Heliyon 10 (2024) e30522

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Acupuncture for cognitive impairment after stroke: A systematic review and meta-analysis

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ARTICLE INFO

Keywords:
acupuncture
Stroke
Cognitive impairment
Meta-analysis
Systematic review

ABSTRACT

Objective: Acupuncture as an alternative therapy for post-stroke cognitive impairment (PSCI) has emerged as a research focus. The inclusion of additional external treatments in many previous studies prevents a clear, direct assessment of acupuncture's impact on PSCI. In order to prevent patients from developing hypersensitivity to other treatments and misinterpreting acupuncture's true therapeutic value, this study establish stricter intervention criteria and exclude therapies beyond acupuncture. The review aimed to offering a clearer evaluation of acupuncture's efficacy and safety in PSCI treatment.
Methods: This research involved a comprehensive search for randomized controlled trials (RCTs) across eight databases, adhering to the Cochrane Systematic Reviewer's Handbook 5.1.0 for risk-of-bias and quality assessments. A meta-analysis was conducted using RevMan 5.3 software.
Results: The inclusion of 18 publications, totaling 1361 patients, was achieved. The meta-analysis demonstrated a significantly higher overall efficacy of acupuncture for PSCI compared to controls (OR = 4.06, 95 % CI 2.86–5.76, Z = 7.82). Notable statistical differences were observed in the Montreal Cognitive Assessment scores (MD = 2.32, 95 % CI 1.68–2.97, Z = 7.10) and the Mini-Mental State Examination scores (MD = 2.02, 95 % CI 1.06–2.98, Z = 4.13) between the groups. Improvements in the Barthel Index scores were noted for the experimental group (MD = 5.70, 95 % CI 4.68–6.72, Z = 10.92).
Conclusion: Integrating acupuncture with Western medications offers significant benefits for treating PSCI over Western medications alone. However, the long-term efficacy of acupuncture in PSCI treatment and its potential in reducing recurrence rates remain undetermined. Further high-standard RCTs are essential to explore acupuncture's effectiveness in PSCI treatment more thoroughly.

1. Introduction

Stroke is a prevalent condition among middle-aged and elderly individuals worldwide, leading to significant morbidity and mortality in adults and representing a considerable threat to public health. The incidence of stroke varies internationally, with China experiencing the highest rates, currently facing the greatest lifetime risk and disease burden from stroke, with these figures increasing rapidly [1–3]. Poststroke cognitive impairment (PSCI) is identified as a clinical syndrome marked by cognitive deficits following a

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https://doi.org/10.1016/j.heliyon.2024.e30522
Received 13 June 2023; Received in revised form 28 April 2024; Accepted 29 April 2024
Available online 1 May 2024

stroke, persisting for up to six months [4]. PSCI significantly reduces patients' quality of life by impairing cognitive functions such as attention and memory, and reducing independence in daily activities, thereby imposing substantial burdens on families, societies, andnations. According to the 2020 China Stroke Report, approximately one-third of stroke survivors suffer from PSCI [5]. Numerous prospective cohort studies have observed cognitive decline post-stroke [6], with about 24.4 % of even mild stroke patients developing dementia within three years [7]. Thus, early detection and intervention for PSCI are critical, making effective treatment strategies a major focus of international stroke research and clinical efforts.

Current PSCI management encompasses pharmacological and non-pharmacological approaches [6,8]. Key pharmacological treatments include cholinesterase inhibitors (donepezil, carboplatin, galantamine), calcium antagonists (nimodipine), Ginkgo Biloba Extract, N-methyl-D-aspartate receptor antagonists, and methylcobalamin [9]. While these medications may alleviate symptoms or decelerate disease progression, their long-term use is associated with severe side effects, including hepatic and renal toxicity, and gastrointestinal issues [10]. Non-pharmacological interventions, such as cognitive rehabilitation training, physical therapy (including hyperbaric oxygen, repetitive transcranial magnetic stimulation, ultrashort wave therapy), and exercise therapy, are also employed [11]. However, the high costs and side effects of these treatments often lead to poor patient compliance.

Acupuncture, a hallmark of Traditional Chinese Medicine (TCM), boasts amillennia-long history and significantly contributes to health protection [12]. China as a leading nation in acupuncture practice, integrating this therapy across various clinical disciplines has positioned its growing global acceptance. In Western nations, TCM is regarded as an alternative medical system, with acupuncture gaining traction particularly among stroke patients [13]. Acupuncture involves the insertion of metal needles into specific body points to modulate meridian flows, thus restoring the balance of yin and yang, enhancing qi and blood circulation, and ultimately aiming at disease treatment. An increasing body of basic research [14–16] supports acupuncture's mechanism in ameliorating cognitive deficits, with randomized controlled trials (RCTs) [17,18] indicating its beneficial effects on cognitive functions and daily living capabilities in PSCI patients. However, the quality of evidence from systematic reviews (SRs) and meta-analyses (MAs) regarding acupuncture as a sole external intervention for PSCI remains uncertain.

This study, a systematic review and meta-analysis, aims to evaluate the clinical efficacy and safety of acupuncture as a supplementary treatment alongsidemodern medicine for PSCI. Given the common inclusion of various non-pharmacological therapies in studies, distinguishing the specific contributions of acupuncture from other treatments poses a challenge. This research adopted prevent patient hypersensitivity to multiple treatments and misinterpretation of acupuncture's true therapeutic value by establishing stringent criteria for interventions, it focuses on clinical effectiveness and the MoCA score, MMSE score, Barthel score as primary observational indices, and adverse reactions as secondary indices,to assess acupuncture's impact on PSCI treatment more directly. This approach will provide more valuable justification for acupuncture's role in enhancing treatment outcomes, reducing adverse effects, and lowering recurrence rates in PSCI management.

2. Materials and methods

2.1. Protocol register

[PROSPERO], identifier [NO. CRD42023413727].

2.2. Search strategy

The following eight electronic databases were searched for relevant RCTs published from beginning to May 1, 2023: Cochrane Library, PubMed, Embase, Web of Science, China National Knowledge Infrastructure (CNKI), Chinese Biomedical Literature Database (CBM), VIP Chinese periodical service platform and Wanfang data knowledge service platform. We used a combination of subject words and free words without language restriction, including "Stroke", "Post Stroke", "Apoplexy", "Cerebrovascular Accident", "Brain Vascular Accident", "Cognitive Dysfunction", "Cognitive Impairment", "Cognitive Disorder", "Cognitive Decline", "Mental Deterioration", "Acupuncture", "Acupuncture therapy", "Acupuncture Treatment", "Scalp Acupuncture", "Warm Acupuncture", "Electro-acupuncture", "Ear Acupuncture", "Eye Needles", "Body Acupuncture", "Fire Needles", etc.

The detailed retrieval strategy is presented in the Supplementary document.

3. Literature inclusion and exclusion criteria

3.1. Literature inclusion criteria

We formulated inclusion criteria based on the principles of PICOS, and literature was included only if it met any of the following criteria: (1) study type: literature on clinical randomized controlled trial (RCT) studies of acupuncture combined with western medicines for PSCI retrieved from the above database. (2) study subjects: conforming to the internationally recognized or authoritative diagnostic criteria for PSCI, patient sex, age, and race were not limited, and the baseline conditions of the two groups were comparable. (3) interventions: acupuncture combined with Western medicines in the experimental group, drug therapy alone in the control group, and the same basic treatment in both groups. (4) outcome indicators: Contains at least one of the following indicators: clinical efficacy, cognitive abnormalities assessment scale [Montreal Cognitive Assessment (MoCA), Mini-mental State Examination (MMSE)], and assessment of daily living skills scale [Barthel index (BI)].

3.2. Literature exclusion criteria

Exclusion criteria were as follows: (1) non-RCT studies, such as reviews, case studies, animal studies, and systematic evaluations, etc. (2) repeatedly published or similar-data studies. (3) complete and valid data could not be extracted. (4) did not meet the inclusion criteria.

3.3. Literature screening

The screening process was conducted in duplicate and researchers agreement was assessed before proceeding with data extraction. Two researchers independently and repeatedly read the title, abstract, and full text of the literature and decided whether to include it based on the inclusion criteria. In cases of disagreement, two researchers discussed and resolved the disagreement or a third party decided.

3.4. Data extraction

An electronic database was prepared using Microsoft Excel to input the following extracted information and data from the literature: title, authors, time of publication, selection of study subjects (nadir criteria and diagnostic criteria), patient baseline status, use of randomization methods, interventions, outcome indicators, shedding, and adverse effects.

3.5. Risk of literature bias and quality assessment

The risk of literature bias assessment was adopted from the Cochrane Handbook of Systematic Reviews version 5.1.0. Two researchers independently assessed the literature for risk bias, and if the results were controversial, they discussed and resolved with a third researcher. The assessment levels were "low risk", "high risk", and "unclear risk". Literature quality was evaluated using a modified Jadad quality scoring method. The total RCT score was 1–7, with scores of 4 and above considered high-quality studies and scores of 1–3 considered low-quality studies.

3.6. Statistical analysis

In this study, a meta-analysis of extracted data was performed using RevMan 5.3 software. The ratio of ratios (OR) was used as an effect-scale indicator for dichotomous variables, the mean difference (MD) was used as an effect-scale indicator for continuous variables, and the corresponding confidence interval (CI) of each effect was calculated as 95 %. The appropriate model was selected based on the Q and I^2 tests of the heterogeneity test results of the included studies. If $P \geq 0.10$ and $I^2 < 50$ %, indicating insignificant heterogeneity between studies, a fixed-effects model was adopted for analysis. If $P < 0.10$ and $I^2 \geq 50$ % indicated significant heterogeneity between studies, a random-effects model was adopted for analysis. Methods such as subgroup analysis or sensitivity

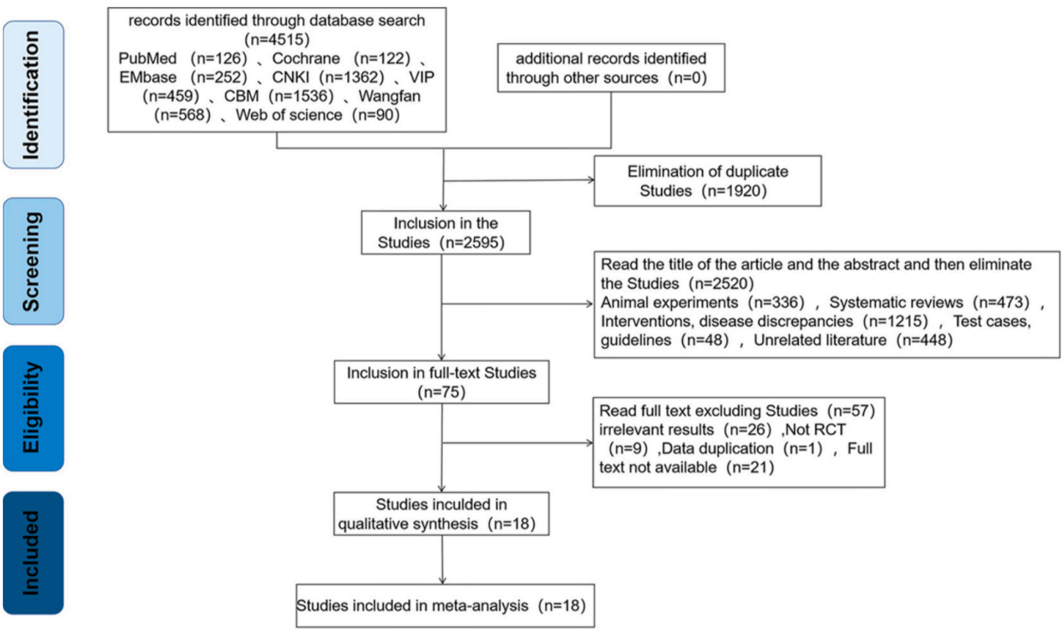

Fig. 1. Flow chart of the literature screening of acupuncture for poststroke cognitive impairment.

Table 1
Basic characteristics of the included literature.

Study	Patients		Ages (yr)		Duration of disease(days/weeks/months)		Intervention		Therapy duration	Outcomes
	Experimental	Control	Experimental	Control	Experimental	Control	Experimental	Control		
Li LC 2019	34	34	63.17 ± 7.84	62.61 ± 7.76	14.48 ± 2.19d	14.41 ± 2.23d	Scalp acupuncture	Nimodipine	3 months	①③⑤
Zheng Q 2014	30	30	68.33 ± 8.33	66.83 ± 8.55	3.10 ± 1.45 m	3.33 ± 1.42 m	Acupuncture	Nimodipine	2 months	①②③⑤
Liu YY 2022	59	59	68.02 ± 5.73	66.18 ± 6.04	7.55 ± 1.89 m	7.09 ± 12.16 m	Acupuncture	Nimodipine	1 month	①②③④
Wu C 2019	40	40	64.05 ± 10.41	62.98 ± 11.41	3.05 ± 0.88d	2.78 ± 1.10d	acupuncture	Nimodipine	1 month	①②③④
Lin F 2013	33	33	60.47 ± 6.82	61.34 ± 6.69	5.51 ± 2.57 m	4.94 ± 2.32 m	Acupuncture	Nimodipine	3 months	①②③⑤
Li W 2010	24	22	68.29 ± 8.30	68.82 ± 7.91	13.33 ± 9.68 mm	12.68 ± 7.82 mm	Acupuncture、electroacupuncture	Nimodipine	3 months	③④
Wang YX 2016	30	30	69.83 ± 4.50	71.05 ± 3.21	3–6 m	3–6 m	Acupuncture	Nimodipine	1 month	①②③④
Bao Y 2012	30	30	63 ± 6	64 ± 6	–	–	Acupuncture	Donepezil	2 months	①②③⑤
Li W 2012	48	46	68.29 ± 8.22	69.22 ± 7.88	13.33 ± 9.58 m	12.26 ± 7.82 m	Acupuncture	Nimodipine	3 months	①③⑤
Liu S 2021	40	40	55.41 ± 4.12	55.67 ± 4.32	2w-6m	2w-6m	Acupuncture	Donepezil	1 month	②③⑤
Wang LF 2018	64	64	69.33 ± 7.56	71.42 ± 8.67	63.34 ± 17.37d	67.57 ± 19.42d	Acupuncture	Nimodipine	2.5 months	②③
Jia L 2022	30	30	62.12 ± 5.52	60.52 ± 6.09	6.45 ± 1.75 m	6.29 ± 1.93 m	Acupuncture	Oxiracetam	2 months	①②④
Yu SF 2022	32	31	59.03 ± 7.65	58.06 ± 7.04	86.81 ± 35.41d	85.81 ± 30.68d	Acupuncture	Oxiracetam	1 month	①②③
Li L 2019	40	40	66.9 ± 5.9	67.4 ± 6.1	89.4 ± 10.3d	90.6 ± 11.4d	Acupuncture	Donepezil	1.5 months	②③
Liu X 2022	33	32	63.58 ± 3.35	63.42 ± 3.56	20.12 ± 6.38 m	20.22 ± 6.55 m	Acupuncture	Oxiracetam	2 months	③⑤
Yu JH 2017	44	44	–	–	–	–	Warm acupuncture	Nimodipine	1.5 months	①②③⑤
Liu YF 2023	32	31	62 ± 5	62 ± 4	4.32 ± 1.36 m	4.34 ± 1.38 m	Scalp acupuncture	Donepezil	2 m + 1 week	①②③④
Wang SH 2016	40	39	65.2 ± 7.1	60.6 ± 6.7	–	–	Acupuncture	Nimodipine	3months	②

①clinical efficacy②MoCA③MMSE④ADL⑤Barthel.

analysis are required to identify the sources of heterogeneity. Statistical significance was indicated by a P value of <0.05; when ≥10 studies were included, funnel plots were used to analyze whether there was publication bias.

4. Results

4.1. Literature search results

The search was conducted according to the search strategy to obtain 4515 relevant studies, and 1920 duplicates were excluded. Based on the inclusion and exclusion criteria, the title, abstract primary screening, and full-text screening were read, and a total of 18 [19–36] studies were finally determined to be included, of which 16 [19–33,35] were in Chinese and 2 [34,36] were in English. The screening process is shown in Fig. 1.

4.2. Basic characteristics of the included literature

The subjects of the 18 included RCTs totaled 1361 cases, including 683 cases in the experimental group and 678 cases in the control group. The baseline status of patients in each study is shown in Table 1.

4.3. Quality evaluation

Risk bias was assessed according to the Cochrane guidelines: 17 studies [19–27,29–36] implemented the correct method of random assignment of subjects, 1 study [28] implemented random assignment in order of admission, 1 study [36] described the allocation concealment, 2 studies [20,36] mentioned implementing double blinding, 5 studies [19,22,29,34,36] mentioned excluding cases, 8 studies [19–22,25,28,30,33] mentioned ethical issues, and 4 studies [19,20,22,36] mentioned follow-up studies. According to the Jadad scale, 1 study [36] scored 7 points, 1 study [20] scored 5 points, 15 studies [19,21–27,29–35] scored 3 points, and 1 study [28] scored 1 point. There were 16 studies with a score of 3 or less and only 2 studies with a score of 4 or higher, indicating that the quality of the relevant literature was low. The methodological quality of the included studies is shown in Fig. 2.

4.4. Meta-analysis results

4.4.1. Clinical efficacy

According to the criteria for assessing the efficacy of the included studies, 'cure', 'significant effect' and 'effective' were considered to be effective treatment responses, and 'ineffective' was considered to be an ineffective treatment response and was converted into dichotomous variable counts. The results of 12 studies [19,21,24–31,34,35] were tested for heterogeneity, thus indicating significant homogeneity among the studies ($I^2 = 0$, $P = 0.99$), therefore, a fixed-effects model was used for statistical analysis. The results showed that the clinical efficacy of the experimental group was significantly better than that of the control group, and the difference was statistically significant (OR = 4.06, 95 % CI: 2.86–5.76, Z = 7.82, $P < 0.00001$) (Fig. 3). This result suggests that cognitive dysfunction was more significantly improved in the experimental group of patients with stroke than in the control group.

4.4.2. MoCA score

14 studies [20,21,24–29,31–36] used the MoCA score as an outcome indicator, and there was statistically high heterogeneity between the results ($I^2 = 85$ %, $P < 0.00001$), therefore, the random-effects model was used for meta-analysis. The analysis showed that the experimental group was better than the control group in improving the MoCA score, with the diamond located on the right side, and the difference was statistically significant (MD = 2.32, 95 % CI 1.68–2.97, Z = 7.10, $P < 0.00001$) (Fig. 4). Subgroup analysis was performed according to the different treatment courses of the included literature (Fig. 5), 5 studies had a 1-month treatment

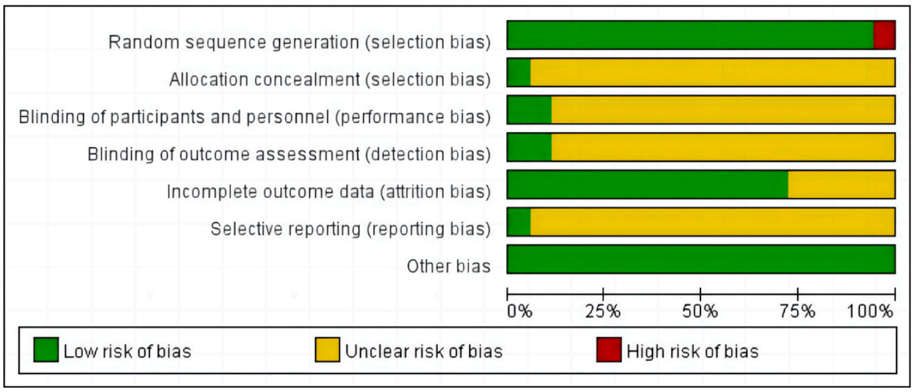

Fig. 2. Methodological quality evaluation of the included literature on acupuncture for poststroke cognitive impairment.

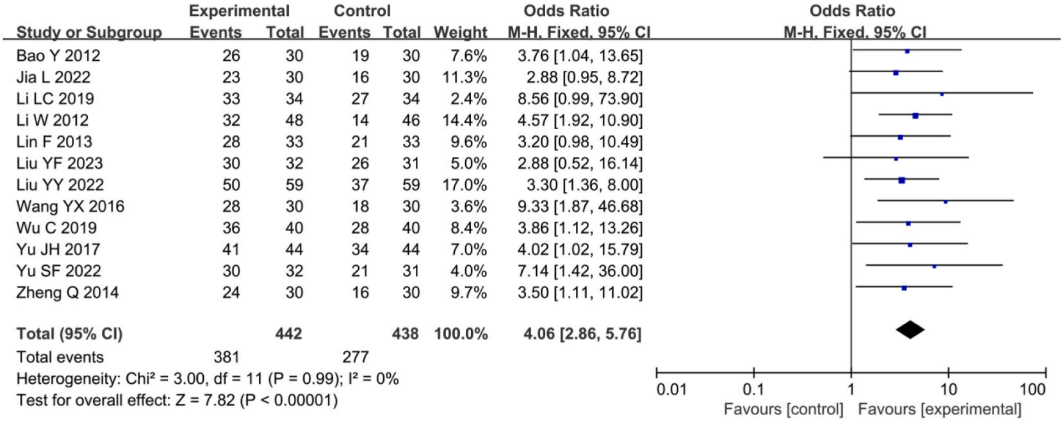

Fig. 3. Forest plot of the meta-analysis of clinical efficacy.

course, and the within-group heterogeneity test result was ($I^2 = 18$ %, $P = 0.30$); 2 studies had a 1.5-months treatment course, and the within-group heterogeneity test result was ($I^2 = 91$ %, $P = 0.001$); 2 studies had a 3-months treatment course, and the within-group heterogeneity test result was ($I^2 = 0$ %, $P = 0.80$). This subgroup analysis significantly reduced the heterogeneity between studies with 1 and 3 months of treatment but increased the heterogeneity in other groups, suggesting that this factor is a cause of heterogeneity.

4.4.3. MMSE score

16 studies [19–34] used the MMSE score as an outcome indicator, and there was statistically significant heterogeneity between the results ($I^2 = 94$ %, $P < 0.00001$), therefore, the random-effects model was used for meta-analysis. The analysis showed that the experimental group was better than the control group in improving the MMSE score, with the diamond located on the right side, and the difference was statistically significant (MD = 2.02, 95 % CI 1.06–2.98, Z = 4.13, $P < 0.0001$) (Fig. 6). Subgroup analysis was performed according to the different treatment courses of the included literature(Fig. 7), 5 studies with a 1-month treatment course, the within-group heterogeneity test suggested ($I^2 = 94$ %, $P < 0.00001$); 2 studies with a 1.5 months treatment course the within-group heterogeneity test suggested ($I^2 = 77$ %, $P = 0.04$); 3 studies with a 2-month treatment course suggested the within-group heterogeneity test ($I^2 = 97$ %, $P < 0.00001$); 4 studies with a 3-months treatment course suggested the within-group heterogeneity test suggested ($I^2 = 45$ %, $P = 0.14$). This subgroup analysis significantly reduced the heterogeneity among studies with a 3-months treatment course, slightly reduced the heterogeneity among studies with a 1.5 months treatment course, and increased the heterogeneity among studies with a 1-month treatment course, suggesting that this factor may be a source of heterogeneity. Since the reduction in heterogeneity was not significant, subgroup analysis was then performed on the differences in the use of cognitive improvement medications in the included literature (Fig. 8). The calcium channel blocker nimodipine was included in a total of 10 studies, and the within-group heterogeneity test result was ($I^2 = 92$ %, $P < 0.00001$); donepezil, a cholinesterase inhibitor, was included in 4 studies, and the within-group heterogeneity test result was ($I^2 = 23$ %, $P = 0.27$); oxiracetam was included in 2 studies, and the within-group heterogeneity test result was ($I^2 = 94$ %, $P < 0.0001$). This subgroup analysis significantly reduced the heterogeneity of cholinesterase inhibitor donepezil drugs across studies and failed to reduce heterogeneity between other groups, suggesting that this factor may also contribute to the heterogeneity.

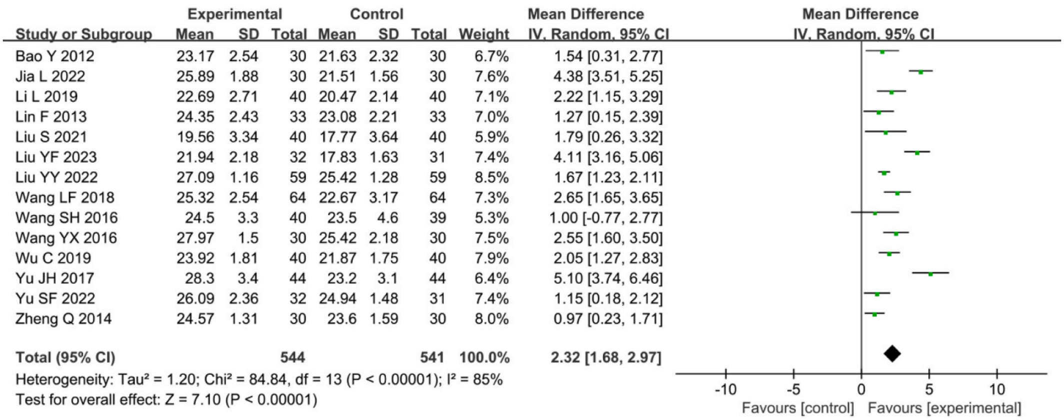

Fig. 4. Meta forest plot of MoCA score.

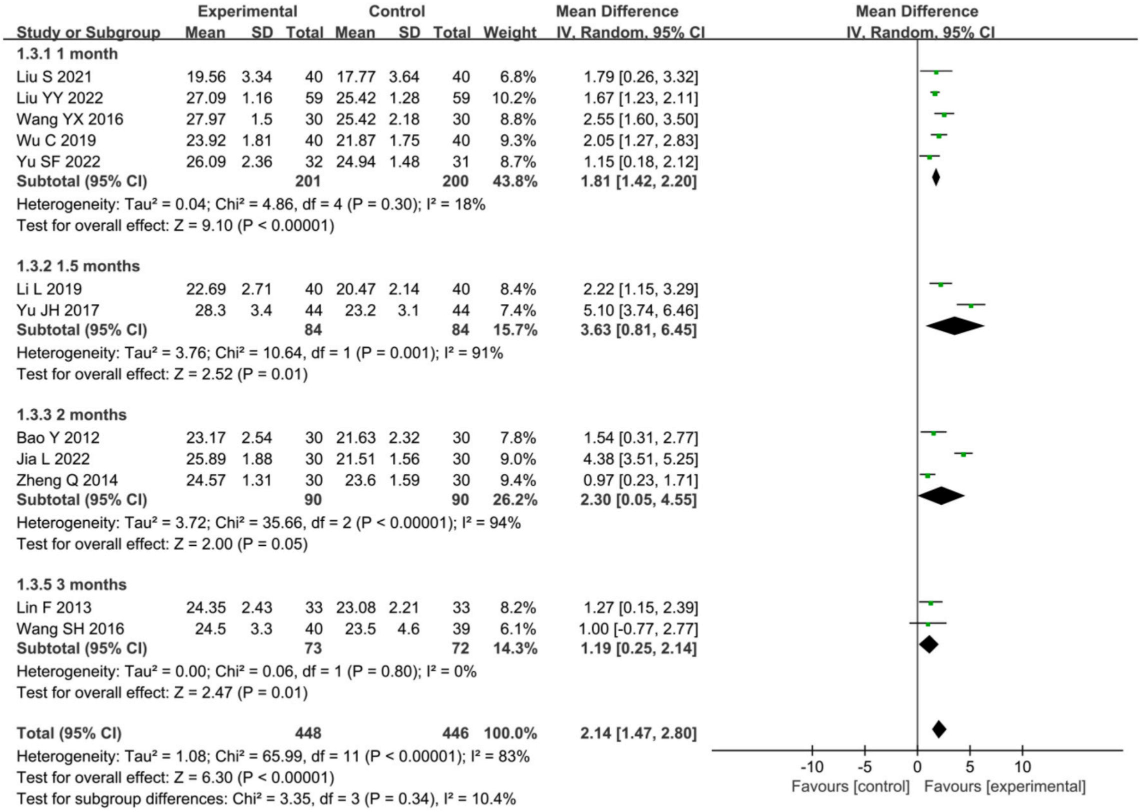

Fig. 5. Meta forest plot of MoCA score session subgroup analysis.

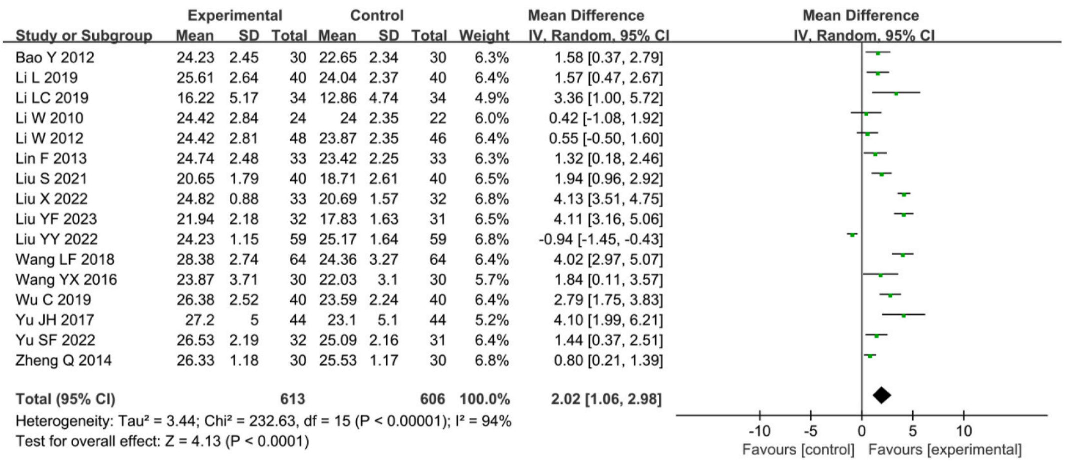

Fig. 6. Meta forest plot of MMSE score.

4.4.4. BI score

7 studies [19,24,26–28,30,33] used the BI score as an outcome indicator. The results of the study were tested for heterogeneity and the results ($I^2 = 27$ %, P = 0.22) indicated significant homogeneity among the studies, therefore, a fixed-effects model was used for statistical analysis. The results showed that the efficacy of the experimental group was significantly better than that of the control group, and the difference was statistically significant (MD = 5.70, 95 % CI 4.68–6.72, Z = 10.92, P < 0.00001) (Fig. 9). This indicates that the self-care abilities of PSCI patients in the experimental group, such as eating, bathing, grooming, dressing, toileting, and walking, were significantly improved.

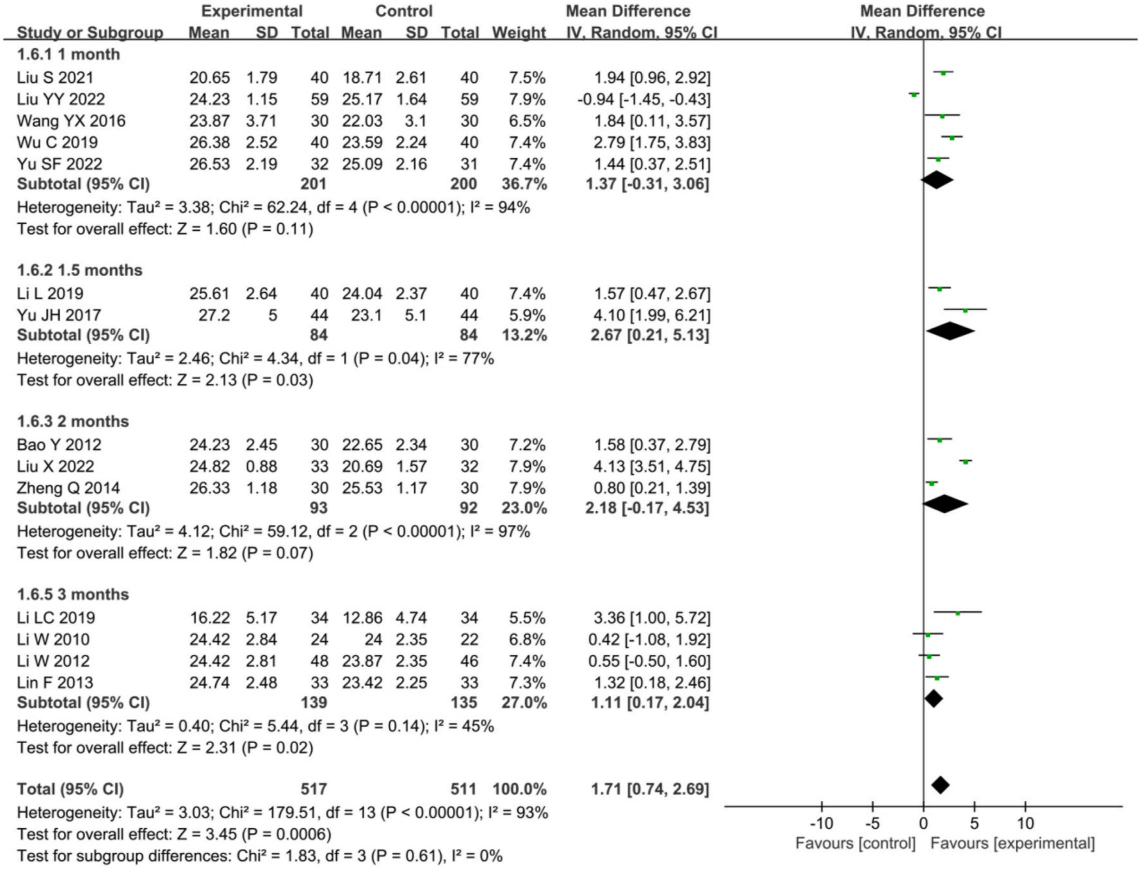

Fig. 7. Meta forest plot of MMSE score session subgroup analysis.

4.5. Publication bias analysis

Since the number of included BI score indicators was <10, which was not suitable for funnel plot analysis, the clinical efficacy, MMSE scores, and MoCA scores were assessed for publication bias. The results showed that no studies deviated from the CI of the funnel plot and that they were largely symmetrical, with P values for both Begg's and Egger's tests being >0.05, indicating no potential publication bias (Figs. 10–12).

4.6. Adverse reactions

8 studies [19–22,25,28,30,33] mentioned adverse effects, 7 studies [19,20,22,25,28,30,33] reported dizziness, nausea and vomiting, hypotension, insomnia, constipation, diarrhoea, limb pain, bleeding after needle removal, or the presence of a hematoma reaction, 1 study [20] mentioned mild nausea and vomiting symptoms after taking the drug, and 1 study [21] clearly mentioned that no adverse effects occurred in either group (See Table 2 for details). The above-mentioned adverse reactions were mild and did not affect follow-up treatment after timely treatment and communication with patients and families.

5. Discussion

5.1. Discussion of meta-analysis results

A total of 18 RCTs on acupuncture combined with cognitive improvement medications for PSCI with a total of 1361 study subjects were included in this meta-analysis. The results of four observational indicators showed a significant beneficial tendency for the clinical efficacy of acupuncture combined with western medicines for poststroke cognitive impairment. Acupuncture as an adjunctive therapy in modern medicine is beneficial in improving overall cognitive function and activities of daily living in patients with PSCI, as demonstrated by clinical efficacy (OR = 4.06, 95 % CI: 2.86–5.76, Z = 7.82, P < 0.00001), MoCA score (MD = 2.32, 95 % CI 1.68–2.97, Z = 7.10, P < 0.00001), MMSE score (MD = 2.02, 95 % CI 1.06–2.98, Z = 4.13, P < 0.0001), and BI score (MD = 5.70, 95 % CI 4.68–6.72, Z = 10.92, P < 0.00001). According to the statistical results of the adverse effects of the included studies, acupuncture does

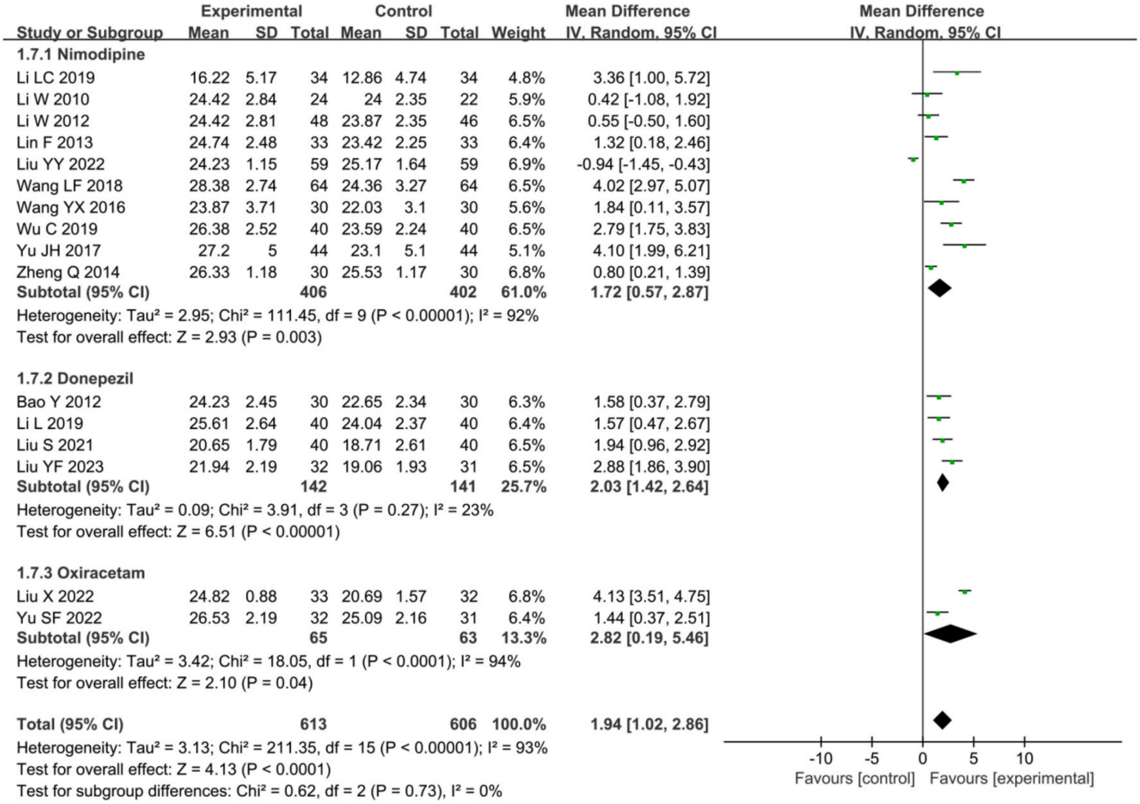

Fig. 8. Meta forest plot of MMSE score drug subgroup analysis.

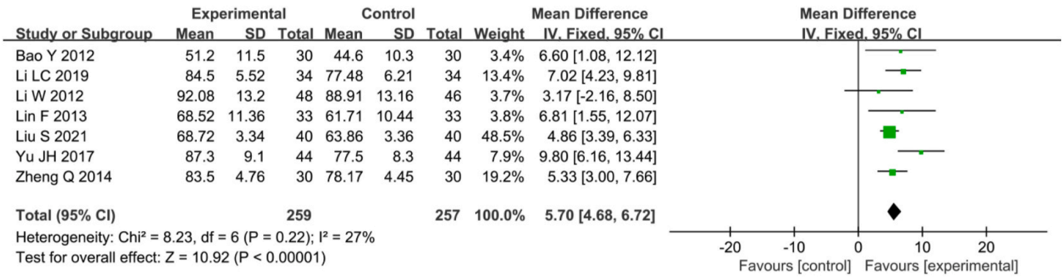

Fig. 9. Meta forest plot of Barthel score.

not cause serious side effects, and those that do occur are resolved more quickly and are more easily accepted by patients and their families, and its safety was recognized. But the methodological quality of most RCTs was low, therefore, significant improvement in the quality of evidence for the efficacy of acupuncture is needed.

5.2. Results-based discussion and insights

Objective and accurate meta-analysis findings rely on high-quality clinical randomized controlled trials. According to the Jadad quality scoring method, studies were categorized into high-quality (4 or more points) and low-quality (1–3 points) literature. Only 11.11 % (2/18) of the studies were of high quality, while the remaining 88.89 % (16/18) of the studies were of low quality, this indicates that there is no guarantee that the investigators or the subjects adhered closely to the study plan throughout the development and execution of the trial, which may increase the risk of bias. There are several reasons for the decline in quality and differences in study design leading to a high risk of study bias. Notably, 17 out of the 18 included studies referenced the correct random sequence generation method, while one study employed a sequential admission allocation method, which is incorrect. Unfortunately, only 2 studies described random sequence generation specifically with one mentioning the correct way to assign concealment, and the rest of the factors were not addressed. All of these factors collectively amplify the risk of bias. The study design and implementation process

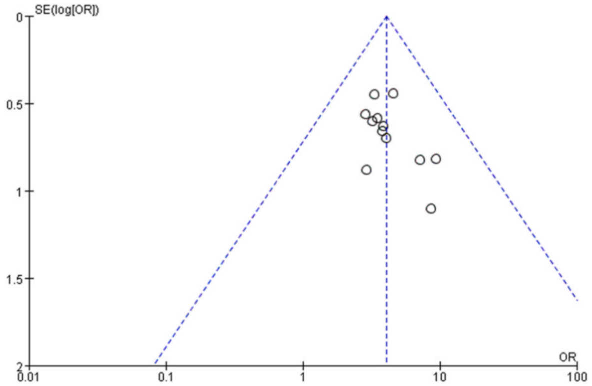

Fig. 10. Clinical efficacy funnel chart.

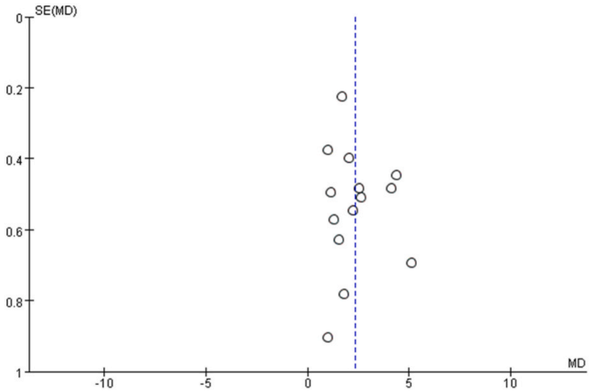

Fig. 11. MoCA funnel chart.

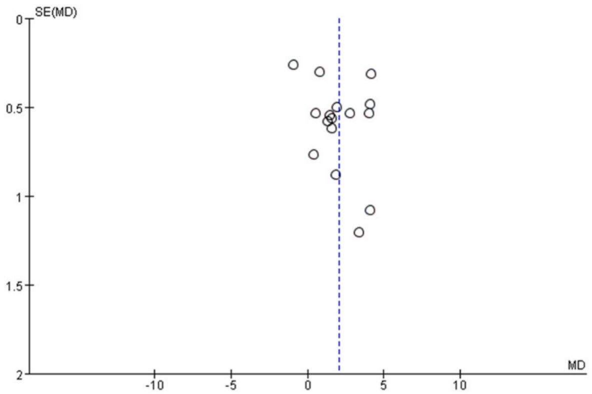

Fig. 12. MMSE funnel chart.

should strictly adhere to random sequence generation and allocation concealment to reduce ROB. Nonpharmacological treatments present challenges in implementing double blinding due to the inherent characteristics of external treatment methods, and it is difficult to implement blinding of the testers during the actual operation. Nevertheless, the application of blinding should be maintained for the allocator, the subject and the outcome assessor, and a sham acupuncture comfort control group can be designed. According to the included studies, the overall diagnostic criteria for stroke combined with the diagnostic criteria for cognitive impairment were followed, however there are no official diagnostic criteria specific to PSCI. This variance in selected diagnostic criteria contributes to high heterogeneity among studies. We hereby call on major health systems to develop the corresponding authoritative diagnostic criteria for PSCI as soon as possible so that researchers can be more clearly regulated in designing the inclusion and exclusion criteria. The noted low methodological quality of the studies, variations in treatment protocols, and lack of uniformity in diagnostic criteria all

Table 2
Adverse reactions.

Study	Number of cases		Number of cases of adverse reactions		Types of adverse reactions	
	Experimental	Control	Experimental	Control	Experimental	Control
Li W 2012	48	46	–	–	Occasionally bleeding after needle removal	
Li L 2019	40	40	3	2	faintng during acupuncture treatment	2 cases of mild nausea after taking the drug Donepezil
Li W 2010	24	22	–	–	Occasionally bleeding after needle removal	
Liu YY2022	59	59	5	3	Hypotension, Headache, Limb pain	Hypotension, Limb pain
Yu JH 2017	44	44	5	3	Hypotension, Constipation	Hypotension, Constipation
Li LC 2019	34	34	2	5	Diarrhoea, Nausea and vomiting	Diarrhoea, Nausea and vomiting, Insomnia
Liu S 2021	40	40	5	2	Dizziness, Vomiting, Insomnia	Dizziness, Insomnia

exacerbate heterogeneity or bias risk during meta-analysis, which reduces the credibility of the conclusions of evidence-based medicine, overestimates the clinical efficacy of therapeutic modalities and is overconfident in ineffective treatments.

Very few PSCI studies currently conduct long-term follow-up, and four papers in this study mentioned follow-up. Two papers described the scale assessment after follow-up in detail. The remaining two papers merely reported the number of participants who were lost to follow-up and the reasons for these losses, while the others did not address follow-up or discuss missing data, thus possibly causing positive results to be presented more easily. Long-term follow-up can aid in determining the long-term efficacy of acupuncture in treating cognitive impairment after stroke and the advantage of reducing recurrence rates, thus providing comprehensive and realistic results and preventing false-negative results. It is common for studies with positive results to be published, and studies with negative results are less likely to be published, which makes it easy for the results of meta-analyses to show inflated positive results, making evidence-based conclusions less reliable and inconsistent with reality.

To further improve the quality of RCTs, investigators are encouraged to strictly adhere to clinical trial protocols. This adherence is crucial for drawing more accurate conclusions regarding the clinical effectiveness, safety, and long-term efficacy of acupuncture as an adjunct therapy for improving cognitive function in patients with PSCI. For guidance on conducting acupuncture clinical trials, researchers should refer to the Acupuncture Clinical Research Specifications and the Standards for Reporting Interventions in Acupuncture Clinical Trials, rigorous design of trial protocols, implementation of trial steps, and reporting of trial results to reduce the potential for false positive results or risk of bias, thereby improving the validity and utility of medical evidence. In addition, trials should be registered with the China Clinical Trials Registry so that other investigators can follow their studies and ensure that the entire process is operating in a standardized manner while reducing reporting bias.

Notably, due to the high heterogeneity in the results of the MoCA and MMSE scale meta-analyses between the included studies and the use of the RE model, we performed subgroup analyses of treatment duration and the type of cognitive improvement medication used as separate stratification factors, with significantly reduced heterogeneity between a few groups and no reduction in heterogeneity between the majority of groups. This may be related to the fact that acupuncture itself is one of the causes of high heterogeneity. The variability in outcomes associated with acupuncture as an intervention can be attributed to multiple factors. For example, uncontrollable parameters such as acupuncture points, manipulation, acupuncture depth and retention time, differences in treatment duration, and differences in operator ability may all cause high heterogeneity, which further complicates the ability to achieve consistent acupuncture parameters.

5.3. Conclusions based on the outcome indicator scale

Assessment of cognitive function status is an indispensable adjunct to the examination of patients with cognitive decompensation, and the common tools used to assess cognitive function are the MMSE, MoCA, HDS-R, NCSE, and LOTCA [37]. The MMSE and MoCA scores, the most widely used assessment tools, were selected as the main outcome indicators in this study. Among the included studies, sixteen utilized the MMSE as both an assessment tool and outcome indicator, while fourteen employed the MoCA for the same purposes. Developed in 1975 by Marshal F. Folstein, Susan E. Folstein, and Paul R. McHugh from the Department of Psychiatry at New York Hospital-Cornell Medical Center and the University of Oregon Medical School, the MMSE is a practical method for evaluating the cognitive status of patients [38]. The MMSE contains items on orientation, memory, attention, computation, language, and visual-spatial aspects, with 30 questions and a total score of 30, with a cutoff value of 27 and a score of <27 being considered to indicate cognitive impairment. While the MMSE is sensitive and specific for dementia, it is less so for mild cognitive impairment, has a relatively low detection rate, and its results can be significantly influenced by the patient's level of education. The MoCA compensates for the low sensitivity of the MMSE scale for mild cognitive impairment. In contrast to the MMSE scale, the MoCA scale, published by Nasreddine, Phillips et al. [39]at the Neurology Clinical Research Centre, Charles LeMoyne Hospital, Canada, in 2005, is highly sensitive to mild cognitive impairment. The scale has 11 parts covering 8 cognitive domains, including visuospatial, executive function, memory, attention, language, abstraction, orientation, and computation. Delayed recall, with a total score of 30 and a cutoff value of 26, was considered to indicate cognitive impairment if the measurement result was <26. The MoCA emphasizes the assessment of executive and attentional cognitive functions and is therefore more valuable for the early screening of cognitive impairment. However, the MoCA's comprehensive nature and the increased difficulty of its questions mean that patients may need more time to complete it, making the test process more complicated compared to the more straightforward MMSE.

The primary objective of post-stroke rehabilitation is to facilitate patients' reintegration into family and social life, necessitating not only cognitive but also physical and behavioral capabilities. The main activities of Daily Living Scales commonly used internationally include the Barthel index (BI), modified Rankin scale (mRS), functional independence measure (FIM), Frenchay Activities Index (FAI), Hasegawa's Dementia Scale (HDS-R) and Katz index [40]. The Barthel Index was introduced by Dorothea Barthel and Florence Mahoney in the United States in 1955 [41]. It assesses patients' ability to live independently and their level of independence across various activities, aiding in prognosis determination, treatment planning, and treatment efficacy evaluation. Consisting of 10 components such as eating, bathing, grooming, dressing, and mobility, the scale assigns a total score of 100, categorizing self-care abilities as ranging from no dependence to mild, moderate, or severe dependence based on the score obtained. Notably, the BI assessment process is straightforward, offering high objectivity and reliability compared to other scales [42].

5.4. Selection of acupoints and studies on the mechanism of acupuncture

In the analysis of the acupuncture points included in the literature, it was revealed that the commonly used local acupuncture points in the head were mainly Baihui (GV20), Shenting (GV24), Sishencong (EX-HN1), Fengchi (GB20), Fengfu (GV16), Yin Tang (EX-HN3), Shuigou (DU26) and Ben Shen (BG13). The commonly used distal acupuncture points were Hegu (LI4), Neiguan (EX-HN1), Zusanli (ST36), Sanyinjiao (SP6), Taixi (KI3), Zhaohai (KI6), and Taichong (LR3). The five most frequently used acupoints were Baihui (GV20), Shenting (GV24), Sishencong (EX-HN1), Shenmen (HT7), Fengchi (GB20) and Taixi (KI3), of which Baihui (GV20), Shenting (GV24) and Sishencong (EX-HN1) are all points on the head of the Directing Vessel, which have the effect of clearing the brain, awakening the mind and educating the mind. In the acupuncture meridian theory system, the Directing Vessel plays an important role in the cognitive function of the brain. The brain is the most sensitive tissue to ischemia and hypoxia, and modern research has found that acupuncture of Baihui (GV20) and Shenmen (HT7) can compensate for the deficiency of the affected cerebral cortex by affecting the glucose metabolism of the healthy side of the brain, thus achieving an improvement in the patient's intelligence [43]. Acupuncture at Baihui (GV20), Sishencong (EX-HN1) and Shenting (GV24) significantly increased the BDNF levels of patients, and their mental status and functional ability improved significantly, indicating that acupuncture can regulate BDNF levels and thus promote the improvement of cognitive function. Related animal experiments also showed that acupuncture at Baihui (GV20) could activate the cholinergic system, upregulate BDNF levels, downregulate the expression of nerve growth inhibitory factor and related receptors, protect damaged neurons, increase neuronal survival in the hippocampus, and improve cognitive function [44–47]. In recent years, an increasing number of studies have explored the potential mechanisms associated with acupuncture in the treatment of PSCI, however, these mechanisms have not been fully elucidated to date and are continually being refined. Most scholars generally agree that the mechanism of acupuncture for PSCI is mainly to protect neurological functions, inhibit apoptosis of neuronal cells, stabilize and repair neuronal structural functions, modulate synaptic plasticity, inhibit the expression of inflammatory cytokines, regulate oxygen free radicals, balance oxidative stress, improve blood circulation in brain tissues, and induce activity in specific regions of the brain [48–50]. This finding suggested that the effect of acupuncture on PSCI is mainly related to the activity of the cerebral vasculature, nerves, and other specific regions.

5.5. Limitations and advantages

The prevailing state of evidence-based medicine for acupuncture in treating PSCI is challenged by the absence of high-quality RCTs, primarily due to inadequate study design and substantial methodological gaps. These deficiencies introduce various confounding factors, leading to a high ROB and less than optimal result reporting, which in turn reduces the evidence quality. Additionally, significant heterogeneity among studies complicates the reduction of between-group differences, even with attempts at subgroup analysis. This issue stems from acupuncture's intricate treatment structure and the diverse factors affecting its efficacy, making uniformity in parameters challenging to achieve. Focusing on studies that exclusively employ acupuncture as the treatment method in the meta-analysis screening process minimizes the heterogeneity caused by other external treatments. This approach provides a clearer insight into acupuncture's clinical efficacy for PSCI and enhances the reliability of the evidence quality for evidence-based practices.

6. Conclusion

In conclusion, the effectiveness of acupuncture as a supplementary therapy to enhance cognitive functions in patients with PSCI is recognized, with clear benefits in stimulating brain activity. This stimulation aids in the regeneration of nerve cells, reconstruction of neural networks, and reorganization of brain functions, positively impacting patients' daily living abilities while presenting minimal side effects. However, the long-term efficacy of acupuncture in treating PSCI and its potential to reduce recurrence rates remain uncertain. In the clinical management of PSCI, acupuncture serves as a valuable addition to pharmacotherapy, cognitive rehabilitation, or other forms of physical therapy, though no evidence currently supports its ability to fully replace these interventions. The conclusions drawn from this study are constrained by the limited scope and quality of the included research. Future investigations, necessitating larger samples, multicenter involvement, and higher-quality randomized controlled trials are essential. These studies should focus on standardizing trial protocols, establishing uniform diagnostic criteria, enhancing follow-up procedures, and further examining acupuncture's role in PSCI to furnish more robust evidence for evidence-based clinical practices.

Data availability statement

The data that support the findings of this study are available from the corresponding author, [Haibo Lin, Email address: linhaibo163@163.com], upon reasonable request.

Ethics statements

Review and/or approval by an ethics committee was not needed for this study because this study didn't involve animal, cellular, or human related experiments, only the data were studied and analyzed.

Funding

This research was funded by the fifth batch of national Traditional Chinese Medicine clinical outstanding talents training project (National Administration of Traditional Chinese Medicine talent education letter No.(2022)1); the Medical and Health Science and Technology Project of Jiangmen (NO. 2022YL03011).

CRediT authorship contribution statement

Weijie Wu: Writing – review & editing, Writing – original draft, Software, Data curation. **Chengning Song:** Validation, Software, Methodology, Data curation. **Yang Yang:** Validation, Resources, Methodology, Funding acquisition. **Yi Hu:** Validation, Resources, Funding acquisition. **Haibo Lin:** Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

We are grateful to those who offered any help in this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e30522.

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