP	MMA	Needle-knife release through tendon layer	WM	Flurbiprofen Cataplasms	Clinical effects	The clinical effects of the intervention group (90%, 27/30) were significantly higher than those o the control group (73.33%, 22/30) *P* < 0.05)	3 months
										ODI	The VAS and ODI scores were significantly lower than those before treatment (*P* < 0.05), and the intervention group showed a greater reduction than the control group (*P* < 0.05)	
										VAS		
										JOA	The JOA score of the two groups was significantly higher than that before treatment (*P* < 0.05), and the intervention group showed a greater improvement than the control group (*P* < 0.05)	

intervention methods: routine acupuncture, meridian-sinew theory-based treatment, electroacupuncture, auricular point application, warm needle acupuncture, fire needling, silver needle therapy and electrical warm needling, and control measures including placebo needling, routine nursing and Western medicine. The line connecting the dots of conventional acupuncture and meridian-sinew theory-based treatment was the thickest. There was a close loop formed by traditional acupuncture, meridian-sinew theory-based treatment, warm needle acupuncture, electroacupuncture, Western medicine and silver needle therapy. The overall response rate network diagram is shown in Additional file 2. The results of the league table show that the overall response rate of warm needle acupuncture, intensive silver needle therapy, meridian-sinew theory-based treatment, fire needling, electroacupuncture and routine acupuncture was higher than that of Western medicine. The overall response rate of intensive silver needle therapy, meridian-sinew theory-based treatment, fire needling, electroacupuncture and routine acupuncture was higher than that of placebo needling. The overall response rate of warm needle acupuncture, intensive silver needle therapy, meridian-sinew theory-based treatment, fire needling, electroacupuncture and routine acupuncture was higher than that of routine nursing. For the above comparisons, the P-values were less than 0.05, which is statistically significant. The detailed information on the overall response rate league table is shown in Table 2. The overall response rates of different intervention measures were ranked in descending order as follows: WAM (81.5), ISN (79.3), MMA (77.2), FN (66.0), EA (60.9), TA (45.1), WM (24.6), PN (10.9), and CC (4.6). The SUCRA diagram of the overall response rate is shown in Additional file 3.

Recovery rate

Eighteen RCTs [28, 31–33, 35, 36, 38–42, 44, 45, 48–51, 54] reporting the recovery rate were included for network analysis and involved 6 interventions (routine acupuncture, meridian-sinew theory-based treatment, electroacupuncture, auricular point application, warm needle acupuncture, fire needling, silver needle therapy and electrical warm needling) and control measures including placebo needling, routine nursing and Western medicine. The line connecting the dots of conventional acupuncture and meridian-sinew theory-based treatment was the thickest. There was a close loop formed by traditional acupuncture, meridian-sinew theory-based treatment, Western medicine, electroacupuncture, warm needle acupuncture, and silver needle therapy. The network diagram of the recovery rate is shown in Additional file 2. The results of the league table show that the recovery rate of warm needle acupuncture, fire needling, meridian-sinew theory-based treatment, intensive silver needle therapy and electroacupuncture was higher than that of Western medicine, and the recovery rate of fire needling, meridian-sinew theory-based treatment, intensive silver needle therapy, electroacupuncture and routine acupuncture was higher than that of routine nursing. For the above comparisons, the *P*-values were less than 0.05, which is statistically significant. The detailed league table of recovery rate is shown in Table 3. The SUCRA value of recovery rate for different intervention measures was ranked in descending order as follows: WAM (77.4), FN (76.3), MMA (70.3), ISN (61.4), EA (55.4), TA (34.8), WM (14.1), and CC (10.2). The SUCRA diagram of the recovery rate is shown in Additional file 3.

Network meta-analysis results of pain indicators

VAS score

Twenty-two RCTs [29, 31, 32, 35–50, 52–54] reported VAS, which involved 8 interventions, such as routine acupuncture, meridian-sinew theory-based treatment, electroacupuncture, auricular point application, warm needle acupuncture, fire needling, intensive silver needle therapy and electrical warm needling, and control measures including placebo needling, routine nursing and Western medicine. The connection between conventional acupuncture and meridian-sinew theory-based treatment, conventional acupuncture and electroacupuncture, and conventional acupuncture and placebo needling was the strongest. Traditional acupuncture, fire needling, Western medicine, meridian-sinew theory-based treatment and silver needle therapy, traditional acupuncture, fire needling, Western medicine and electroacupuncture form a closed loop. The network diagram of the VAS score is shown in Additional file 2. The results of the league table show that intensive silver needle therapy, warm needle acupuncture, meridian-sinew theory-based treatment, routine acupuncture, fire needling, auricular point application and electroacupuncture had better VAS scores than Western medicine. The VAS score of warm needle acupuncture, meridian-sinew theory-based treatment, fire needling, auricular point application and electroacupuncture was better than that of routine nursing. The VAS score of intensive silver needle therapy, warm needle acupuncture, meridian-sinew theory-based treatment, fire needling and electroacupuncture was better than that of the placebo needling. For the above comparisons, the *P*-values were less than 0.05 (Table 4). The detailed VAS score league table is shown in Table 4. The SUCRA value of VAS scores for different interventions in descending order were EN (92.8), ISN (78.6), WAM (62.8), MMA (59.4), TA (54.4), FN (53.5), AA (47.7), EA (42.4), WM

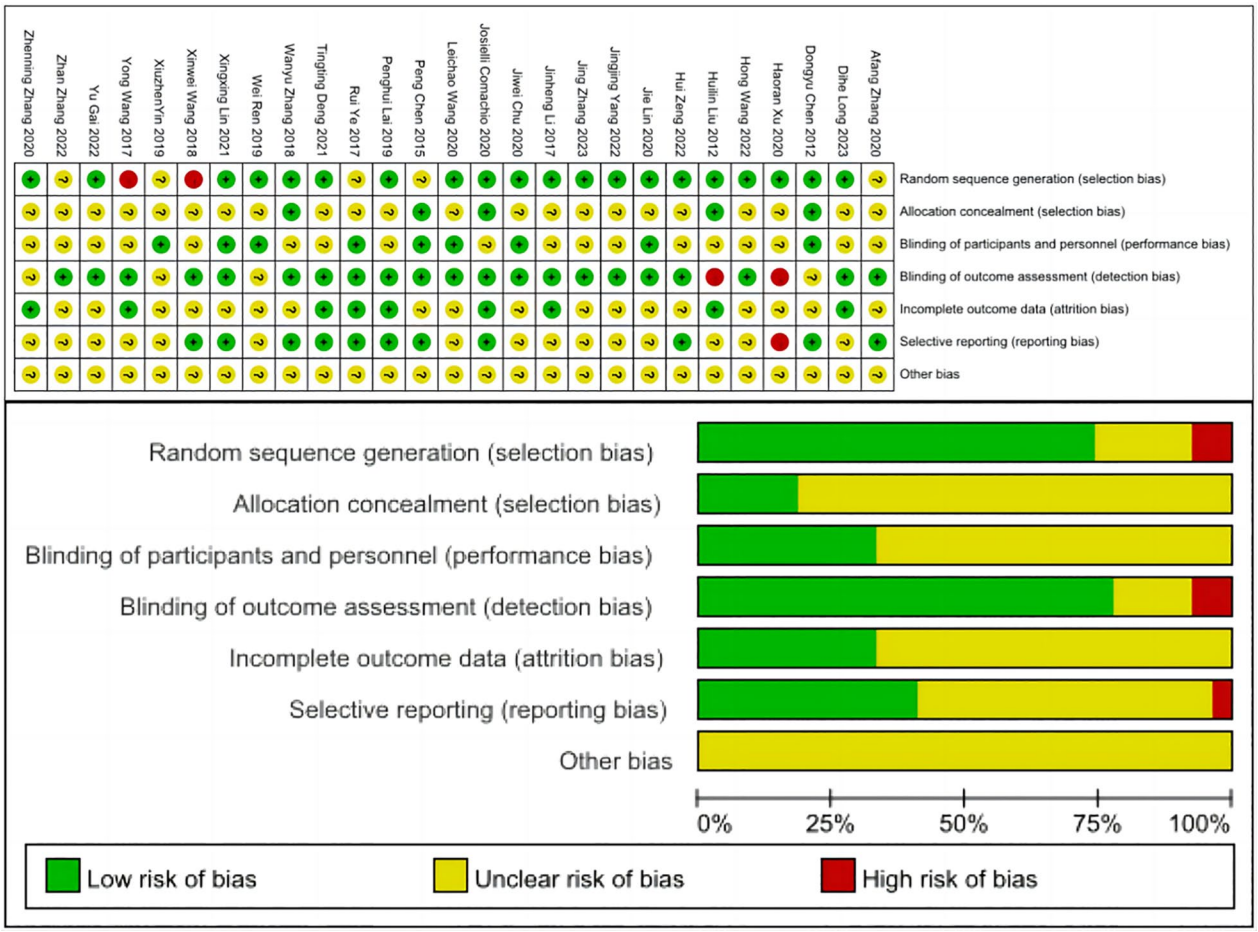

Fig. 2 Risk of bias assessment

(32.1), CC (16.8), and PN (9.5). The SUCRA diagram of the VAS score is shown in Additional file 3. The analysis of the VAS score difference obtained similar results, as shown in Table 4 and Additional files 3 and 4.

JOA scores

In this network analysis, 10 RCTs [38, 39, 41, 44, 49–54] reported JOA score, which included seven intervention methods: routine acupuncture, meridian-sinew theory-based treatment, electroacupuncture, auricular point application, warm needle acupuncture, fire needling, intensive silver needle therapy and electrical warm needling, and three control measures: placebo needling, routine nursing and Western medicine. The connection between conventional acupuncture and electroacupuncture, conventional acupuncture and routine nursing, and conventional acupuncture and Western medicine was the strongest. Traditional acupuncture, Western medicine, meridian-sinew theory-based treatment, warming needle acupuncture, electroacupuncture and electrical warm needling form a closed loop. The network diagram of the JOA score is shown in Additional file 2. The results of the league table show that the JOA score of warm needle acupuncture, intensive silver needle therapy, routine acupuncture, electroacupuncture, meridian-sinew theory-based treatment and auricular point application was higher than that of Western medicine. While for warm needle acupuncture, electroacupuncture and meridian-sinew theory-based treatment, the JOA score was higher than that of routine nursing. For the above comparisons, the P-values were less than 0.05, which is statistically significant. The detailed JOA score league table is shown in Table 5. The SUCRA value of JOA score for different interventions in descending order was EN (99.7), WAM (72.4), ISN (64.6), TA (57.7), EA (56.6), MMA (41.1), AA (33.0), WM (21.2), and CC (3.8) (Additional file 3). The analysis of the JOA score difference obtained similar results, as shown in Table 5 and Additional files 3 and 4.

Table 2 Overall response rate league table

WAM	ISN	MMA	FN	EA	TA	WM	PN	CC
WAM	0.91 (0.07,11.77)	0.38 (0.03,4.80)	0.57 (0.03,9.40)	0.47 (0.11,1.99)	0.28 (0.03,2.32)	0.12 (0.02,0.75)	2.93 (0.44,19.68)	0.03 (0.00,0.43)
1.09 (0.08,14.08)	ISN	0.42 (0.04,4.82)	0.62 (0.06,6.33)	0.51 (0.06,4.23)	0.30 (0.07,1.26)	0.13 (0.02,0.73)	0.05 (0.01,0.50)	0.03 (0.00,0.29)
2.62 (0.21,32.99)	2.40 (0.21,27.74)	MMA	1.48 (0.10,22.37)	1.23 (0.15,9.87)	0.73 (0.10,5.34)	0.31 (0.06,1.70)	0.49 (0.05,4.37)	0.07 (0.00,1.02)
1.77 (0.11,29.35)	1.62 (0.16,16.53)	0.67 (0.04,10.16)	FN	0.83 (0.07,9.25)	0.49 (0.08,3.09)	0.21 (0.03,1.69)	0.11 (0.02,0.63)	0.05 (0.00,0.61)
2.13 (0.50,9.01)	1.95 (0.24,16.04)	0.81 (0.10,6.50)	1.20 (0.11,13.43)	EA	0.59 (0.12,2.81)	0.25 (0.08,0.81)	0.13 (0.02,1.16)	0.05 (0.00,0.61)
3.60 (0.43,30.12)	3.29 (0.80,13.65)	1.37 (0.19,10.09)	2.04 (0.32,12.84)	1.69 (0.36,8.04)	TA	0.42 (0.15,1.16)	0.18 (0.08,0.43)	0.09 (0.01,0.59)
8.58 (1.33,55.31)	7.85 (1.37,45.07)	3.27 (0.59,18.17)	4.86 (0.59,39.76)	4.03 (1.24,13.11)	2.38 (0.86,6.59)	WM	0.43 (0.11,1.63)	0.22 (0.03,1.82)
0.34 (0.05,2.29)	19.89 (2.01,196.50)	2.06 (0.23,18.58)	9.34 (1.58,55.35)	7.58 (0.87,66.46)	5.52 (2.35,12.99)	2.32 (0.61,8.77)	PN	0.51 (0.07,3.92)
39.25 (2.34,659.27)	35.89 (3.46,372.06)	14.97 (0.98,228.27)	22.21 (1.63,303.34)	18.44 (1.63,208.27)	10.89 (1.70,69.77)	4.57 (0.55,38.02)	1.97 (0.26,15.25)	CC

Network meta-analysis results of functional indicators

ODI scores

A total of 16 articles [28, 31, 32, 34, 36, 37, 39–42, 44, 46, 48, 49, 51, 54] reported ODI score and included five intervention methods, such as routine acupuncture, meridian-sinew theory-based treatment, electroacupuncture, fire needling and intensive silver needle therapy, and control measures, such as placebo needling, routine nursing and Western medicine. The connection between conventional acupuncture and meridian-sinew theory-based treatment was the strongest, which signifies multiple direct comparative studies. Among them, traditional acupuncture, meridian-sinew theory-based treatment, Western medicine and fire needling form a closed loop. The network diagram of the ODI score is shown in Additional file 2. The results of the league table show that the ODI score of meridian-sinew theory-based treatment, conventional acupuncture, electroacupuncture and fire needling was better than that of routine nursing. For routine acupuncture, electroacupuncture, fire needling and intensive silver needle therapy, the ODI score was better than that of placebo needling. While for meridian-sinew theory-based treatment, electroacupuncture, fire needling and intensive silver needle therapy, the score was better than that of Western medicine. For the above comparisons, the *P*-values were less than 0.05, which is statistically significant. The detailed information on the ODI score league table is shown in Table 6. As shown in Additional file 3, the ODI scores of different interventions in descending order were MMA (SUCRA = 97.9), TA (SUCRA = 80.3), EA (SUCRA = 49.5), FN (SUCRA = 41.7), CC (SUCRA = 41.5), ISN (SUCRA = 41.2), PN (SUCRA = 36.6), and WM (SUCRA = 11.3). The analysis of the ODI score difference obtained similar results, as shown in Table 6 and Additional files 3 and 4.

Table 3 Recovery rate league table

WAM	FN	MMA	ISN	EA	TA	WM	CC
WAM	0.73 (0.01,44.97)	0.21 (0.00,12.40)	0.39 (0.01,29.36)	0.30 (0.02,4.36)	0.14 (0.00,5.58)	0.06 (0.00,1.32)	8.00 (0.44,146.24)
1.37 (0.02,83.94)	FN	0.29 (0.01,11.32)	0.54 (0.03,10.00)	0.41 (0.02,9.39)	0.19 (0.03,1.24)	0.08 (0.01,1.06)	0.13 (0.01,2.97)
4.66 (0.08,269.70)	3.41 (0.09,131.94)	MMA	1.84 (0.04,88.15)	1.40 (0.07,29.57)	0.66 (0.03,15.36)	0.26 (0.02,3.27)	0.42 (0.02,11.81)
2.54 (0.03,189.05)	1.86 (0.10,34.48)	0.54 (0.01,26.09)	ISN	0.76 (0.03,22.37)	0.36 (0.04,3.42)	0.14 (0.01,2.63)	0.04 (0.00,2.40)
3.33 (0.23,48.39)	2.44 (0.11,55.82)	0.71 (0.03,15.08)	1.31 (0.04,38.57)	EA	0.47 (0.04,5.86)	0.19 (0.03,1.01)	0.18 (0.00,7.03)
7.06 (0.18,278.54)	5.17 (0.81,33.17)	1.51 (0.07,35.21)	2.78 (0.29,26.51)	2.12 (0.17,26.32)	TA	0.39 (0.06,2.53)	0.28 (0.04,1.74)
17.99 (0.76,427.22)	13.17 (0.95,183.04)	3.86 (0.31,48.68)	7.09 (0.38,132.01)	5.40 (0.99,29.42)	2.55 (0.40,16.42)	WM	0.71 (0.05,9.70)
0.12 (0.01,2.28)	7.59 (0.34,170.74)	2.37 (0.08,66.37)	25.28 (0.42,1533.00)	5.42 (0.14,206.39)	3.58 (0.58,22.26)	1.41 (0.10,19.15)	CC

RMDQ scores

A total of three articles [30, 47, 48] reported RMDQ scores, which involved three intervention methods, including routine acupuncture, meridian-sinew theory-based treatment and electroacupuncture. The network diagram did not form a closed loop. The network diagram of the RMDQ score is shown in Additional file 2. The results of the league table show that there was no significant difference in various treatment methods, and the detailed information of the league table of RMDQ score is shown in Additional file 5. As shown in Additional file 3, the SUCRA value of RMDQ score for different interventions in descending order was MMA (98.8), TA (49.0), and EA (2.3), and the data analysis of RMDQ score difference has obtained similar results, as shown in Additional files 2, 3, 5.

Publication bias

In order to test whether there is publication bias, a separate comparison-correction funnel plot (including VAS score, ODI score, JOA score, RMDQ score, overall response rate and recovery rate) was drawn for RCTs involving more than 3 outcome indicators. The results of the comparison-correction funnel plot show that most indicators of the RCTs (VAS score, JOA score, RMDQ score, overall response rate and recovery rate) were within 95%CI, which are evenly distributed on both sides of the red midline. However, the RCT distribution of ODI's comparison-correction funnel plot was uneven, and the included angle between the regression line and the horizontal line was large, suggesting the possibility of publication bias. The details are shown in Additional file 4.

GRADE evidence quality classification

GRADE guideline was used to assessed the evidence quality of all outcomes. The total effective rate, VAS and other outcome indicators demonstrated high quality. However, due to methodological limitations and small sample sizes, the recovery rate and ODI outcome indicator were assessed as having medium quality, while the JOA and RMDQ scores were classified as low quality (Table 7).

Discussion

For different acupuncture treatments for chronic nonspecific low back pain, there was a network meta-analysis published in 2022 [22]. After reading the full text of this study, it was found that although the title was related to different acupuncture, the content was actually focused on the comparison between standardized acupuncture and individualized acupuncture and between auricular acupuncture and electroacupuncture, rather than the conventional classification methods of acupuncture in China, such as warm needle acupuncture, fire needling, and meridian-sinew theory-based treatment. Comparing the difference in curative effect between standardized acupuncture and individualized acupuncture cannot well display the characteristics and advantages of traditional Chinese acupuncture and moxibustion and choices for different types of acupuncture methods. Therefore, based on this background, this paper summarizes the common acupuncture methods at home and abroad to form a network meta-analysis. Based on the NMA analysis results of overall response rate, recovery rate, VAS, JOA, ODI and RMDQ, most external treatment methods of traditional Chinese medicine may be better than Western medicine, routine nursing and sham acupuncture, which is consistent with the research findings of Alice Baroncini et al. [22].

In this study, the effectiveness of 8 kinds of acupuncture therapy (including routine acupuncture, electroacupuncture, meridian-sinew theory-based treatment, warm needle acupuncture, fire needling, intensive silver needle therapy, electrical warm needling and auricular point application) in treating CNLBP was evaluated, and 25 articles were included. Among all the outcome indicators, the evidence level of the total effective rate, VAS and other outcome indicators is classified as high. In contrast, the evidence level of the recovery rate and ODI outcome score is considered medium, while the evidence level of the JOA and RMDQ scores is categorized as very low. The results of network meta-analysis showed that the top three treatment schemes were warm needle acupuncture, intensive silver needle therapy and meridian-sinew theory-based treatment. In terms of relieving pain, the top three treatments were electrical warm needling, intensive silver needle therapy and warm needle acupuncture. In improving the range of motion, the top three were meridian-sinew theory-based treatment, routine acupuncture and electroacupuncture. Among the six included outcome indicators, the ranking of external treatment of traditional Chinese medicine is different. The possible reasons for this result are that the number of included articles for each outcome indicator is different (overall response rate: $n=19$, recovery rate: $n=18$, VAS: $n=23$, JOA: $n=10$, ODI: $n=17$, RMDQ: $n=3$), and the sample size is too small, which easily affects the results.

Based on the results of network meta-analysis for six indicators, warm needle acupuncture, electrical warm needling and meridian-sinew theory-based treatment are recommended in treatment, and each has its own strength. Warm needle acupuncture[55] has the highest response rate, which may be due to the combination of

Table 4 VAS score league table

EN	ISN	WAM	MMA	TA	FN	AA	EA	WM	CC	PN
EN	1.14 (−2.58,4.85)	1.82 (−0.38,4.02)	2.06 (−1.09,5.20)	2.37 (−0.76,5.51)	2.35 (−0.51,5.21)	2.62 (−1.28,6.52)	2.70 (0.53,4.87)	3.01 (0.56,5.46)	3.81 (0.46,7.16)	3.08 (0.23,5.93)
−1.14 (−4.85,2.58)	ISN	0.68 (−3.04,4.41)	0.92 (−2.47,4.32)	1.24 (−0.76,3.23)	1.21 (−1.94,4.37)	1.49 (−1.57,4.54)	1.56 (−1.45,4.58)	1.87 (−0.92,4.67)	2.67 (0.36,4.99)	2.45 (−0.93,5.83)
−1.82 (−4.02,0.38)	−0.68 (−4.41,3.04)	WAM	0.24 (−2.92,3.39)	0.55 (−2.60,3.70)	0.53 (−2.34,3.40)	0.80 (−3.11,4.71)	0.88 (−1.30,3.06)	1.19 (−1.28,3.66)	1.99 (−1.37,5.35)	1.57 (−1.01,4.16)
−2.06 (−5.20,1.09)	−0.92 (−4.32,2.47)	−0.24 (−3.39,2.92)	MMA	0.31 (−2.43,3.06)	0.29 (−2.17,2.75)	0.56 (−3.03,4.16)	0.64 (−1.64,2.92)	0.95 (−1.02,2.92)	1.75 (−1.24,4.74)	0.28 (−2.61,3.17)
−2.37 (−5.51,0.76)	−1.24 (−3.23,0.76)	−0.55 (−3.70,2.60)	−0.31 (−3.06,2.43)	TA	−0.02 (−2.47,2.43)	0.25 (−2.07,2.57)	0.33 (−1.94,2.59)	0.64 (−1.32,2.60)	1.44 (0.26,2.62)	1.90 (0.53,3.27)
−2.35 (−5.21,0.51)	−1.21 (−4.37,1.94)	−0.53 (−3.40,2.34)	−0.29 (−2.75,2.17)	0.02 (−2.43,2.47)	FN	0.27 (−3.10,3.65)	0.35 (−1.51,2.21)	0.66 (−0.81,2.13)	1.46 (−1.26,4.18)	1.65 (−1.04,4.34)
−2.62 (−6.52,1.28)	−1.49 (−4.54,1.57)	−0.80 (−4.71,3.11)	−0.56 (−4.16,3.03)	−0.25 (−2.57,2.07)	−0.27 (−3.65,3.10)	AA	0.08 (−3.16,3.32)	0.39 (−2.65,3.43)	1.19 (−0.81,3.19)	−0.63 (−3.09,1.83)
−2.70 (−4.87,−0.53)	−1.56 (−4.58,1.45)	−0.88 (−3.06,1.30)	−0.64 (−2.92,1.64)	−0.33 (−2.59,1.94)	−0.35 (−2.21,1.51)	−0.08 (−3.32,3.16)	EA	0.31 (−0.84,1.46)	1.11 (−1.44,3.66)	2.22 (−0.78,5.22)
−3.01 (−5.46,−0.56)	−1.87 (−4.67,0.92)	−1.19 (−3.66,1.28)	−0.95 (−2.92,1.02)	−0.64 (−2.60,1.32)	−0.66 (−2.13,0.81)	−0.39 (−3.43,2.65)	−0.31 (−1.46,0.84)	WM	0.80 (−1.49,3.09)	1.26 (−1.06,3.59)
−3.81 (−7.16,−0.46)	−2.67 (−4.99,−0.36)	−1.99 (−5.35,1.37)	−1.75 (−4.74,1.24)	−1.44 (−2.62,−0.26)	−1.46 (−4.18,1.26)	−1.19 (−3.19,0.81)	−1.11 (−3.66,1.44)	−0.80 (−3.09,1.49)	CC	0.46(−1.34,2.27)
−3.08 (−5.93,−0.23)	−2.45 (−5.83,0.93)	−1.57 (−4.16,1.01)	−0.28 (−3.17,2.61)	−1.90 (−3.27,−0.53)	−1.65 (−4.34,1.04)	0.63 (−1.83,3.09)	−2.22 (−5.22,0.78)	−1.26 (−3.59,1.06)	−0.46 (−2.27,1.34)	PN

EN	ISN	WAM	TA	EA	AA	FN	WM	CC	PN	MMA
EN	1.42 (−2.24,5.07)	1.53 (−0.65,3.71)	2.57 (−0.40,5.53)	2.74 (0.57,4.91)	3.22 (−0.67,7.11)	3.45 (0.55,6.36)	4.04 (1.54,6.54)	4.28 (1.06,7.50)	4.00 (1.45,6.55)	10.88 (7.60,14.17)
−1.42 (−5.07,2.24)	ISN	0.11 (−3.55,3.77)	1.15 (−1.02,3.31)	1.32 (−1.64,4.28)	1.80 (−1.52,5.12)	2.04 (−0.92,4.99)	2.62 (−0.06,5.31)	2.86 (0.36,5.36)	2.97 (0.12,5.82)	9.46 (6.11,12.82)
−1.53 (−3.71,0.65)	−0.11 (−3.77,3.55)	WAM	1.04 (−1.93,4.00)	1.21 (−0.96,3.38)	1.69 (−2.20,5.58)	1.92 (−0.98,4.83)	2.51 (0.01,5.01)	2.75 (−0.47,5.97)	1.76 (−0.13,3.64)	9.35 (6.06,12.64)
−2.57 (−5.53,0.40)	−1.15 (−3.31,1.02)	−1.04 (−4.00,1.93)	TA	0.17 (−1.87,2.21)	0.65 (−1.87,3.18)	0.89 (−1.15,2.92)	1.48 (−0.14,3.09)	1.71 (0.45,2.97)	1.93 (0.72,3.14)	8.32 (5.74,10.89)
−2.74 (−4.91,−0.57)	−1.32 (−4.28,1.64)	−1.21 (−3.38,0.96)	−0.17 (−2.21,1.87)	EA	0.48 (−2.76,3.72)	0.71 (−1.23,2.66)	1.30 (0.05,2.56)	1.54 (−0.86,3.93)	−6.39 (−8.88,−3.89)	8.14 (5.67,10.61)
−3.22 (−7.11,0.67)	−1.80 (−5.12,1.52)	−1.69 (−5.58,2.20)	−0.65 (−3.18,1.87)	−0.48 (−3.72,2.76)	AA	0.23 (−3.00,3.47)	0.82 (−2.17,3.81)	1.06 (−1.13,3.24)	−1.00 (−3.25,1.26)	7.66 (4.06,11.26)
−3.45 (−6.36,−0.55)	−2.04 (−4.99,0.92)	−1.92 (−4.83,0.98)	−0.89 (−2.92,1.15)	−0.71 (−2.66,1.23)	−0.23 (−3.47,3.00)	FN	0.59 (−0.91,2.08)	0.82 (−1.56,3.21)	1.28 (−1.51,4.06)	7.43 (4.84,10.01)
−4.04 (−6.54,−1.54)	−2.62 (−5.31,0.06)	−2.51 (−5.01,−0.01)	−1.48 (−3.09,0.14)	−1.30 (−2.56,−0.05)	−0.82 (−3.81,2.17)	−0.59 (−2.08,0.91)	WM	0.24 (−1.81,2.28)	0.45 (−0.98,1.89)	6.84 (4.71,8.97)

Table 4 (continued)

EN	ISN	WAM	TA	EA	AA	FN	WM	CC	PN	MMA
−4.28 (−7.50,−1.06)	−2.86 (−5.36,−0.36)	−2.75 (−5.97,0.47)	−1.71 (−2.97,−0.45)	−1.54 (−3.93,0.86)	−1.06 (−3.24,1.13)	−0.82 (−3.21,1.56)	−0.24 (−2.28,1.81)	CC	0.22 (−1.52,1.96)	6.60 (3.74,9.46)
−4.00 (−6.55,−1.45)	−2.97 (−5.82,−0.12)	−1.76 (−3.64,0.13)	−1.93 (−3.14,−0.72)	6.39 (3.89,8.88)	1.00 (−1.26,3.25)	−1.28 (−4.06,1.51)	−0.45 (−1.89,0.98)	−0.22 (−1.96,1.52)	PN	−9.05 (−11.80,−6.30)
−10.88 (−14.17,−7.60)	−9.46 (−12.82,−6.11)	−9.35 (−12.64,−6.06)	−8.32 (−10.89,−5.74)	−8.14 (−10.61,−5.67)	−7.66 (−11.26,−4.06)	−7.43 (−10.01,−4.84)	−6.84 (−8.97,−4.71)	−6.60 (−9.46,−3.74)	9.05 (6.30,11.80)	MMA

Table 5 JOA score league table

EN	ISN	WAM	MMA	TA	FN	AA	EA	WM	CC	PN
EN	1.14 (−2.58,4.85)	1.82 (−0.38,4.02)	2.06 (−1.09,5.20)	2.37 (−0.76,5.51)	2.35 (−0.51,5.21)	2.62 (−1.28,6.52)	2.70 (0.53,4.87)	3.01 (0.56,5.46)	3.81 (0.46,7.16)	3.08 (0.23,5.93)
−1.14 (−4.85,2.58)	ISN	0.68 (−3.04,4.41)	0.92 (−2.47,4.32)	1.24 (−0.76,3.23)	1.21 (−1.94,4.37)	1.49 (−1.57,4.54)	1.56 (−1.45,4.58)	1.87 (−0.92,4.67)	2.67 (0.36,4.99)	2.45 (−0.93,5.83)
−1.82 (−4.02,0.38)	−0.68 (−4.41,3.04)	WAM	0.24 (−2.92,3.39)	0.55 (−2.60,3.70)	0.53 (−2.34,3.40)	0.80 (−3.11,4.71)	0.88 (−1.30,3.06)	1.19 (−1.28,3.66)	1.99 (−1.37,5.35)	1.57 (−1.01,4.16)
−2.06 (−5.20,1.09)	−0.92 (−4.32,2.47)	−0.24 (−3.39,2.92)	MMA	0.31 (−2.43,3.06)	0.29 (−2.17,2.75)	0.56 (−3.03,4.16)	0.64 (−1.64,2.92)	0.95 (−1.02,2.92)	1.75 (−1.24,4.74)	0.28 (−2.61,3.17)
−2.37 (−5.51,0.76)	−1.24 (−3.23,0.76)	−0.55 (−3.70,2.60)	−0.31 (−3.06,2.43)	TA	−0.02 (−2.47,2.43)	0.25 (−2.07,2.57)	0.33 (−1.94,2.59)	0.64 (−1.32,2.60)	1.44 (0.26,2.62)	1.90 (0.53,3.27)
−2.35 (−5.21,0.51)	−1.21 (−4.37,1.94)	−0.53 (−3.40,2.34)	−0.29 (−2.75,2.17)	0.02 (−2.43,2.47)	FN	0.27 (−3.10,3.65)	0.35 (−1.51,2.21)	0.66 (−0.81,2.13)	1.46 (−1.26,4.18)	1.65 (−1.04,4.34)
−2.62 (−6.52,1.28)	−1.49 (−4.54,1.57)	−0.80 (−4.71,3.11)	−0.56 (−4.16,3.03)	−0.25 (−2.57,2.07)	−0.27 (−3.65,3.10)	AA	0.08 (−3.16,3.32)	0.39 (−2.65,3.43)	1.19 (−0.81,3.19)	−0.63 (−3.09,1.83)
−2.70 (−4.87,−0.53)	−1.56 (−4.58,1.45)	−0.88 (−3.06,1.30)	−0.64 (−2.92,1.64)	−0.33 (−2.59,1.94)	−0.35 (−2.21,1.51)	−0.08 (−3.32,3.16)	EA	0.31 (−0.84,1.46)	1.11 (−1.44,3.66)	2.22 (−0.78,5.22)
−3.01 (−5.46,−0.56)	−1.87 (−4.67,0.92)	−1.19 (−3.66,1.28)	−0.95 (−2.92,1.02)	−0.64 (−2.60,1.32)	−0.66 (−2.13,0.81)	−0.39 (−3.43,2.65)	−0.31 (−1.46,0.84)	WM	0.80 (−1.49,3.09)	1.26 (−1.06,3.59)
−3.81 (−7.16,−0.46)	−2.67 (−4.99,−0.36)	−1.99 (−5.35,1.37)	−1.75 (−4.74,1.24)	−1.44 (−2.62,−0.26)	−1.46 (−4.18,1.26)	−1.19 (−3.19,0.81)	−1.11 (−3.66,1.44)	−0.80 (−3.09,1.49)	CC	0.46(−1.34,2.27)
−3.08 (−5.93,−0.23)	−2.45 (−5.83,0.93)	−1.57 (−4.16,1.01)	−0.28 (−3.17,2.61)	−1.90 (−3.27,−0.53)	−1.65 (−4.34,1.04)	0.63 (−1.83,3.09)	−2.22 (−5.22,0.78)	−1.26 (−3.59,1.06)	−0.46 (−2.27,1.34)	PN

EN	ISN	WAM	TA	EA	AA	FN	WM	CC	PN	MMA
EN	1.42 (−2.24,5.07)	1.53 (−0.65,3.71)	2.57 (−0.40,5.53)	2.74 (0.57,4.91)	3.22 (−0.67,7.11)	3.45 (0.55,6.36)	4.04 (1.54,6.54)	4.28 (1.06,7.50)	4.00 (1.45,6.55)	10.88 (7.60,14.17)
−1.42 (−5.07,2.24)	ISN	0.11 (−3.55,3.77)	1.15 (−1.02,3.31)	1.32 (−1.64,4.28)	1.80 (−1.52,5.12)	2.04 (−0.92,4.99)	2.62 (−0.06,5.31)	2.86 (0.36,5.36)	2.97 (0.12,5.82)	9.46 (6.11,12.82)
−1.53 (−3.71,0.65)	−0.11 (−3.77,3.55)	WAM	1.04 (−1.93,4.00)	1.21 (−0.96,3.38)	1.69 (−2.20,5.58)	1.92 (−0.98,4.83)	2.51 (0.01,5.01)	2.75 (−0.47,5.97)	1.76 (−0.13,3.64)	9.35 (6.06,12.64)
−2.57 (−5.53,0.40)	−1.15 (−3.31,1.02)	−1.04 (−4.00,1.93)	TA	0.17 (−1.87,2.21)	0.65 (−1.87,3.18)	0.89 (−1.15,2.92)	1.48 (−0.14,3.09)	1.71 (0.45,2.97)	1.93 (0.72,3.14)	8.32 (5.74,10.89)
−2.74 (−4.91,−0.57)	−1.32 (−4.28,1.64)	−1.21 (−3.38,0.96)	−0.17 (−2.21,1.87)	EA	0.48 (−2.76,3.72)	0.71 (−1.23,2.66)	1.30 (0.05,2.56)	1.54 (−0.86,3.93)	−6.39 (−8.88,−3.89)	8.14 (5.67,10.61)
−3.22 (−7.11,0.67)	−1.80 (−5.12,1.52)	−1.69 (−5.58,2.20)	−0.65 (−3.18,1.87)	−0.48 (−3.72,2.76)	AA	0.23 (−3.00,3.47)	0.82 (−2.17,3.81)	1.06 (−1.13,3.24)	−1.00 (−3.25,1.26)	7.66 (4.06,11.26)
−3.45 (−6.36,−0.55)	−2.04 (−4.99,0.92)	−1.92 (−4.83,0.98)	−0.89 (−2.92,1.15)	−0.71 (−2.66,1.23)	−0.23 (−3.47,3.00)	FN	0.59 (−0.91,2.08)	0.82 (−1.56,3.21)	1.28 (−1.51,4.06)	7.43 (4.84,10.01)
−4.04 (−6.54,−1.54)	−2.62 (−5.31,0.06)	−2.51 (−5.01,−0.01)	−1.48 (−3.09,0.14)	−1.30 (−2.56,−0.05)	−0.82 (−3.81,2.17)	−0.59 (−2.08,0.91)	WM	0.24 (−1.81,2.28)	0.45 (−0.98,1.89)	6.84 (4.71,8.97)

Table 5 (continued)

EN	ISN	WAM	TA	EA	AA	FN	WM	CC	PN	MMA
−4.28 (−7.50,−1.06)	−2.86 (−5.36,−0.36)	−2.75 (−5.97,0.47)	−1.71 (−2.97,−0.45)	−1.54 (−3.93,0.86)	−1.06 (−3.24,1.13)	−0.82 (−3.21,1.56)	−0.24 (−2.28,1.81)	CC	0.22 (−1.52,1.96)	6.60 (3.74,9.46)
−4.00 (−6.55,−1.45)	−2.97 (−5.82,−0.12)	−1.76 (−3.64,0.13)	−1.93 (−3.14,−0.72)	6.39 (3.89,8.88)	1.00 (−1.26,3.25)	−1.28 (−4.06,1.51)	−0.45 (−1.89,0.98)	−0.22 (−1.96,1.52)	PN	−9.05 (−11.80,−6.30)
−10.88 (−14.17,−7.60)	−9.46 (−12.82,−6.11)	−9.35 (−12.64,−6.06)	−8.32 (−10.89,−5.74)	−8.14 (−10.61,−5.67)	−7.66 (−11.26,−4.06)	−7.43 (−10.01,−4.84)	−6.84 (−8.97,−4.71)	−6.60 (−9.46,−3.74)	9.05 (6.30,11.80)	MMA

Table 6 ODI score league table

MMA	TA	EA	FN	CC	ISN	PN	WM
MMA	−7.04 (−16.92,2.84)	−3.19 (−14.22,7.83)	−1.84 (−12.09,8.41)	−2.16 (−13.18,8.86)	−1.52 (−7.56,4.51)	10.77 (0.23,21.32)	1.97 (−6.06,10.00)
7.04 (−2.84,16.92)	TA	3.85 (−1.05,8.75)	5.20 (−3.49,13.88)	4.88 (−0.01,9.77)	5.52 (−6.06,17.09)	5.49 (−0.06,11.03)	9.01 (3.10,14.91)
3.19 (−7.83,14.22)	−3.85 (−8.75,1.05)	EA	1.35 (−8.62,11.32)	1.03 (−5.89,7.95)	1.67 (−10.90,14.24)	−1.55 (−12.72,9.63)	5.16 (−2.52,12.83)
1.84 (−8.41,12.09)	−5.20 (−13.88,3.49)	−1.35 (−11.32,8.62)	FN	−0.32 (−10.29,9.65)	0.32 (−11.58,12.21)	1.64 (−5.76,9.04)	3.81 (−2.56,10.18)
2.16 (−8.86,13.18)	−4.88 (−9.77,0.01)	−1.03 (−7.95,5.89)	0.32 (−9.65,10.29)	CC	0.64 (−11.93,13.20)	0.61 (−6.77,8.00)	4.13 (−3.54,11.80)
1.52 (−4.51,7.56)	−5.52 (−17.09,6.06)	−1.67 (−14.24,10.90)	−0.32 (−12.21,11.58)	−0.64 (−13.20,11.93)	ISN	9.42 (−0.98,19.82)	3.49 (−6.56,13.53)
−10.77 (−21.32,−0.23)	−5.49 (−11.03,0.06)	1.55 (−9.63,12.72)	−1.64 (−9.04,5.76)	−0.61 (−8.00,6.77)	−9.42 (−19.82,0.98)	PN	3.52 (−4.47,11.51)
−1.97 (−10.00,6.06)	−9.01 (−14.91,−3.10)	−5.16 (−12.83,2.52)	−3.81 (−10.18,2.56)	−4.13 (−11.80,3.54)	−3.49 (−13.53,6.56)	−3.52 (−11.51,4.47)	WM
MMA	**PN**	**FN**	**TA**	**EA**	**ISN**	**WM**	**CC**
MMA	−0.55 (−15.56,14.46)	1.98 (−15.97,19.93)	4.78 (−8.10,17.67)	6.09 (−10.16,22.33)	7.50 (−4.21,19.20)	7.38 (−5.81,20.58)	8.40 (−7.11,23.90)
0.55 (−14.46,15.56)	PN	5.20 (−6.72,17.13)	3.90 (−2.75,10.55)	−0.88 (−12.46,10.69)	−2.55 (−21.71,16.61)	6.50 (−3.22,16.22)	7.52 (−3.27,18.30)
−1.98 (−19.93,15.97)	−5.20 (−17.13,6.72)	FN	2.81 (−12.83,18.44)	4.11 (−14.40,22.62)	5.52 (−14.62,25.67)	5.41 (−6.77,17.59)	6.42 (−11.61,24.45)
−4.78 (−17.67,8.10)	−3.90 (−10.55,2.75)	−2.81 (−18.44,12.83)	TA	1.30 (−8.62,11.22)	2.71 (−12.75,18.18)	2.60 (−7.23,12.42)	3.62 (−5.87,13.10)
−6.09 (−22.33,10.16)	0.88 (−10.69,12.46)	−4.11 (−22.62,14.40)	−1.30 (−11.22,8.62)	EA	1.41 (−16.95,19.77)	1.30 (−12.66,15.25)	2.31 (−11.41,16.03)
−7.50 (−19.20,4.21)	2.55 (−16.61,21.71)	−5.52 (−25.67,14.62)	−2.71 (−18.18,12.75)	−1.41 (−19.77,16.95)	ISN	−0.12 (−16.17,15.94)	0.90 (−16.79,18.59)
−7.38 (−20.58,5.81)	−6.50 (−16.22,3.22)	−5.41 (−17.59,6.77)	−2.60 (−12.42,7.23)	−1.30 (−15.25,12.66)	0.12 (−15.94,16.17)	WM	1.02 (−12.29,14.32)
−8.40 (−23.90,7.11)	−7.52 (−18.30,3.27)	−6.42 (−24.45,11.61)	−3.62 (−13.10,5.87)	−2.31 (−16.03,11.41)	−0.90 (−18.59,16.79)	−1.02 (−14.32,12.29)	CC

acupuncture's function of dredging meridians and moxibustion's warmth and fragrance. When the needle penetrates the skin, the warmth can transmit deep into the acupoints, which can achieve the effects of eliminating dampness, warming meridians, activating qi and promoting blood circulation and regulating visceral activity, and effectively alleviating the symptoms of patients' low back pain and limb numbness. Electroacupuncture[38] has a good effect on relieving pain, which may be due to the fact that the pathological changes in the pain area of muscle ligament mainly occur in soft tissues, especially in soft tissues, which are sensitized by receptors that receive pain feelings, and then lead to sensitization of stimulation conduction pathways and neurogenic inflammatory reactions. The stimulation of pain is reflected in the central area of the brain, which can lead to the change of reflex arc in a short time. Therefore, the electrical warm needling introduces heat into the acupoint through the needle to stimulate the deep muscle tissue, which can warm the meridians, dispel cold and relieve pain. In addition, the combination of acupuncture and moxibustion also enhances the effect of eliminating local inflammatory edema. Meridian-sinew theory-based treatment[56] has the best effect in improving joint mobility, which may be due to its physiological functions of "binding bones", "benefiting organs", protecting tissues and regulating meridians. Different meridian tendons cover the waist in surface, patches and bands, which support and protect the waist and sacrum from both inside and outside, thus improving joint mobility. Except for the three therapies, the intervention effect of other therapies is still uncertain.

The sample size of the included studies is generally small, and selected acupoints across these studies are inconsistent. Therefore, our results need to be interpreted with caution. There are a wide variety of external TCM treatments. This study only focused on some external TCM treatments, including conventional acupuncture, electroacupuncture, channel tendon theory, warm

Table 7 GRADE evidence quality grade

Certainty assessment							Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
19	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	⊕⊕⊕⊕ High	Critical
18	Randomised trials	Not serious	Not serious	Not serious	Serious	None	⊕⊕⊕◯ Moderate	Critical
22	Randomised trials	Not serious	Not serious	Not serious	Not serious	None	⊕⊕⊕⊕ High	Critical
10	Randomised trials	Serious	Not serious	Not serious	Serious	None	⊕⊕◯◯ Low	Important
16	Randomised trials	Serious	Not serious	Not serious	Not serious	None	⊕⊕⊕◯ Moderate	Critical
3	Randomised trials	Serious	Very serious	Very serious	Very serious	None	⊕◯◯◯ Very low	Important

Question: Different acupuncture methods compared to placebo needling, Western medicine and routine nursing for chronic nonspecific low back pain. CI: confidence interval

needle acupuncture, fire needling, intensive silver needle therapy, electrical warm needling, and auricular plaster therapy. Syndrome differentiation and treatment are the core features of traditional Chinese medicine. In China, syndrome differentiation and treatment are mostly based on low back pain and lumbar paralysis, while foreign studies mostly distinguish acute, subacute, and chronic low back pain based on the duration of the disease. Hence, it is impossible to highlight the differences in the efficacy of various external TCM methods in different syndrome types. Because acupuncture is derived from traditional Chinese medicine, relatively in-depth and large-scale research has been conducted in China. This is the reason why this study included a large amount of studies from China. In the future, relevant foreign clinical studies are warranted to supplement and update evidence-based findings.

Conclusion

To sum up, for CNLBP patients, warm needle acupuncture, electrical warm needling and meridian-sinew theory-based treatment have the best therapeutic effects. If the patient has obvious pain, it is strongly recommended to use electroacupuncture for the best effect. On the contrary, for patients with decreased joint mobility, it is advocated to adopt meridian-sinew theory-based treatment.

Abbreviations

CNLBP Chronic nonspecific low back pain
RCTs Randomized controlled trials
LBP Low back pain
DALYs Disability-adjusted life years
YLDs Years lived with disability
AMA American Medical Association
NASS North American Spine Society
TCM Traditional Chinese medicine

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13018-024-05118-8.

Additional file 1.

Author contributions

KZ: Conceptualization, visualization, formal analysis, project administration, writing—original draft, writing—review and editing. XL: Visualization, investigation, formal analysis, data curation. ZL: Methodology, formal analysis, data curation. YF: Data curation, writing—original draft. LW: Software, Investigation, writing—review and editing. DZ: Investigation, writing—review and editing. QZ: Data curation, writing—review and editing. FZ: Conceptualization, writing—review and editing. XW: Resources, data curation. BD: Conceptualization, supervision, funding acquisition, writing—review and editing.

Funding

This work was supported by the Joint Fund Project of Liaoning Provincial Department of Science and Technology (No.: 2022-NLTS-13-04); Key project of Liaoning Provincial Department of Education (LJKZ0902). The fund was not involved in any study design, data collection, analysis and interpretation, report writing, and article submission for publication.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval can be found in the included studies. This manuscript does not involve human or animal experimentation.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Received: 13 August 2024 Accepted: 25 September 2024
Published online: 30 September 2024

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