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Review Article

Enhancing symptom relief and quality of life in patients with stroke-induced spastic hemiplegia: a comprehensive systematic review and meta-analysis of acupuncture modalities' effectiveness

Yi Su[1*], Meihua Xiao[2*], Songchun Liu[3], Min Ye[4]

[1]Department of Rehabilitation Physiotherapy, First Hospital of Qinhuangdao, Qinhuangdao 066000, Hebei, China; [2]Department of Rehabilitation, Ezhou Central Hospital, Ezhou 436000, Hubei, China; [3]Department of Clinical Nutrition, Ezhou Central Hospital, Ezhou 436000, Hubei, China; [4]Department of Rehabilitation Medicine, No. 926 Hospital, Joint Logistics Support Force of PLA, Kaiyuan 661600, Yunnan, China. [*]Equal contributors and co-first authors.

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Abstract: Background: Stroke survivors often experience diminished quality of life due to physical, cognitive, and emotional challenges. While rehabilitative interventions are considered the cornerstone of treatment for stroke recovery, complementary therapies, such as acupuncture, herbal, or aroma therapies, have also gained recognition for their potential to enhance post-stroke recovery. Methods: A comprehensive search of electronic databases yielded 30 studies meeting the inclusion criteria. Studies employing acupuncture and rehabilitation interventions, alone or in combination, were included. Quality assessment was performed using the JADAD and PEDro scale. Standardized mean differences (SMD) were calculated to quantify the effect sizes. Random and fixed-effects models were applied to analyze the data. Results: The meta-analysis revealed a significant improvement in both spastic paralysis functions and quality of life following acupuncture and rehabilitation interventions. For motor function (19 studies, 1353 participants), the pooled effect size indicated a substantial positive impact (SMD = 1.15, 95% CI: [0.10; 2.20], P < 0.0001). Similarly, there were improvement on hand function (3 studies, SMD = 0.65, 95% CI: [0.19; 1.1], P = 0.006), upper limb function (3 studies, SMD = 0.53, 95% CI: [0.04; 1.03], P = 0.021), and lower limb function (4 studies, SMD = 0.52, 95% CI: [0.31; 0.74], P < 0.0001). For quality of life (20 studies, 1503 participants), the pooled effect size was also significant (SMD = 0.8379, 95% CI: [0.7306; 0.9452], P < 0.0001). The heterogeneity across studies was moderate to high (I^2 = 77.7% for quality of life and I^2 = 88.3% for motor function). While funnel plot analysis suggested potential publication bias for motor function outcomes, sensitivity analyses confirmed the robustness of the quality of life findings. Reported adverse events were generally mild and transient. Conclusion: This meta-analysis provides robust evidence supporting the positive effect of acupuncture and rehabilitation interventions on both spastic paralysis functions and the quality of life among stroke survivors. The findings highlight the potential of these therapies in promoting holistic recovery and underscore the need for their integration into standard post-stroke care protocols. Healthcare providers and policymakers should consider these results in shaping comprehensive rehabilitation strategies for stroke survivors, ultimately fostering improved well-being and long-term outcomes.

Keywords: Stroke, acupuncture, rehabilitation, quality of life, meta-analysis, complementary therapies

Introduction

Stroke-induced hemiplegia, a debilitating consequence of stroke, significantly impacts the quality of life of affected individuals [1, 2]. Hemiplegia, characterized by weakness or paralysis on one side of the body, often leads to a myriad of physical, emotional, and social challenges [3]. As traditional treatment methods have limitations in addressing the complexities of this condition, there has been a growing interest in complementary therapies such as acupuncture [4].

Acupuncture, a key component of traditional Chinese medicine, involves the insertion of thin

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needles into specific points on the body to stimulate energy flow and promote natural healing processes [5]. Over the years, acupuncture has gained recognition for its potential in managing various neurological disorders, including stroke-induced hemiplegia [6, 7]. However, the efficacy of different acupuncture modalities in alleviating symptoms and improving the overall quality of life in these patients remains a topic of extensive research and debate [8].

This comprehensive systematic review and meta-analysis aim to critically evaluate the effectiveness of diverse acupuncture modalities in addressing the symptoms of stroke-induced spastic hemiplegia and enhancing the quality of life for affected individuals. By synthesizing existing evidence from rigorous clinical studies and trials, this review seeks to provide a comprehensive overview of the current state of knowledge in this field.

In this review, we explore various acupuncture techniques, including traditional acupuncture, electroacupuncture, auricular acupuncture, and scalp acupuncture, among others. By analyzing the collective outcomes of these modalities, we aim to identify patterns of effectiveness, potential synergies, and areas for further research. Additionally, we examine the safety profile of these interventions, ensuring a balanced assessment of risks and benefits.

Understanding the impact of acupuncture on symptom relief and quality of life in stroke-induced hemiplegia patients is crucial for optimizing their rehabilitation and recovery journey. By synthesizing the available evidence, this review seeks to provide valuable insights for healthcare professionals, researchers, and policymakers, ultimately contributing to the enhancement of therapeutic approaches and the overall well-being of individuals affected by stroke-induced hemiplegia.

Methods

Literature search

We systematically searched several databases, including Medline, EMBASE, and the Cochrane Central Register of Controlled Trials, using a combination of medical subject headings (MeSH) and relevant keywords. The search terms included “acupuncture”, “stroke-induced spastic hemiplegia”, “hemiparesis”, “quality of life”, and variations of these terms. The search was limited to studies published in English and Chinese from the inception of each database to October 2023. Additionally, for Korean publications, we manually examined 19 traditional medicine journals that were either accredited or under consideration for accreditation by the National Research Foundation of Korea (http://www.nrf.re.kr) to identify relevant articles. The China Integrated Knowledge Resources Database (http://www.cnki.net) was also searched for articles in Chinese. Furthermore, a manual search of references from previous systematic reviews was conducted to identify additional relevant studies. Lastly, we searched the international database (https://www.clinicaltrials.gov/) for trial registrations to identify ongoing or recently completed trials.

Study selection criteria

Studies were included if they met the following criteria: Randomized controlled trials (RCTs) and clinical trials investigating the effectiveness of various acupuncture modalities in stroke-induced hemiplegia patients. Studies assessing symptom relief, functional improvement, or quality of life as primary or secondary outcomes. Studies with clearly defined acupuncture techniques and appropriate control groups. Specifically, we looked for explicit descriptions of the acupuncture protocols used in the intervention groups, including details such as:

1. Acupuncture point selection: We assessed whether the studies provided clear information on the specific acupuncture points targeted during treatment sessions. This includes the location of acupuncture points on the body and any rationale for their selection based on traditional Chinese medicine principles or previous empirical evidence.

2. Needling technique: We examined whether the studies described the needling techniques employed, such as depth of needle insertion, manipulation methods (e.g., manual rotation, twirling, or lifting-thrusting), and duration of needle retention.

3. Treatment frequency and duration: We evaluated whether the studies provided clear information on the frequency and duration of acu-

puncture sessions. This includes details on the number of treatment sessions per week, total treatment duration, and any variations in treatment schedules across study groups.

4. Adjunctive interventions: We assessed whether the studies reported any additional interventions or modalities used in conjunction with acupuncture, such as electroacupuncture, moxibustion, or cupping therapy, and how they were integrated into the overall treatment protocol.

Data extraction

Two independent reviewers extracted data from selected studies, including study design, participant characteristics, acupuncture modalities used, treatment duration, control interventions, primary and secondary outcomes, and adverse events. Any discrepancies were resolved through consensus or consultation with a third reviewer.

Quality assessment

The methodological quality of included studies was assessed using established tools, such as the JADAD score for RCTs and PEDro scale. The JADAD scale, a widely used tool for assessing the methodological quality of clinical trials, comprises three items. Each item contributes one point to the overall score, with a higher score indicating better methodological quality. Also, the PEDro scale is a widely utilized tool for evaluating the methodological quality of randomized controlled trials in physiotherapy and rehabilitation research. It consists of 11 items, with the first item focusing on external validity (not contributing to the total score), while the remaining 10 items gauge the study's internal validity. A higher score indicates a greater risk of bias, categorized as follows: 9-10: excellent; 6-8: good; 4-5: fair; < 4: poor. Studies were evaluated for randomization methods, allocation concealment, blinding, selective reporting, and other potential biases.

Statistical analysis

Quantitative data, including mean differences and 95% confidence intervals, were calculated for relevant outcome measures across studies. Effect estimates were expressed as standardized mean differences (SMDs) with corresponding 95% confidence intervals (CIs). Inter-study heterogeneity was assessed using Cochran's Q test and the I^2 statistic; a *P*-value of less than 0.1 or an I^2 value exceeding 50% indicated significant heterogeneity among the included studies. Subgroup analyses were conducted to detect sources of heterogeneity based on moderator variables, including the method of intervention (EA vs. EA plus RT vs. MA vs. MA plus RT) and intervention duration (≤ 4 weeks vs. > 4 weeks). In addition, sensitivity analyses were conducted using the leave-out-method to assess the impact of each study on the pooled effect size. The evidence of publication bias was evaluated using Egger's regression test and a funnel plot, both statistically and visually. All statistical analyses were performed using STATA software version 12.0 (Stata Corp., College Station, TX) and RevMan V.5.3 software (Cochrane Collaboration, Oxford, UK).

Reporting

The findings of this systematic review and meta-analysis are reported following the PRISMA guidelines, ensuring transparency and comprehensiveness in reporting the methodology, results, and conclusions of the studies [9].

Results

Study selection

The initial literature search yielded a total of 1171 relevant studies. After screening titles and abstracts, 73 studies were selected for full-text assessment. Following rigorous inclusion criteria, 30 randomized controlled trials (RCTs) or clinical trials and 3 case-control studies were included in the final meta-analysis. The PRISMA flowchart illustrates the study selection process (**Figure 1**).

Study characteristics

The mean age of participants in the experimental groups (EG) ranged from 51.00 to 67.0 years, with a total sample size of 1136 in the EG and control groups (CG) combined. The interventions varied across studies, including Manual Acupuncture (MA) and Electroacupuncture (EA) combined with Rehabilitation Training (RT). Control groups primarily received RT alone.

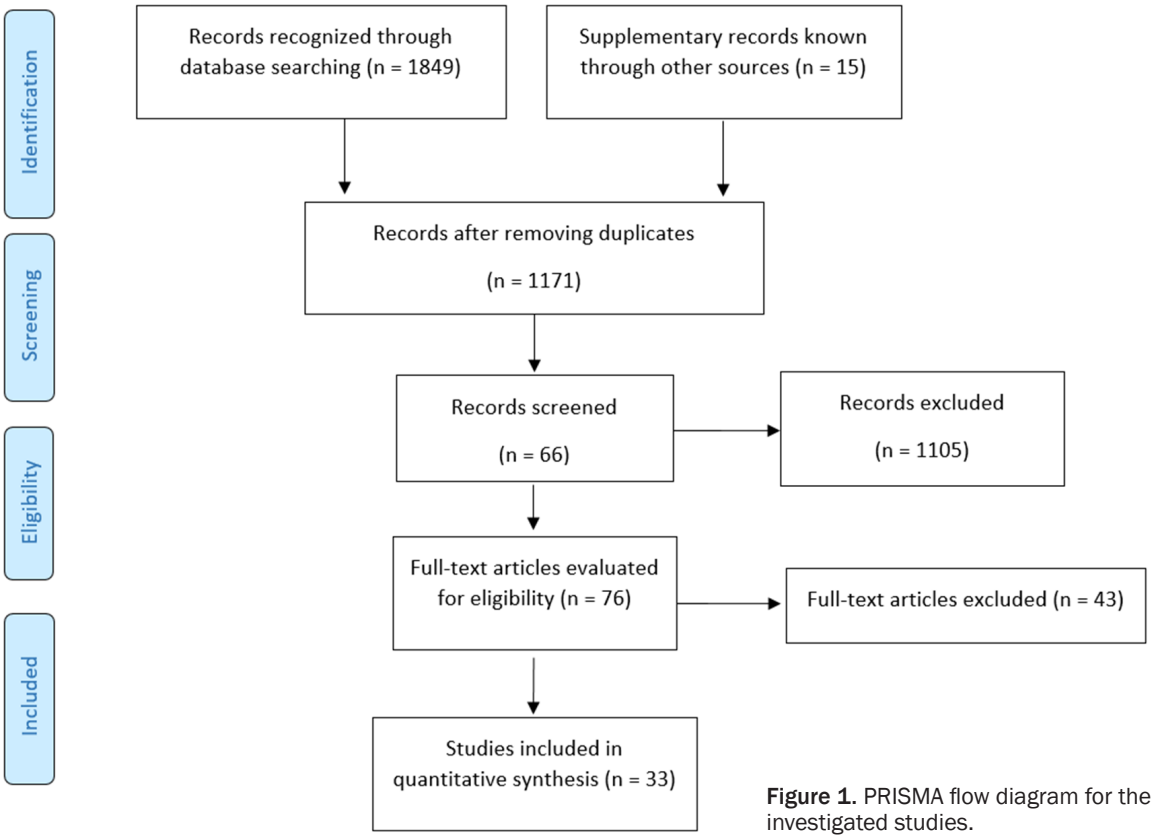

Figure 1. PRISMA flow diagram for the investigated studies.

The duration of interventions in clinical trials varied, ranging from 2 weeks to 12 weeks. **Table 1** provides a summary of the studies included in our analysis, offering valuable insights into the diverse methodologies and interventions employed across these investigations.

Risk of bias within studies

The mean PEDro score among the selected studies was 4.6 points, with scores ranging from 3 to 8 out of a maximum of 10 criteria (**Table 2**). This indicates a fair overall methodological quality across the studies. Notably, none of the studies achieved an excellent score, primarily due to the inherent challenges associated with blinding both therapists and patients in physical therapy settings, which often involves active interventions and direct patient-therapist interactions. Despite these limitations, the included studies demonstrated a reasonable level of methodological rigor in addressing key aspects of study design and execution.

Furthermore, the methodological quality of the included studies was also assessed using the JADAD score and Newcastle-Ottawa Scale (NOS) score for clinical trials and case-control studies. JADAD scores ranged from 2 to 4 across the studies (**Table 1**). The JADAD score provides additional insights into the internal validity of the studies, focusing on factors such as randomization, blinding, and reporting of withdrawals and dropouts. While the JADAD score complements the findings obtained from the PEDro scale, it reaffirms the overall methodological rigor observed in the included studies. As shown in **Table 1**, the methodological quality of observational studies using the NOS score varied between 6 and 7, with higher scores indicating higher quality observational studies.

Outcome measures

Primary outcome measures included changes in spastic paralysis functions, assessed using the Fugl-Meyer Assessment (FMA) [10]. Secondary outcome measures focused on quality-of-life indicator, including Barthel Index (BI)

Table 1. Summary of included studies

Study	Publication Year	Sample Size (EG/CG)	Mean Age (EG/CG)	Method of Intervention	Control	JADAD or NOS scores	Duration
Zhang [44]	2023	20/20	55.95/59.8	MA + RT	RT	4	2 weeks
Nguyen [45]	2023	60/60	-	EA	RT	3	2 weeks
Xu [46]	2022	32/32	65.76/65.31	MA	RT	2	4 weeks
Sui [47]	2021	34/34	51.00/54.40	EA	RT	3	2 weeks
Li [48]	2019	33/33	59.6/59.8	MA + RT	RT	2	4 weeks
Wang [49]	2018	30/30	60/61	MA + RT	RT	2	3 weeks
Tan [50]	2018	44/44	54.78/54.93	MA + RT	RT	3	12 weeks
Hu [51]	2017	30/30	64.2/65.8	EA + RT	RT	3	8 weeks
Lei [52]	2017	39/40	55.1/54.6	EA + RT	RT	2	2 weeks
Xu [53]	2017	30/30	55/61	MA	RT	3	40 days
Xu [54]	2016	36/35	60/65	MA + RT	RT	3	4 weeks
Cheng [55]	2016	60/32	65.76/65.31	MA + RT	RT	2	30 days
Huang [56]	2016	35/71	60.15/57.40	EA + RT	RT	4	4 weeks
Wang [57]	2016	33/32	56.24/55.11	MA	RT	3	4 weeks
Chai [58]	2015	71/71	63.4/62.7	MA	RT	3	4 weeks
Hao [59]	2015	30/29	-	MA + RT	RT	2	2 weeks
Xing [60]	2015	30/30	60.0/62.6	EA + RT	RT	3	30 days
Li [61]	2015	30/30	61.47/65.73	MA	RT	2	3 weeks
Si [62]	2014	30/30	-	MA	RT	3	4 weeks
Yang [63]	2013	40/38	61.42/62.36	MA	RT	4	2 weeks
Yu [64]	2013	32/32	64.80/62.5	MA	RT	3	4 weeks
Lang [65]	2013	47/47	67/64	MA	RT	4	4 weeks
Lu [66]	2013	40/40	61.30/62.10	MA	RT	4	2 weeks
Gu [67]	2013	40/40	-	EA	RT	3	4 weeks
Tong [68]	2013	44/42	69/69	MA + RT	RT	2	4 weeks
Lang [69]	2011	36/42	66.20/63.60	MA	RT	4	4 weeks
Jin [70]	2010	24/22	-	EA	RT	3	4 weeks
Chen [71]	2010	40/40	66.7/67.9	MA + RT	RT	2	8 weeks
Lu [72]	2011	30/30	56.70/56.83	EA + RT	RT	3	4 weeks
Sun [73]	2017	31/30	63.10/63.10	MA	RT	4	4 weeks
Li [74]	2012	60/60		EA	RT	7	12 weeks
Mao [75]	2008	30/30		MA	RT	6	12 weeks
Zhao [76]	2009	67/64		MA	RT	7	4 weeks

scores, which provided valuable insights into patients' ability to perform activities of daily living and their overall functional independence [11].

Meta-analysis results on spastic paralysis functions

In terms of spastic paralysis functions, the meta-analysis included data from 22 studies, comprising a total of 1664 participants. The combined effect size, calculated using a random-effects model, indicated a significant improvement in spastic paralysis functions in stroke patients following acupuncture and rehabilitation interventions on motor function (Standardized Mean Difference [SMD] = 1.15, 95% CI [0.10; 2.20], P < 0.0001), hand function (SMD = 0.65, 95% CI: [0.19; 1.1], P = 0.006), upper limb function (SMD = 0.53, 95% CI: [0.04; 1.03], P = 0.021), and lower limb function (SMD = 0.52, 95% CI: [0.31; 0.74], P < 0.0001). **Figure 2A-D** present the effect sizes and corresponding 95% confidence intervals (CI) for each study included in the meta-analysis.

Table 2. PEDro scale scores for acupuncture studies on post-stroke hemiplegia

Author (Year)	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Total Score
Zhang (2023)	Yes (1)	Yes (1)	No (0)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	8
Duc Nguyen (2023)	Yes (1)	Yes (1)	No (0)	Yes (1)	No (0)	Yes (1)	No (0)	Yes (1)	Yes (1)	No (0)	No (0)	6
Xu L (2022)	Yes (1)	Yes (1)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	8
Sui M (2021)	Yes (1)	Yes (1)	Yes (1)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	7
Li ZW (2019)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	5
Wang (2018)	Yes (1)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	No (0)	4
Tan SH (2018)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	No (0)	3
Hu DY (2017)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	No (0)	3
Lei B (2017)	Yes (1)	Yes (1)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	8
Xu L (2017)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	7
Xu S (2016)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	5
Cheng (2016)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Huang (2016)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	5
Wang (2016)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	5
Chai (2015)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Hao (2015)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Xing (2015)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Li JX (2015)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Si SL (2014)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Yang (2013)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Yu (2013)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Lang (2013)	Yes (1)	Yes (1)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	8
Lu (2013)	Yes (1)	Yes (1)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	Yes (1)	Yes (1)	8
Gu (2013)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	5
Tong (2013)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	5
Lang (2011)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Jin (2010)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Chen (2010)	Yes (1)	No (0)	No (0)	Yes (1)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	5
Lu (2011)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4
Sun (2017)	Yes (1)	No (0)	No (0)	No (0)	No (0)	No (0)	No (0)	Yes (1)	Yes (1)	No (0)	Yes (1)	4

In the PEDro scale, the items are typically scored as follows: 1. Eligibility criteria were specified (Yes/No). 2. Subjects were randomly allocated to groups (Yes/No). 3. Allocation was concealed (Yes/No). 4. The groups were similar at baseline regarding the most important prognostic indicators (Yes/No). 5. There was blinding of all subjects (Yes/No). 6. There was blinding of all therapists who administered the therapy (Yes/No). 7. There was blinding of all assessors who measured at least one key outcome (Yes/No). 8. Measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups (Yes/No). 9. All subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by "intention to treat" (Yes/No). 10. The results of between-group statistical comparisons are reported for at least one key outcome (Yes/No). 11. The study provides both point measures and measures of variability for at least one key outcome (Yes/No).

Due to significant heterogeneity across studies, subgroup analyses were conducted based on moderator variables, including the method of intervention (EA vs. EA plus RT vs. MA vs. MA plus RT) and intervention duration (≤ 4 weeks vs. > 4 weeks). Due to lower number of included studies for hand function, upper limb function, and lower limb function, subgroup analyses could only be performed for motor function outcome.

The findings of subgroup analysis on motor function revealed that studies employing MA (number of studies = 9, SMD = 0.657, 95% CI: 0.195 to 1.118) and EA (number of studies = 1, SMD = 0.780, 95% CI: 0.329 to 1.230) interventions demonstrated statistically significant effects when compared to other groups, such as EA plus RT (number of studies = 3, SMD = 0.647, 95% CI: -0.206 to 1.500) and MA plus RT (number of studies = 6, SMD = 2.404, 95% CI: -1.875 to 6.683). In the subgroup analysis based on intervention duration, the results for studies with ≤ 4 weeks (number of studies = 16, SMD = 1.150, 95% CI: -0.143 to 2.443) and for studies with > 4 weeks (number of studies = 3, SMD = 1.251, 95% CI: -0.008 to 2.510) were not statistically significant.

Sensitivity analyses using the leave-one-out method showed that excluding each study for motor function and lower limb function resulted in consistent pooled SMDs, indicating robustness. For hand function and upper limb function, after excluding studies conducted by Nguyen et al. (SMD = 0.62, 95% CI: -0.17, 1.41)

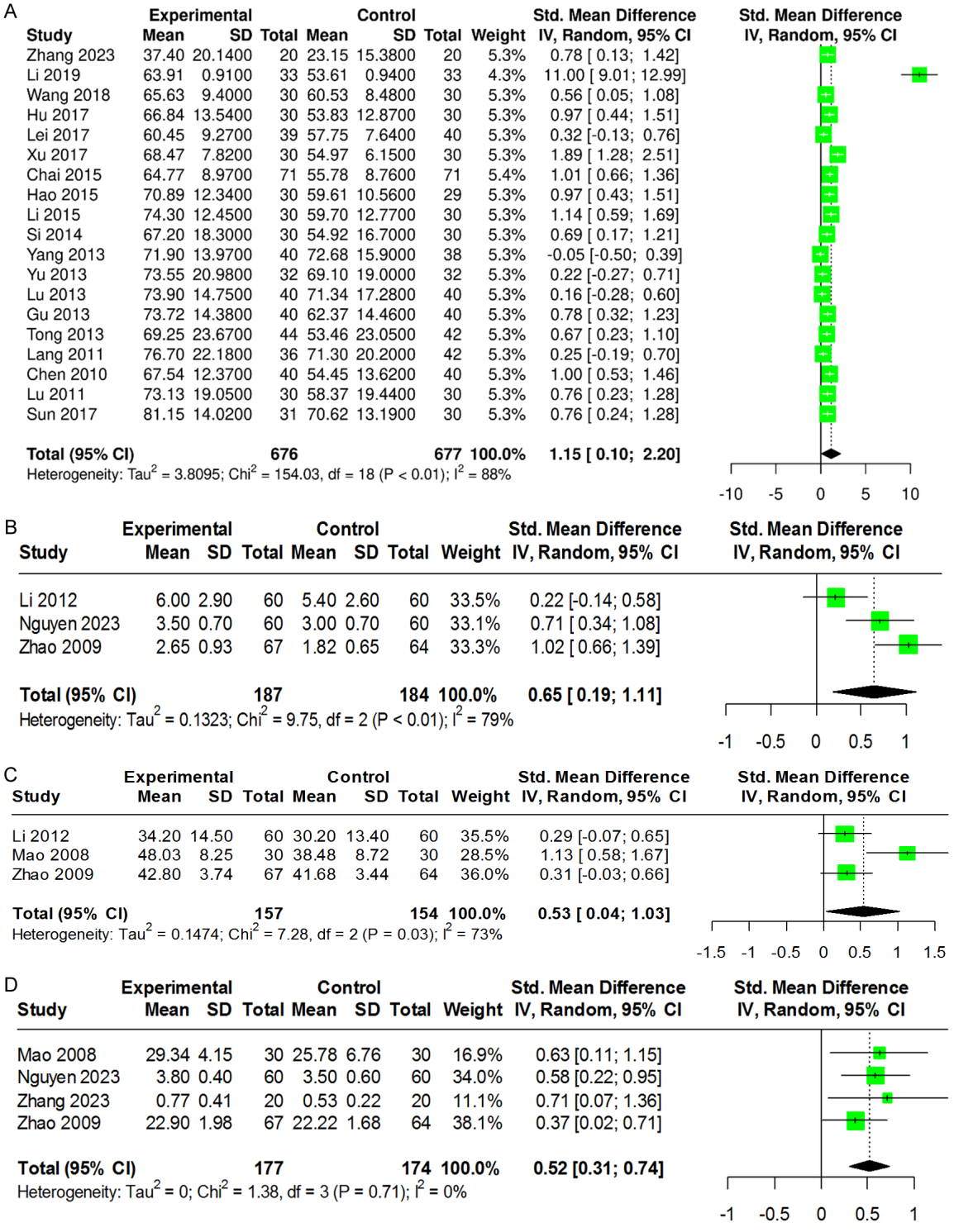

Figure 2. The forest plot for (A) FMA, (B) hand function, (C) upper limb function, and (D) lower limb function meta-analysis.

and Zhao et al. (SMD = 0.67, 95% CI: -0.14, 1.48) the pooled SMDs were changed, respectively (**Figure 3A-D**).

The funnel plot, which assesses publication bias, suggested some asymmetry, leading to an Egger's regression test (t = 4.73, df = 17, P =

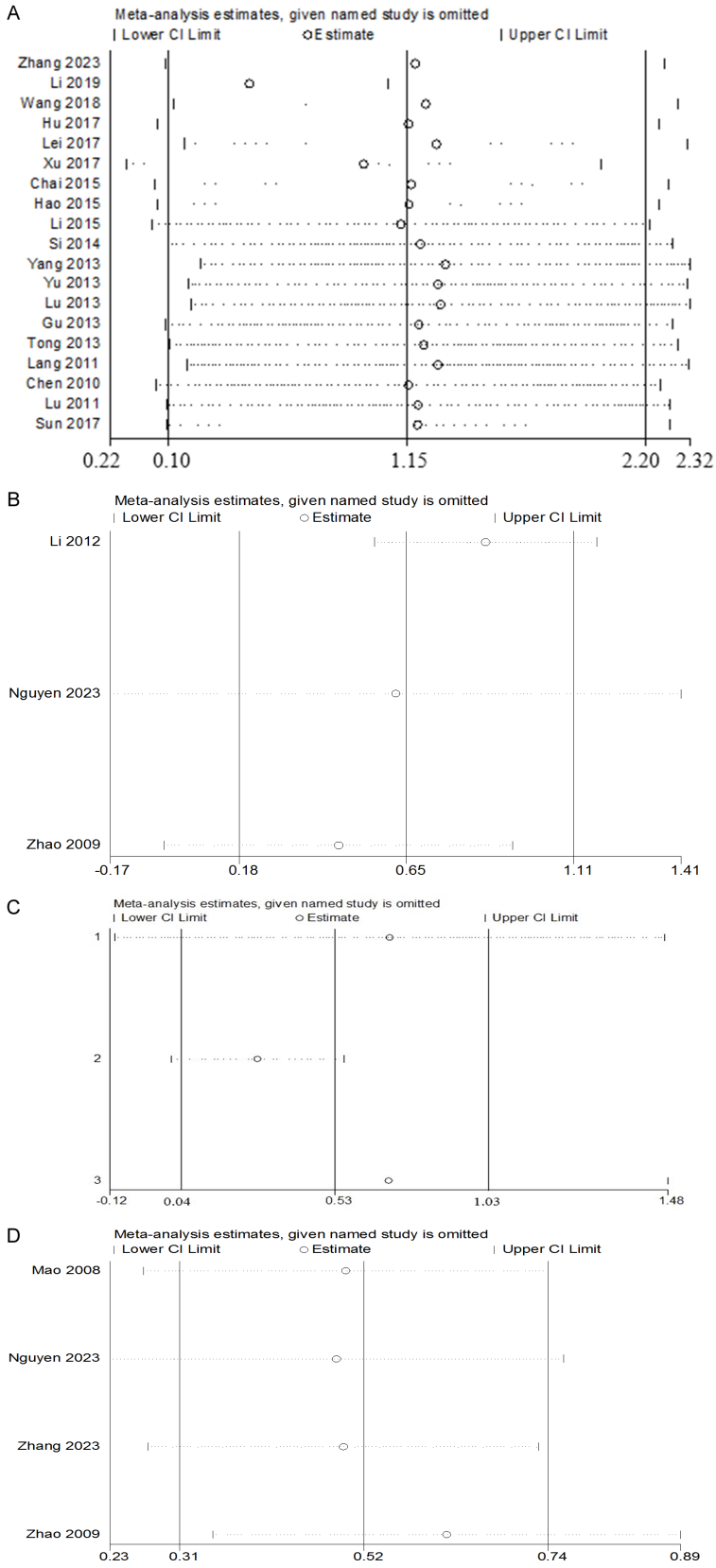

Figure 3. The sensitivity analysis results for (A) Fugl-Meyer assessment (FMA), (B) hand function, (C) upper limb function, and (D) lower limb function meta-analysis.

0.0002). This result indicated potential publication bias in the smaller studies, emphasizing the need for caution when interpreting the findings (**Figure 4A**). Due to less than 10 studies on other spastic paralysis functions, based on Cochrane handbook, we did not assessment for potential publication bias.

Meta-analysis results on quality-of-life measures

In terms of quality-of-life measures, the meta-analysis of 20 studies, encompassing 1503 participants, revealed a significant improvement in the quality of life among stroke patients undergoing acupuncture and rehabilitation interventions. The pooled effect size, computed using a random-effects model, demonstrated a significant effect (number of studies = 20, SMD = 0.83, 95% CI [0.60; 1.07], P < 0.0001), suggesting consistency in the improvement across different studies. However, the test of heterogeneity (Q = 85.20, df = 19, P < 0.0001) indicated some degree of variability among the included studies (**Figure 5**).

Quantifying the heterogeneity, the analysis revealed a moderate level of inconsistency (I^2 = 77.7%, τ^2 = 0.1969), suggesting potential differences in the intervention methods or patient populations across studies. In the subgroup analyses for quality-of-life outcomes, the findings indicated that studies employing EA plus RT (number of studies = 4, SMD = 0.505, 95% CI: 0.049 to 0.961), MA (number of studies = 7, SMD = 0.759, 95% CI: 0.287 to 1.232), and MA plus RT (number of studies = 7,

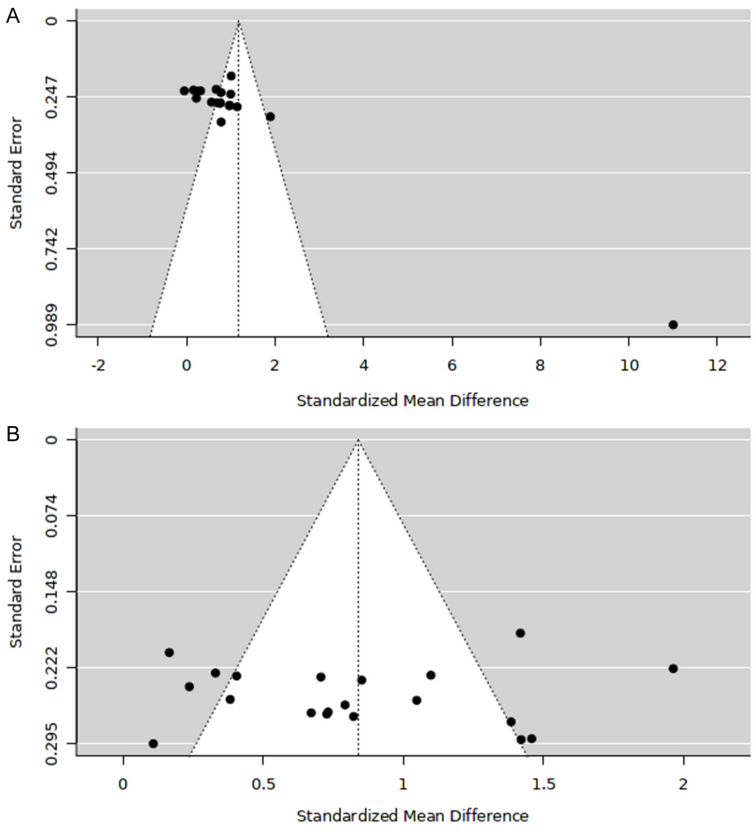

Figure 4. Funnel plot for meta-analysis of (A) Fugl-Meyer assessment (FMA) and (B) quality-of-life.

SMD = 1.209, 95% CI: 0.806 to 1.611) interventions demonstrated statistically significant effects compared to other groups, such as EA (number of studies = 2, SMD = 0.434, 95% CI: -3.353 to 4.220). In the subgroup analysis based on intervention duration, the results remained significant for studies with ≤ 4 weeks (number of studies = 16, SMD = 0.782, 95% CI: 0.494 to 1.069) and for those with > 4 weeks (number of studies = 4, SMD = 1.039, 95% CI: 0.600 to 1.479).

Sensitivity analysis showed that pooled results of motor function are not sensitive to removing any of included studies. However, the higher and lower pooled SMD of outcome are presented in **Figure 6**.

The funnel plot, assessing publication bias, did not display significant asymmetry, as confirmed by the Egger's regression test (t = -0.15, df = 18, P = 0.8817). These results imply that publication bias was not a major concern in this meta-analysis (**Figure 4B**).

Adverse events

The reported adverse events related to acupuncture interventions were generally mild and transient, including localized pain at the needle insertion site and occasional bruising. No serious adverse events were documented in the analyzed studies.

Discussion

The comprehensive meta-analysis conducted in this study evaluated the effectiveness of acupuncture in enhancing the quality of life among stroke survivors. The findings underscore the significant positive impact of these interventions not only on physical health but also on the psychosocial aspects contributing to the overall well-being of patients' post-stroke, encompassing factors such as emotional resilience, social integration, and sense of purpose.

The meta-analysis demonstrates a substantial improvement in the quality of life among stroke survivors receiving acupuncture and rehabilitation interventions. In our investigation, rehabilitation interventions encompassed a broad spectrum of therapeutic modalities aimed at addressing the multifaceted needs of individuals with post-stroke spastic hemiplegia as routine intervention in both groups of the analyzed studies. While we primarily focused on the effectiveness of acupuncture modalities in improving symptom relief and quality of life among stroke survivors, it is essential to provide clarity on the rehabilitation components involved.

The rehabilitation interventions included in the studies analyzed varied across trials but commonly incorporated standard physiotherapy and occupational therapy techniques. These interventions were designed to target specific impairments, such as muscle weakness, spasticity, limited range of motion, and functional limitations, commonly observed in individuals

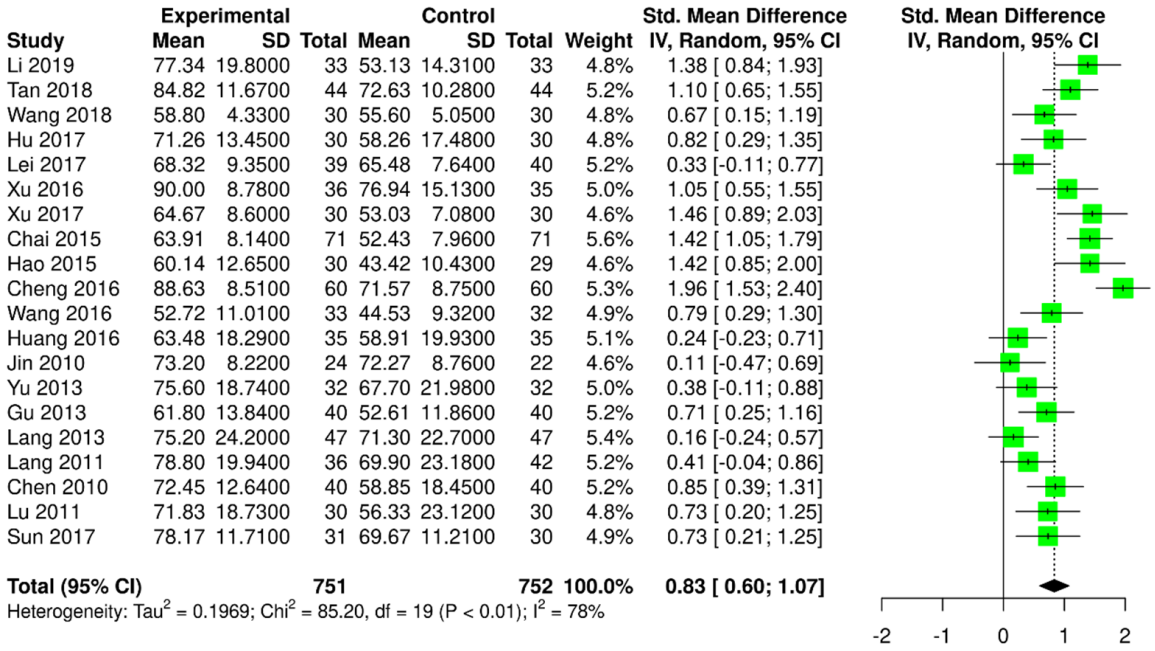

Figure 5. The forest plot for quality-of-life meta-analysis.

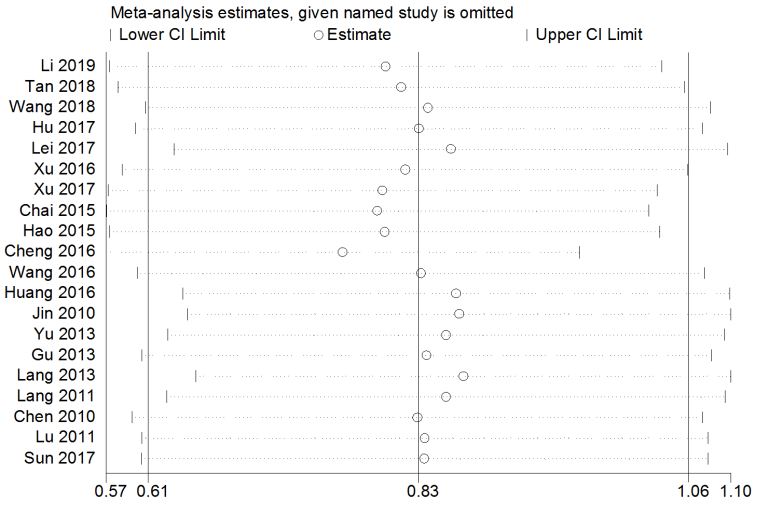

Figure 6. The sensitivity analysis results for quality-of-life meta-analysis.

with post-stroke hemiplegia. Similar to our findings, a review by Shahid et al. (2023) emphasized the importance of comprehensive rehabilitation programs in addressing various post-stroke impairments, including those mentioned above [12].

While our study did not specifically investigate in-patient rehabilitation therapy or subsequent ambulatory care rehabilitation following acute inpatient rehabilitation courses, we acknowledge the importance of these comprehensive approaches in stroke rehabilitation. A study by Oyanagi et al. (2021) highlights the benefits of early intensive rehabilitation in improving functional outcomes after stroke, supporting the integration of both inpatient and outpatient rehabilitation services [13].

Additionally, various modalities were implemented as part of the rehabilitation courses included in the analyzed studies. These modalities may have included but were not limited to stretching exercises, therapeutic exercises, gait training, functional electrical stimulation, and constraint-induced movement therapy. Each modality was tailored to the individual needs of the participants and aimed at maximizing their rehabilitation potential.

The results of our study are consistent with previous research, highlighting the holistic benefits of the acupuncture and rehabilitation interventions [14, 15]. The positive effect ob-

served across diverse studies suggests the robustness of this intervention in ameliorating the physical, psychological, and social aspects of life among stroke survivors [15]. A systematic review by Park et al. (2001) also indicates that acupuncture can improve motor recovery and functional independence in stroke patients, which aligns with our findings related to the quality of life [16].

Several mechanisms could explain the observed improvements. Acupuncture, a traditional Chinese medicine practice, is believed to modulate various physiological processes, including pain perception, inflammation, and neuroplasticity [17]. By stimulating specific acupuncture points, the therapy may enhance neural regeneration and connectivity, aiding in motor and cognitive recovery among stroke patients [18]. Additionally, the combination of acupuncture with rehabilitation exercises likely amplifies the therapeutic effects, promoting mobility, muscle strength, and overall functional capacity [19].

Recent studies have suggested that acupuncture may influence neuroplasticity by modulating brain-derived neurotrophic factor (BDNF) levels and enhancing synaptic plasticity. Furthermore, acupuncture has demonstrated anti-inflammatory effects, potentially reducing secondary brain damage and promoting recovery after stroke [20, 21].

While the meta-analysis reveals a moderate level of heterogeneity among the included studies, this variability could be attributed to differences in intervention protocols, patient demographics, or the duration of the interventions. Standardizing the treatment protocols and conducting subgroup analyses based on these variables could provide a nuanced understanding of the interventions' effectiveness in specific patient populations.

Acupuncture has emerged as a promising therapeutic avenue, prompting a deeper exploration into novel techniques, personalized interventions, and long-term outcomes that extend beyond the purview of existing meta-analyses [22]. These endeavors aim to enrich our understanding of acupuncture's potential and its application in diverse clinical contexts.

Novel techniques such as electroacupuncture, laser acupuncture, and auricular acupuncture offer intriguing possibilities [23]. Electroacupuncture, for instance, warrants investigation into various parameters like frequency, intensity, and duration of electrical stimulation in conjunction with acupuncture needles [24]. Similarly, laser acupuncture presents an avenue for research on efficacy and safety, comparing its outcomes with traditional needle acupuncture across a spectrum of health conditions [25]. Auricular acupuncture, focusing on stimulating specific points on the ear, holds promise for conditions ranging from pain management to addiction treatment, necessitating tailored protocols and anatomical/physiological elucidation [26].

Personalized interventions underscore the importance of patient stratification based on biomarkers or genetic markers associated with acupuncture response [27]. Advanced techniques like genomics, proteomics, or metabolomics could pave the way for predictive models guiding personalized treatment selection. Integrative approaches, combining acupuncture with other therapies like herbal medicine or physical therapy, highlight the synergistic effects and optimal treatment combinations tailored to individual patient needs [28].

Long-term outcome assessments are crucial for understanding the sustained effects of acupuncture beyond short-term observations. These include longitudinal studies with extended follow-up periods, comparative effectiveness research against standard treatments, and real-world effectiveness evaluations in diverse populations and healthcare settings.

Mechanistic studies delve into the underlying neurobiological mechanisms, immunomodulatory effects, and psychophysiological responses triggered by acupuncture. These investigations leverage neuroimaging techniques, immunological assays, and psychophysiological assessments to unravel acupuncture's impact on pain processing, immune system function, and stress-related biomarkers [29]. Functional MRI studies, for example, have demonstrated that acupuncture can modulate activity in brain regions associated with pain processing and motor control, providing insight into its potential mechanisms of action [30-32].

Health economics and implementation science aim to assess the economic implications of integrating acupuncture into healthcare systems and to identify barriers and facilitators for its adoption in clinical practice. These efforts include cost-effectiveness analyses, implementation strategies, and health policy research to promote evidence-based policies supporting acupuncture's integration into mainstream healthcare delivery.

Limitations and future directions

It is essential to acknowledge the limitations of this meta-analysis. The quality of included studies, although assessed through JADAD scores, varied, potentially influencing the overall effect size. While the JADAD score complements the findings obtained from the PEDro scale, it reaffirms the overall methodological rigor observed in the included studies. However, it is important to acknowledge the limitations inherent in blinding in studies involving physical therapy interventions, as complete blinding may not always be feasible or practical. Nonetheless, the consistent application of rigorous methodological standards across the included studies enhances the credibility and reliability of the findings derived from this systematic review and meta-analysis. In addressing the limitations and future directions of this meta-analysis, it is important to delve deeper into the nuances of acupuncture and rehabilitation interventions in stroke recovery. While our study focused on evaluating the overall effectiveness of these interventions, it is essential to acknowledge the heterogeneity in study quality and outcome measures, as well as potential sources of bias that may have influenced our findings [33, 34].

Another important limitation of our study is the predominantly Chinese study population included in the synthesis, which may limit the generalizability of our findings to a more diverse global population. As acupuncture is deeply rooted in Chinese traditional medicine, its practice and application may vary across different cultural and geographical contexts [35]. Consequently, the efficacy and outcomes of acupuncture interventions observed in Chinese populations may not fully translate to other ethnic or cultural groups [36, 37].

This limitation has potential implications for the applicability of our results in clinical practice. Healthcare providers and policymakers should exercise caution when extrapolating the findings of our study to populations outside of China. The cultural, social, and environmental factors that influence the response to acupuncture treatments may differ among diverse populations, necessitating tailored approaches to patient care [38].

To address this limitation and enhance the validity of our findings, further research involving more diverse populations is warranted. Future studies should aim to include participants from various ethnic and cultural backgrounds to better understand the efficacy, safety, and acceptability of acupuncture interventions across different populations. By conducting multicenter studies with larger and more diverse samples, researchers can generate robust evidence that informs clinical decision-making and improves patient outcomes.

To further advance the field, future research should aim to elucidate the specific components of acupuncture and rehabilitation interventions that contribute to the observed improvements in stroke survivors [39]. For instance, studies could explore the optimal timing, frequency, and duration of acupuncture sessions, as well as the integration of specific rehabilitation modalities such as constraint-induced movement therapy or virtual reality-based interventions.

Moreover, investigating the long-term effects of these therapies on various domains of quality of life, including emotional well-being and social participation, would provide a more comprehensive understanding of their impact on stroke survivors' overall recovery trajectory. This could involve longitudinal studies with extended follow-up periods to assess sustained improvements and identify potential predictors of long-term outcomes [40, 41].

Furthermore, integrating qualitative research methods such as interviews or focus groups could provide valuable insights into patients' experiences and perceptions of acupuncture and rehabilitation interventions, shedding light on factors that contribute to their effectiveness and acceptability [42, 43]. In terms of clinical implications, the positive outcomes of this

meta-analysis underscore the importance of integrating acupuncture into standard care protocols for stroke survivors. However, it is imperative for healthcare providers to consider individual patient preferences, needs, and clinical characteristics when implementing these interventions, to ensure personalized and patient-centered care. By addressing these areas of inquiry and consideration, future research endeavors can contribute to refining and optimizing the delivery of acupuncture in stroke rehabilitation, ultimately enhancing the quality of life and overall well-being of stroke survivors.

Conclusion

In conclusion, this meta-analysis consolidates existing evidence and reaffirms the positive impact of acupuncture and rehabilitation interventions on the quality of life among stroke survivors. Despite the heterogeneity observed in the studies, the consistent improvement across various domains of quality of life emphasizes the potential of these interventions. As stroke continues to be a leading cause of long-term disability globally, embracing multidisciplinary approaches like acupuncture and rehabilitation can significantly enhance the lives of stroke survivors, fostering a more comprehensive and sustained recovery.

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Disclosure of conflict of interest

None.

Address correspondence to: Min Ye, Department of Rehabilitation Medicine, No. 926 Hospital, Joint Logistics Support Force of PLA, Kaiyuan 661600, Yunnan, China. E-mail: yemin198609@outlook.com; Yemin19860919@163.com

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