Original Articles

Acupuncture and Herbal Medicine

Acupuncture for insomnia among individuals with substance use disorder: a systematic review and meta-analysis

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Abstract

Objective: Insomnia is a common comorbidity and a recognized risk factor among individuals with substance use disorder (SUD). It is imperative to consider nonpharmacological adjunct therapies for bidirectional effects when treating insomnia in individuals with SUD. This systematic review and meta-analysis aimed to evaluate the efficacy and safety of acupuncture for treating insomnia in individuals with SUD.

Methods: Electronic databases were searched from inception to December 2024 to identify relevant randomized controlled trials (RCTs) comparing needle acupuncture with sham acupuncture, conventional care, non-acupuncture active treatment, or waitlist controls in patients with insomnia and SUD. The primary outcome was sleep quality, which was measured using the Pittsburgh Sleep Quality Index (PSQI) (lower scores indicate better sleep quality). Pooled effects were estimated using random-effects models. The certainty of evidence was assessed using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) framework. Trial sequential analysis (TSA) was used to assess the risk of false-positive and false-negative results.

Results: Eighteen RCTs with 1,750 participants met the inclusion criteria. All the RCTs were conducted in China. Sixteen RCTs had a moderate-to-high risk of bias. The pooled results showed that manual acupuncture (MA) yielded a better total PSQI score than sham acupuncture (mean difference [MD], −2.15 [95% confidence interval [CI], −2.93 to −1.38], $P < 0.00001$; minimal clinically important difference (MCID): −1.25), with low-certainty evidence. The TSA results suggested that the required information volume had been reached, indicating that additional trials may not be necessary in terms of sample size. Subgroup analyses revealed that acupuncture interventions had a greater effect among individuals with opioid use disorder (OUD) (MD, −1.93 [95% CI, −2.61 to −1.25], $P < 0.00001$) than on those with alcohol use disorder (MD, −1.49 [95% CI, −2.12 to −0.87], $P < 0.00001$) or new drug use disorder (MD, −3.94 [95% CI, −7.99 to 0.12], $P = 0.06$). However, the evidence regarding the efficacy of other forms of acupuncture and the comparative effectiveness between various forms of acupuncture was limited.

Conclusions: A review of 18 RCTs provides low-certainty evidence that MA may be more effective than sham acupuncture for improving sleep quality in individuals with SUD, with the effect potentially stronger among those with OUD. Given that most of the included studies exhibited a moderate-to-high risk of bias, the strength of the conclusions should be interpreted with caution. Therefore, additional research on the use of acupuncture to alleviate insomnia and reduce SUD withdrawal symptoms is warranted.

Keywords: Acupuncture, Insomnia, Meta-analysis, Sleep disorder, Substance dependence, Substance use disorder, Systematic review

Graphical Abstract: https://links.lww.com/AHM/A234

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HM9_V6N3.indb 358 26-Sep-26 15:38:10

Introduction

Insomnia, clinically characterized by prolonged sleep onset latency, frequent nocturnal awakenings, and fragmented sleep architecture, represents a pervasive and debilitating comorbid condition that plagues the vast majority of individuals suffering from substance use disorders (SUD)[1]. Epidemiological data reveal that insomnia is highly prevalent across various SUDs, particularly manifesting as diagnostic insomnia among individuals with alcohol use disorder, clinically significant sleep disturbances during methadone maintenance treatment for opioid dependence, and severe insomnia during the acute phase of cocaine withdrawal[2]. The etiology of insomnia in SUD populations is multifactorial, encompassing neurochemical dysregulation, withdrawal-related changes, and psychosocial stressors[3–5]. Evidence suggests a bidirectional relationship between the two conditions, whereby insomnia can precipitate and perpetuate substance use, while SUD-related distress can exacerbate insomnia symptoms[6–8]. According to Global Burden of Disease estimates, SUD, including alcohol, opioid, cocaine, amphetamine, and cannabis dependence, accounts for approximately 37.8 million disability-adjusted life years, representing 1.5% of the global disease burden[9]. Given its high prevalence and potential to increase disability, healthcare utilization, and relapse risk, insomnia in SUD populations represents a critical but under-addressed clinical problem.

Acupuncture is recognized as one of the most promising nonpharmacological adjunct therapies for SUD[10]. Several studies have shown that acupuncture therapy (AT) is effective in preventing insomnia symptoms by improving total sleep time, shortening the time it takes to fall asleep, and reducing nighttime awakenings in individuals with SUD. Acupuncture also alleviates other withdrawal symptoms among individuals with SUD, such as opioid craving, depression, and anxiety; reduces adverse effects; and improves their quality of life[11–14]. Currently, conventional methods for managing insomnia in individuals with SUD include benzodiazepine receptor agonists, Z-drugs (typified by zolpidem or eszopiclone), melatonin receptor agonists, and cognitive behavioral therapy for insomnia[15]. Compared with these therapies, acupuncture is safer and rarely accompanied by side effects such as dependency and tolerance with long-term use, next-day hangovers, and serious contraindications[16–18]. Acupuncture can be readily implemented in the community[19]. Although systematic reviews have evaluated the efficacy of acupuncture in treating insomnia, most studies have not specifically targeted patients with SUD. Similarly, existing meta-analyses of acupuncture for SUD have not included insomnia as a primary outcome measure[20–22]. Furthermore, these analyses seldom examined differential treatment effects across intervention modalities or patient subgroups. Considering that population characteristics and intervention modalities can substantially influence therapeutic outcomes, addressing these gaps is essential to produce clinically relevant and generalizable evidence.

Therefore, in this meta-analysis of randomized controlled trials (RCTs), the efficacy of acupuncture in alleviating sleep disorders, depression, and anxiety in patients with SUD was assessed. The effects of acupuncture were compared across different subgroups, including individuals with OUD, AUD, and other new drug use disorders (nDUD). By filling this gap in the literature, the study aimed to provide insights into the potential of acupuncture as a complementary treatment for SUD to improve insomnia-related outcomes.

Methods

This systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines[23]. The protocol was registered in PROSPERO (CRD42022319594).

Data sources

MEDLINE, Cochrane Library, Web of Science, Embase, China National Knowledge Infrastructure, Science and Technology Journal Database, and Wanfang Databases were systematically searched from inception to December 2024. Acupuncture-related terms were combined with SUD terms, and the search was limited to RCTs. The full search strategy for the databases is provided in Supplementary Table S1 (https://links.lww.com/AHM/A235).

Eligibility criteria

Types of studies

This review included RCTs with two- or three-arm designs that compared the efficacy of AT for insomnia in individuals with SUD. Parallel and crossover designs were also included. Studies published in both Chinese and English were considered eligible for inclusion. Abstracts and preprints were excluded from the study.

Types of participants

Eligible trials enrolled adults (≥18 years old) presenting with comorbid sleep disturbances evaluated by standardized instruments, such as the Pittsburgh Sleep Quality Index (PSQI). Participants were required to have a formal diagnosis of SUD classified under the Diagnostic and Statistical Manual of Mental Disorders (DSM) or the International Classification of Diseases (ICD) criteria. Informed consent had been obtained from all patients. Trials were excluded if the patients had any other neurological or serious medical diseases that could cause brain dysfunction.

Types of interventions and comparisons

The following needle-based ATs were eligible for inclusion: manual acupuncture (MA), electroacupuncture (EA), fire acupuncture (FA), and warm acupuncture (WA). There were no restrictions regarding the number of treatments or overall intervention duration. Eligible studies were strictly restricted to trials evaluating traditional acupuncture that involved needle insertion into acupoints. Subgroup analyses were subsequently performed to evaluate and compare the therapeutic effects of these distinct needle-based modalities.

HM9_V6N3.indb 359 26-Sep-26 15:38:10

The control interventions included conventional treatment, waiting treatment, placebo acupuncture, or sham acupuncture (SA). Conventional treatment refers to drug therapy or psychological treatment for insomnia in individuals with SUD. Placebo acupuncture typically involves non-penetrating needles secured to the cutaneous surface, regardless of acupoint specificity. Furthermore, standard inert control methodologies encompass either invasive sham needling at anatomically invalid non-acupoints or alternative non-invasive modalities such as subliminal transcutaneous electrical skin stimulation[24–25].

Our quantitative synthesis evaluated four distinct comparative frameworks: acupuncture *versus* treatment as usual (TAU) or sham controls, and adjunctive acupuncture combined with TAU *versus* TAU alone. Eligible protocols encompassed these interventions either as monotherapies or within combination regimens, provided they utilized structured, standardized delivery. Conversely, trials isolating technical variations of an identical intervention, including differences in stimulation intensity, format, or duration, were excluded from the analysis.

Types of outcome measures

Primary outcome

Sleep quality improvement was evaluated as a continuous outcome *via* the PSQI, a standardized self-rating scale encompassing seven components that assess subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is scored from 0 to 3, yielding a global score ranging from 0 to 21, where higher cumulative values signify progressively poorer sleep quality.

Two primary approaches are commonly used to establish the minimal clinically important difference (MCID): anchor-based and distribution-based methods[26–27]. In this study, an absolute reduction of 1.25 points on the PSQI was adopted as the plausible MCID. This specific threshold was determined based on historically established and empirically validated results from previous cross-sectional and pilot studies in similar populations[28–29].

Secondary outcomes

Other sleep disorder scores were measured using several clinician-rated scales (eg, the Insomnia Severity Index [ISI], which is used to assess the severity of insomnia and its effects on daytime function).

Anxiety and depression were measured using the Hamilton Anxiety Rating Scale (HAMA), which assesses the anxiety level of patients with insomnia; the Hamilton Depression Rating Scale (HAMD), which assesses the degree of depression in patients with insomnia; or other clinician-rated scales of depression severity or anxiety level.

Sleep performance was measured using a sleep diary or other objective measurements such as electroencephalography. The total sleep duration and time spent falling asleep were also recorded.

Adverse events were measured by adding the number of participants with at least one adverse event, including any expected or unexpected adverse health events associated with AT.

Timing of outcome assessment

The timeframe for reporting the primary and secondary outcomes was classified as short-term (<30 days after treatment completion) or long-term (≥30 days after treatment completion). If a study reported several time points during the timeframe (eg, during treatment), this meta-analysis used the last observation before treatment completion.

Study selection and data extraction

Following the eligibility criteria, two reviewers independently screened the titles and abstracts of the retrieved studies to identify potentially relevant studies. The full texts of potentially relevant articles were obtained, and the same two authors independently screened the full texts based on the inclusion criteria. All disagreements were resolved by consensus.

Two investigators independently extracted data using a pre-established standardized information form and resolved any disagreements through discussion. The corresponding authors of the included studies were contacted *via* e-mail to obtain missing data or clarify the study details. The following data were extracted from the included studies: number and characteristics of participants, study background, intervention types in the experimental and control groups, length of follow-up, outcomes, country of origin, and conflicts of interest.

Methodological quality assessment

Two authors independently assessed the risk of bias using the Cochrane Risk of Bias tool. The following risk of bias domains were assessed: random sequence generation, allocation concealment, blinding of subjects and investigators, blinding of outcome assessment, incomplete outcome data, selective outcome reporting, and other biases. The overall risk of bias was graded as low risk, unclear, or high risk. All disagreements were resolved by consensus.

Certainty of evidence

We evaluated the certainty of evidence for each pooled outcome using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) framework. Methodological quality was systematically downgraded by one or two levels depending on the severity of identified risks, specifically encompassing the risk of bias, inconsistency, indirectness, imprecision, and publication bias. Ultimately, higher certainty tiers reflect the robust stability of our synthesized findings against future empirical variations.

Statistical analysis

When the mean change and standard deviation (SD) were reported, they were used directly. For studies

HM9_V6N3.indb 360 26-Sep-26 15:38:10

that provided pre- and post-intervention measures, the Cochrane Handbook method to compute the mean change and SD of change was applied. For studies reporting the mean and sample size for outcomes but not providing SD, the following approach was applied: When available, SD was calculated from other reported statistics, such as confidence interval (CI), *P* value, standard error (SE), or interquartile ranges, following the formulas in the Cochrane Handbook. If this information was unavailable, attempts to obtain missing data were made by contacting the corresponding authors. If data could not be obtained, the SD was conservatively estimated based on other similar groups within the same study or from comparable studies included in the meta-analysis (eg, using pooled or maximum SD). Sensitivity analyses were conducted to assess the effect of these estimates on the robustness of the results[30]. For studies that did not meet the criteria for quantitative analysis, qualitative analysis of the results was conducted.

Pairwise meta-analyses were performed using RevMan version 5.4.1. Dichotomous data were summarized using odds ratios (OR) with 95% CI. Continuous data were expressed as the mean difference (MD) with a 95% CI. If outcomes were conceptually the same but were measured in different ways, for example, using different instruments, the standardized mean difference (SMD) with 95% CI was used to express continuous data. Statistical analyses were performed using the inverse variance method. A random-effects model was applied to calculate pooled pairwise estimates.

Clinical heterogeneity was assessed first, followed by statistical heterogeneity between studies. Clinical heterogeneity was assessed by identifying between-trial differences in the distribution of participant factors (eg, age, sex, diagnosis type, disease duration, and associated disease) and methodological heterogeneity by identifying differences in trial designs (eg, randomization concealment, blinding, follow-up, and intervention). Heterogeneity was assessed using the I^2 statistic based on the Cochrane Handbook for Systematic Reviews of Interventions. An I^2 of 0% to 40% might not indicate significant heterogeneity, 30% to 60% may represent moderate heterogeneity, 50% to 90% may represent substantial heterogeneity, and 75% to 100% indicates considerable heterogeneity[30]. Heterogeneity was formally tested by examining the *P* values of the I^2 statistics. When determining the importance of heterogeneity, the magnitude and direction of the effects and the strength of the evidence of heterogeneity (the *P* value of the χ^2 test or the width of the CI for the I^2 statistic) were considered.

Trial sequential analysis (TSA) was performed using TSA software (version 0.9.5.10 Beta; Copenhagen Trial Unit) to control the risk of false-positive or false-negative findings[31]. A trial-sequential monitoring boundary was established based on an anticipated MD equivalent to a 5% reduction in the baseline PSQI score. The type I error (α) and statistical power were set at 0.05 and 80%, respectively. The required information size (RIS) was calculated utilizing the pooled SD and mean values of the control groups. Firm evidence of an intervention effect is achieved if the cumulative Z-curve crosses either the trial-sequential monitoring boundary or the futility boundary. Conversely, if the Z-curve fails to cross any boundary and does not reach the RIS, the cumulative evidence remains insufficient.

Funnel plots and Egger regression tests were used to assess potential publication bias[32]. The egger regression test evaluates funnel plot asymmetry by regressing the standardized effect estimates against their precision. A funnel plot was constructed by plotting the effect size of each study against its SE (or sample size) to visually assess asymmetry. Visual inspection of the funnel plot (effect size *vs*. precision) was complemented by the Egger test to quantify potential publication bias. If ten or more studies were included for a particular outcome, funnel plots and Egger tests were used to investigate publication bias. Statistically significant publication bias was identified by *P* values ≤0.10. If visual assessment revealed asymmetry, the possible reasons for publication bias were explored by performing the tests proposed in the Cochrane Handbook for Systematic Reviews of Interventions.

Sensitivity analysis was performed to assess the robustness of the results by excluding the following types of trials to determine their potential contribution to the results: (1) trials with unclear reports of the randomization process or concealment of random allocation; (2) trials with incorrect diagnostic criteria for insomnia or SUD; and (3) trials with a dropout rate greater than 20%.

Considering that the effects of acupuncture may be influenced by the clinical characteristics of RCTs, a pre-specified subgroup analysis was performed to examine the effects of different stimulation modes of acupuncture (eg, MA, EA, or FA) and different populations of SUD (eg, OUD, AUD, or nDUD). The definitions of the different terms are presented in the glossary [Supplementary Table S2, https://links.lww.com/AHM/A235].

Results

Study characteristics

A total of 792 articles were retrieved through the database searches, of which 761 remained after deduplication. After screening titles and abstracts, 22 full-text articles were assessed. Ultimately, 18 RCTs[33–50] with 1,750 individuals with insomnia and SUD met the inclusion criteria. This study compared various acupuncture modes, including MA, EA, FA, and WA, with SA, waitlist control, psychotherapy, and conventional treatment. The number of acupoints varied, with PC6, HT7, ST36, SP6, and DU20 being the most frequently used. The duration of treatment ranged from short-term (<30 days) to long-term (≥30 days). All the RCTs were conducted in China (Figure 1, Table 1 and Supplementary Table S3, https://links.lww.com/AHM/A235).

Risk of bias

Most trials (17/18, 94%) had a risk of bias in at least one domain; 11 studies (61%) adequately generated their randomization sequence, seven (39%) concealed allocation, four (22%) reported sufficient detail regarding blinding, and four (22%) blinded outcome assessors.

HM9_V6N3.indb 361 26-Sep-26 15:38:10

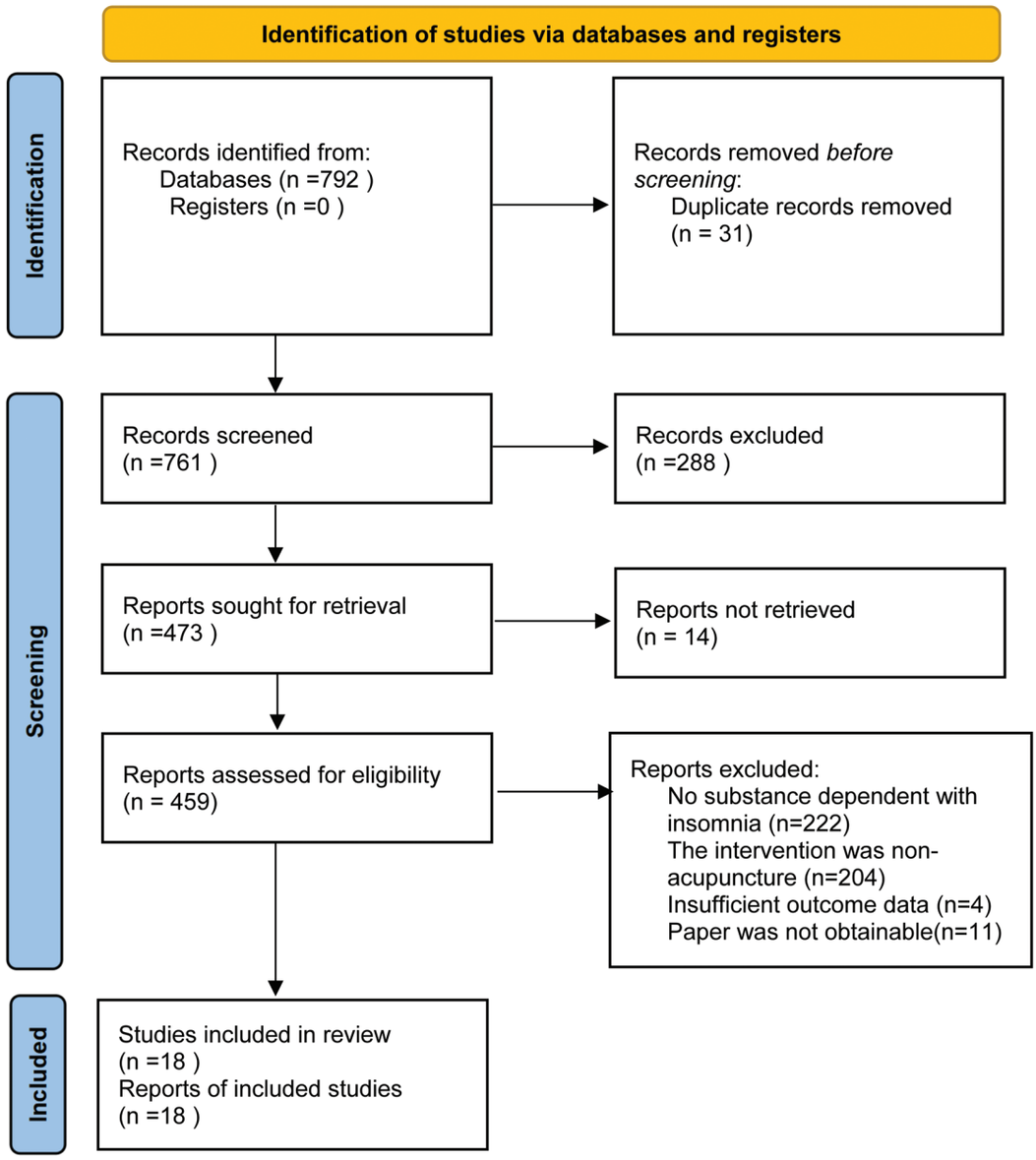


Figure 1. Flow diagram.

Most trials (16, 89%) reported missing outcome data (<20%). Considering the complexities associated with needle insertion, implementing blinding and concealed allocation in acupuncture trials has proven challenging. Consequently, the overall quality of the included studies was low, largely owing to insufficient blinding and inadequate allocation concealment. Supplementary Figure S1 (https://links.lww.com/AHM/A235) shows a graphical summary of the risk of bias assessments for the 18 included studies.

Efficacy of acupuncture

Pittsburgh Sleep Quality Index

The pooled analysis of 10 trials[33–35,38,43–44,46–49] showed a statistically significant reduction in PSQI scores in favor of acupuncture (pooled across all acupuncture modalities) compared with control conditions (including SA, TAU, or blank group) (MD, −2.08 [95% CI, −2.74 to −1.42], $P < 0.00001$). Because the objective of this analysis was to compare the effects across different SUDs, all acupuncture modalities reporting PSQI outcomes were combined into a single category to ensure sufficient power. Subgroup analyses by substance type indicated that the effect was more evident in participants with OUD (MD, −1.93 [95% CI, −2.61 to −1.25], $P < 0.00001$; MCID: −1.25 points, low-certainty evidence) than in those with AUD (MD, −1.49 [95% CI, −2.12 to −0.87], $P < 0.00001$; MCID: −1.25 points, low-certainty evidence). For nDUD, the estimate was imprecise and did not reach statistical significance (MD, −3.94 [95% CI, −7.99 to 0.12], $P = 0.06$; MCID: −1.25 points, very low-certainty evidence) (Figure 2, Table 2, and Supplementary Figure S2, https://links.lww.com/AHM/A235).

HM9_V6N3.indb 362 26-Sep-26 15:38:12

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Table 1

Characteristics of included studies

Study	Sample size		Duration of addiction, mean (SD)		Interventions		Substance of dependence	Duration, weeks	Outcome
	T	C	T	C	T	C			
Shi et al. 2011[33]	35	27	9.98 (5.98), years	9.48 (6.20), years	MA	Blank group	Opioids	8	PSQI, total sleep duration, time to fall asleep
Wang et al. 2021[34]	120	120	94.81 (62.02), months	99.82 (59.80), months	MA	Naltrexone	Alcohol	12	PSQI, AE
Wang 2020[35]	20	C1: 21 C2: 20	19.30 (8.30), months	17.90 (11.20), months	MA + EA	C1: SA C2: waitlist	Opioids	4	PSQI, HAMA, HAMD, AE
Zong et al. 2009[36]	30	30	70.38 (58.63), months	70.38 (58.63), months	MA + EA	Blank group	Opioids	2.14	Sleep disorder score
Wen et al. 2005[37]	111	109	20.08 (8.26), months	20.19 (8.44), months	MA	Lofexidine	Opioids	1.43	HAMA
Li et al. 2012[38]	38	37	11.90 (7.50), years	10.10 (8.30), years	MA	SA	Opioids	8	PSQI, AE rate
Li et al. 2014[39]	45	45	2.20, years	2.20, years	MA	Blank group	New drugs	3	HAMA, HAMD
Tao et al. 2019[40]	T1: 28 T2: 29	29	T1: 72.50 (99), months T2: 59.00 (94), months	72 ± 89, months	T1: MA + EA T2: MA + EA	Blank group	New drugs (methamphetamine)	4	HAMD, sleep disorder score
Gao et al. 2021[41]	28	28	181.80 (72.60), months	189.30 (70.50), months	WA	Methadone	Opioids	2	Sleep disorder score
He 2019[42]	19	17	23.90 (11.71), months	23.03 (10.14), months	FA	Psychotherapy	Tobacco	3	HAMD
Wang 2019[43]	35	35	3.71 (2.19), years	3.83 (1.49), years	MA + TAU	TAU	New drugs (sedative-hypnotic drugs)	4	PSQI
Sun et al. 2022[44]	37	38	0.61 (0.19), years	0.57 (0.21), years	MA	Psychotherapy	New drugs	3.43	PSQI, HAMA
Zhu et al. 2005[45]	25	25	4.13 (2.98), years	4.93 (2.77), years	EA	Blank group	Opioids	7	Sleep disorder score
Song et al. 2020[46]	57	60	9.53 (4.32), years	10.14 (5.16), years	EA + diazepam	Diazepam	Alcohol	2	PSQI
Chan et al. 2014[47]	30	30	6.53 (4.44), years	7.57 (5.03), years	MA + methadone	SA + methadone	Opioids	4	PSQI, AE
Wen et al. 2021[48]	62	61	16.76 (6.12), years	16.44 (8.54), years	MA + MMT	MMT	Opioids	6	PSQI
Lu et al. 2024[49]	60	56	13.7 (1.96), years	15.2 (1.02), years	MA	SA	Opioids	8	PSQI
Ahlberg et al. 2016[50]	73	80	/	/	MA	Psychotherapy	Substance abuse and psychiatric comorbidity	5	ISI

AE: Adverse event; C: Control group; EA: Electroacupuncture; FA: Fire acupuncture; HAMA: Hamilton Anxiety Rating Scale; HAMD: Hamilton Depression Rating Scale; ISI: Insomnia Severity Index; MA: Manual acupuncture; PSQI: Pittsburgh Sleep Quality Index; SA: Sham acupuncture; T: Trial group; TAU: Treatment as usual; WA: Warm acupuncture.

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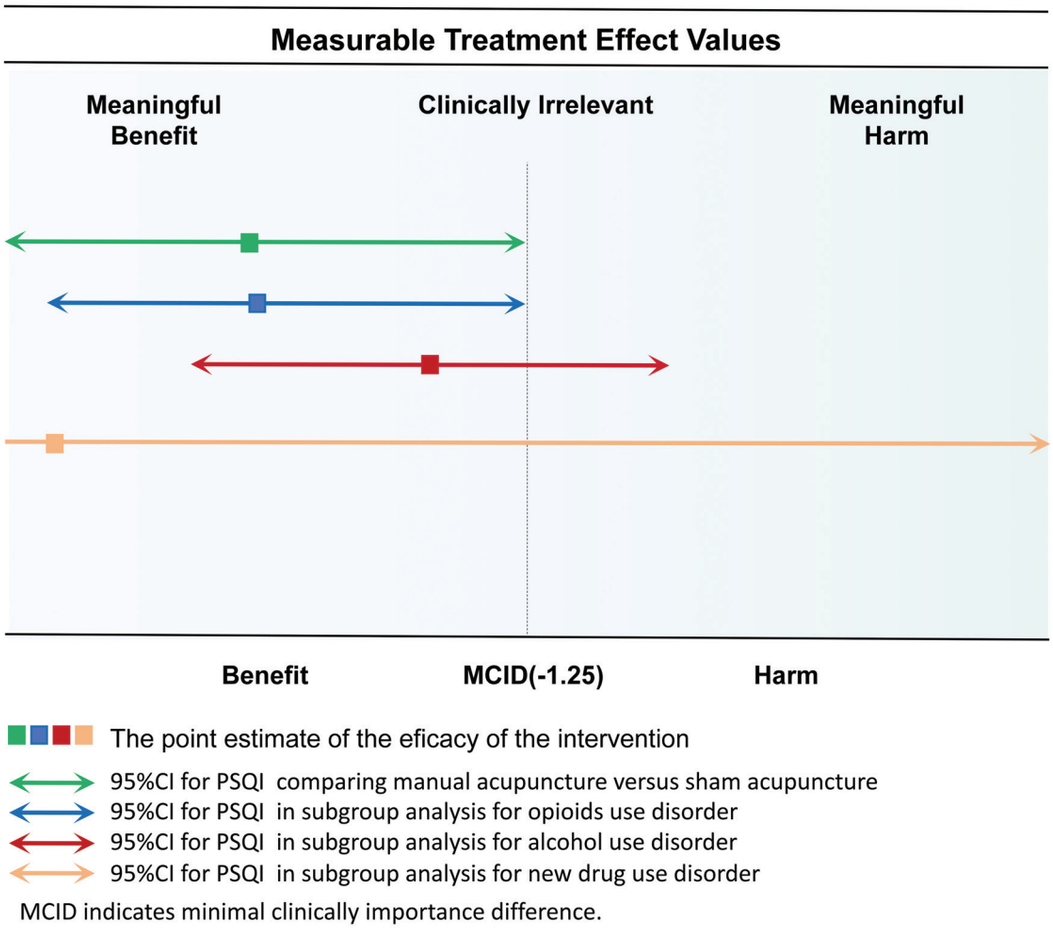


Figure 2. The confidence intervals in this study include clinically significant results. CI: Confidence interval; MCID: Minimal clinically important difference; PSQI: Pittsburgh Sleep Quality Index.

Three trials[38,47,49] compared MA *versus* SA, revealing that MA yielded significantly better PSQI total scores at the post-treatment endpoint (MD −2.15 [95% CI, −2.93 to −1.38], $P < 0.00001$; low-certainty evidence). Because the upper limit of the 95% CI was less than the MCID (−1.25), this benefit represents a definite clinical importance (Figure 2, Table 2, and Supplementary Figure S3, https://links.lww.com/AHM/A235). Regarding long-term outcomes, only one trial[49] extended evaluation through a 12-week follow-up period, reporting that MA maintained a statistically significant reduction in the PSQI score compared with SA (MD, −0.9 [95% CI, −1.8 to −0.0]). Two trials[33,35] showed that MA did not significantly improve PSQI scores *versus* a blank group (MD, −1.23 [95% CI, −3.02 to 0.56], $P = 0.18$), nor did MA + EA *versus* a waitlist (MD, −1.80 [95% CI, −3.97 to 0.37], $P = 0.10$). Subgroup differences were not significant ($P = 0.69$; Supplementary Figure S4, https://links.lww.com/AHM/A235).

The pooled analysis of these four trials[34,44–45,48] revealed that patients in the MA group had better PSQI scores after treatment than did those in the TAU group (SMD −0.79 [95% CI, −1.14 to −0.44], $P < 0.00001$, MCID: −1.25; low-certainty evidence; Table 2 and Supplementary Figure S5, https://links.lww.com/AHM/A235). One trial[46] aimed to compare the efficacy of transcutaneous electrical acupoint stimulation (TEAS) combined with diazepam against diazepam alone for the treatment of acute alcohol withdrawal syndrome. The results revealed a similar improvement in the total PSQI score between the two groups on days 1 and 7; however, it was significantly lower in the TEAS group than in the control group on day 14.

Total HAMD or HAMA score

One trial[39] compared HAMD scores between the MA and control groups. After 4 weeks of treatment, MA was associated with a statistically significant reduction in HAMD scores compared with the blank control group (SMD, −6.08 [95% CI, −7.08 to −5.08], $P < 0.00001$, low-certainty evidence, Supplementary Figure S6, https://links.lww.com/AHM/A235). Notably, while data extraction was confirmed to be accurate, this extreme and clinically anomalous effect size must be interpreted with absolute caution. The pooled analysis of two trials[35,40] revealed that the MA + EA group had an improved score after treatment compared with the blank group (SMD, −1.17 [95% CI, −1.51 to −0.82], $P < 0.00001$, low-certainty evidence; Table 2 and Supplementary Figure S6, https://links.lww.com/AHM/A235). Subgroup analyses based on the acupuncture

HM9_V6N3.indb 364 26-Sep-26 15:38:14

Table 2

Overall effect and subgroup analyses for outcomes

Outcome or subgroup	No. of RCTs	No. of patients	SMD/MD (95%CI), random effects	*P* value	GRADE quality of body of evidence
PSQI					
Type of intervention-comparator					
MA *vs.* SA	3	251	–2.15 (–2.93 to –1.38)	<0.001	Low*,†
MA *vs.* blank group/waitlist	2	102	–1.46 (–2.84 to –0.08)	0.040	Low*,‡
MA *vs.* TAU	4	508	–0.79 (–1.14 to –0.44)	<0.001	Low*,§,‖
EA *vs.* TAU	1	117	–0.37 (–0.74 to –0.01)	0.050	Low*,†,‡
Type of substance use					
Opioids use	7	524	–1.93 (–2.61 to –1.25)	<0.001	Low*,†,‖
Alcohol use	2	357	–1.49 (–2.12 to –0.87)	<0.001	Low*,†,‖
New drugs use	2	145	–3.94 (–7.99 to 0.12)	0.060	Very low*,‡,§
Short-term follow-up					
MA *vs.* SA	1	116	–3.01 (–3.55 to –2.47)	<0.001	Moderate‡
HAMA					
Type of intervention-comparator					
MA *vs.* SA	1	41	–0.73 (–1.37 to –0.10)	0.020	Low*,‡,‖
MA *vs.* TAU	2	295	–1.13 (–2.10 to –0.15)	0.020	Low*,†,‖
MA *vs.* blank group	1	90	–4.49 (–5.28 to –3.70)	<0.001	Low*,†,‡,‖
MA + EA *vs* Blank group	1	40	–1.08 (–1.75 to –0.41)	0.002	Low*,†,‡,‖
Type of substance use					
Opioids use	3	301	–3.99 (–4.61 to –3.37)	<0.001	Low*,§,‖
New drugs use	2	165	–11.03 (–28.71 to 6.65)	0.220	Very low*,‡,§
HAMD					
Type of intervention-comparator					
MA *vs.* SA	1	41	–0.54 (–1.17 to 0.08)	0.090	Low*,‡
MA *vs.* blank group	1	90	–6.08 (–7.08 to –5.08)	<0.001	Low*,‡
MA + EA *vs.* blank group	2	155	–1.17 (–1.51 to –0.82)	<0.001	Low*,‡
FA *vs.* psychotherapy	1	36	–0.49 (–1.16 to 0.17)	0.150	Low*,†
Type of substance use					
Opioids use	2	81	–3.20 (–5.19 to–1.21)	0.002	Low*,‡
Alcohol use	1	36	–1.83 (–4.19 to 0.53)	0.130	Low*,†
New drugs use	3	205	–5.21 (–11.40 to 0.98)	0.100	Low*,†
Sleep disorder score					
Type of intervention-comparator					
EA *vs.* blank group	1	50	–5.46 (–6.71 to –4.21)	<0.001	Low*,‡
MA + EA *vs.* blank group	2	175	–2.09 (–3.08 to –1.09)	<0.001	Low*,‡
WA *vs.* TAU	1	56	–19.52 (–23.31 to –15.73)	<0.001	Low*,‡
Type of substance use					
Opioids use	3	166	–2.36 (–3.23 to –1.50)	<0.001	Low*,‡
New drugs use	1	115	–1.43 (–2.34 to –0.52)	0.002	Low*,‡
Total sleep duration (h)					
Type of intervention-comparator					
MA *vs.* blank group/waitlist	2	330	0.82 (–0.01 to 1.65)	0.050	Low*,†

(Continued)

HM9_V6N3.indb 365 26-Sep-26 15:38:14

Table 2
(Continued)

Outcome or subgroup	No. of RCTs	No. of patients	SMD/MD (95%CI), random effects	*P* value	GRADE quality of body of evidence
Sleep onset latency(min)					
Type of intervention-comparator					
MA *vs.* blank group/waitlist	2	330	–3.55 (–10.47 to 3.38)	0.320	Low*,†
ISI					
Short-term follow-up					
AA *vs.* psychotherapy	1	69	–1.61 (–2.15 to –1.06)	<0.001	Low*,‡,‖
Adverse event	4	456	1.40 (0.55–3.54)	0.480	Low*,†

CI: Confidence interval; EA: Electroacupuncture; FA: Fire acupuncture; GRADE: Grading of Recommendations, Assessment, Development, and Evaluation; HAMA: Hamilton Anxiety Rating Scale; HAMD: Hamilton Depression Rating Scale; ISI: Insomnia Severity Index; MA: Manual acupuncture; MD: Mean difference; PSQI: Pittsburgh Sleep Quality Index; RCT: Randomized controlled trial; SA: Sham acupuncture; SMD: Standardized mean difference; TAU: Treatment as usual; WA: Warm acupuncture.
Short-term follow-up = 4–12 weeks.
*Downgraded one level for risk of bias: most of the included RCTs had a high risk of blinding for participants and personnel.
†95% CIs around the pooled estimate included no effect and appreciable benefit.
‡Total sample size is smaller than 200.
§Downgraded one level for heterogeneity: the statistical test for heterogeneity showed that large variation (I^2 > 50%) existed in point estimates due to among-study differences.
‖Downgraded one level for risk of bias: most of the included RCTs had an unclear risk of concealment of allocation.
Footnotes * and ‖ were considered under risk of bias, and footnotes † and ‡ were considered under imprecision, without duplicate downgrading within the same domain.

type indicated that studies using MA reported larger effect estimates than those using MA + EA (test for subgroup differences: I^2 = 98.8%, χ^2 = 80.93, P < 0.00001). Given the extremely high between-study heterogeneity and the small sample size, these findings should be interpreted cautiously. Differences in acupuncture type may have contributed to the observed heterogeneity rather than reflecting the true differences in treatment efficacy [Supplementary Figure S6, https://links.lww.com/AHM/A235].

Two trials[35,39] reported clinically relevant differences in the total HAMA scores. MA was associated with a significant reduction in HAMA scores compared with the blank control group (SMD, –4.49 [95% CI, –5.28 to – 3.70], P < 0.00001; very low-certainty evidence). In addition, MA + EA also showed a significant reduction in HAMA scores compared with the blank control group (SMD, –1.08 [95% CI, –1.75 to – 0.41], P = 0.002; very low-certainty evidence; Table 2 and Supplementary Figure S7, https://links.lww.com/AHM/A235). The pooled analysis of two trials[33,37] revealed a slight improvement in HAMA scores in the MA group compared with the TAU group (SMD, –1.13 [95% CI, –2.10 to –0.15], P = 0.02; low-certainty evidence; Table 2 and Supplementary Figure S5, https://links.lww.com/AHM/A235). One trial[42] that explored the effects of FA and health education on the efficacy of smoking cessation reported that the HAMD total score after 8 weeks of treatment was significantly lower than that in the health education group (Table 2).

Sleep disorder score

One trial[41] aimed to determine the clinical efficacy of WA compared to TAU for protracted withdrawal symptoms in heroin addicts with kidney yang deficiency. The results revealed a significant improvement in sleep disorder scores on a clinician-rated scale between the two groups (Table 2). One trial[45] on EA reported an improvement in sleep disorder scores on a clinician-rated scale compared with the blank group (SMD, –5.46 [95% CI, –6.71 to –4.21], P < 0.00001, low-certainty evidence; Table 2 and Supplementary Figure S8, https://links.lww.com/AHM/A235). Two trials[36,40] on EA + MA reported an improvement in sleep disorder scores on a clinician-rated scale compared with the blank group (SMD, –2.09 [95% CI, –3.08 to –1.09], P < 0.0001, low-certainty evidence; Table 2 and Supplementary Figure S8, https://links.lww.com/AHM/A235). Subgroup analyses indicated a statistically significant difference in the effect estimates between the EA and EA + MA subgroups (test for subgroup differences: I^2 = 94.2%, χ^2 = 17.2, P < 0.0001), suggesting that the type of intervention may be associated with variations in treatment effects. However, the EA + MA subgroup showed substantial within-group heterogeneity (I^2 = 86%), indicating that additional sources of heterogeneity may remain [Supplementary Figure S8, https://links.lww.com/AHM/A235].

Sleep parameters

Two trials[33,39] examined MA and reported the total sleep duration (hours) and sleep onset latency (minutes). The pooled analysis of these two trials revealed no clinically relevant difference between MA and the control group (TAU or blank group) in terms of total sleep duration (SMD, 0.82 [95% CI, –0.01 to 1.65], P = 0.05; low-certainty evidence; Table 2 and Supplementary Figure S9, https://links.lww.com/AHM/A235) or sleep onset latency (SMD, –3.55 [95% CI, –10.47 to 3.38], P = 0.32; low-certainty evidence; Table 2 and Supplementary Figure S9, https://links.lww.com/AHM/A235).

Total ISI score

One trial[50] reported the total ISI score for auricular acupuncture compared with that for psychotherapy. The results indicated that both auricular acupuncture

HM9_V6N3.indb 366 26-Sep-26 15:38:14

and psychotherapy decreased the mean ISI score to a mild-to-moderate range. On average, patients in the two groups started at the border of subclinical insomnia/moderate insomnia and progressed to the lowest level of subthreshold insomnia, just above the score indicating the absence of insomnia. One trial[50] used the ISI to measure sleep quality and conducted a 12-week follow-up. The trial reported that patients receiving auricular acupuncture had improved sleep quality compared with those receiving psychotherapy. However, the corresponding effect sizes were small (Table 2).

Safety of acupuncture

Two trials[34–35] reported adverse events, including pain and mild subcutaneous hemorrhage. All symptoms resolved after acupuncture was stopped. Two additional trials[38,47] reported adverse events without specifying the symptoms. No significant difference in adverse event frequency was observed between the MA and SA, waitlist, or conventional maintenance treatment groups (OR, 1.40 [95% CI, 0.55–3.54], $P = 0.48$; low-certainty evidence; Table 2, Table S2 and Supplementary Figure S10, https://links.lww.com/AHM/A235). This finding was further supported by the absence of serious adverse events or documented physical harm resulting from needling.

Trial sequential analysis

The results of the TSA with respect to the post-intervention PSQI scores are shown in Figure 3. Ten studies[33,35,38,43–44,46–49] were included in the TSA based on the results of the meta-analysis. The TSA results revealed that the cumulative Z-curve successfully crossed both the conventional test boundary and the trial-sequential monitoring boundary before reaching the RIS (RIS = 1,019). This clear crossover indicates that the cumulative evidence has achieved statistical consensus ahead of time, confirming that no further trials are required to validate the therapeutic efficacy.

Publication bias

The PSQI scores of individuals with SUD were assessed in 10 studies[33–35,38,43–44,46–49] involving 12 comparisons. Publication bias was assessed using the Egger regression test and funnel plots. The overall funnel plot was relatively symmetrical. Egger linear regression test was performed to statistically examine small-study effects, and the results revealed no potential bias ($P_{Egger} = 0.727$) (Figure 4).

Discussion

Principal findings

To the best of our knowledge, this is the first systematic review to examine the clinical effects of acupuncture on insomnia in individuals with SUD by comparing different forms of acupuncture (MA, EA, FA, and WA, with or without additional therapy) with SA, usual care, and no treatment. Data from 1,750 patients across eighteen RCTs indicated that acupuncture, particularly MA, may be an effective treatment for insomnia among individuals with SUD. The pooled results indicate that MA may improve

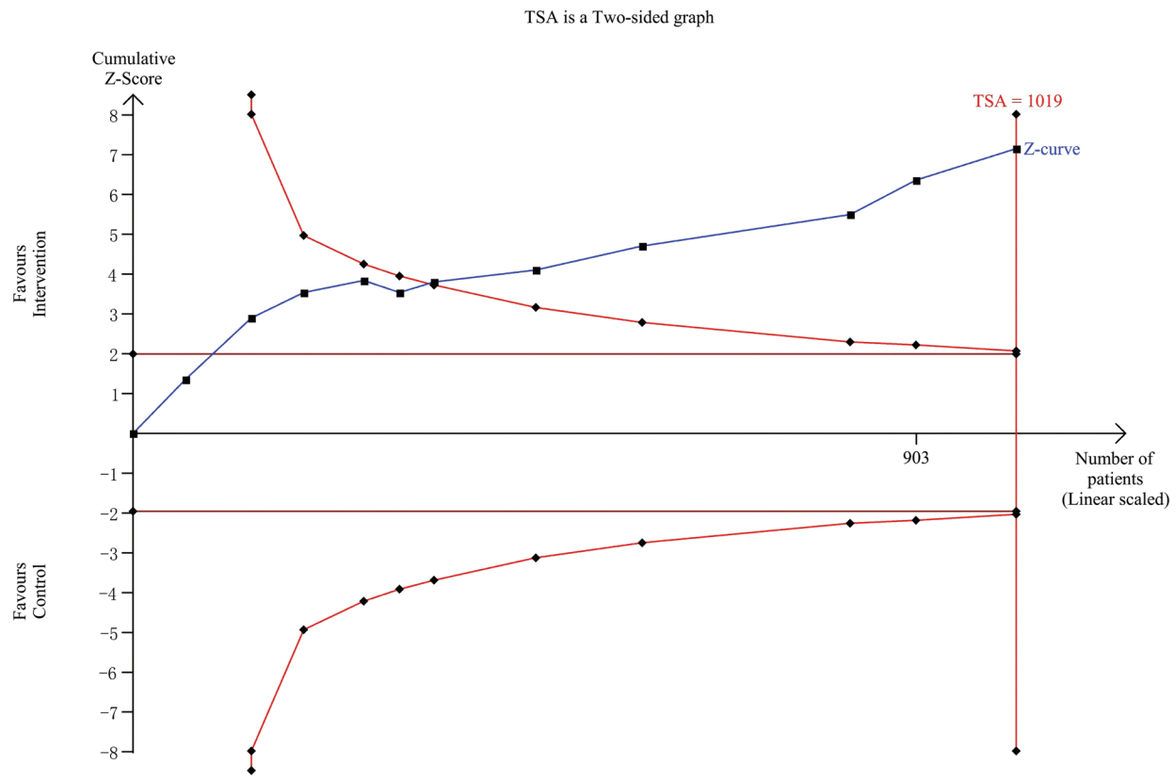


Figure 3. TSA for the Pittsburgh Sleep Quality Index among individuals with substance use disorder. TSA: Trial sequential analysis.

HM9_V6N3.indb 367 26-Sep-26 15:38:15

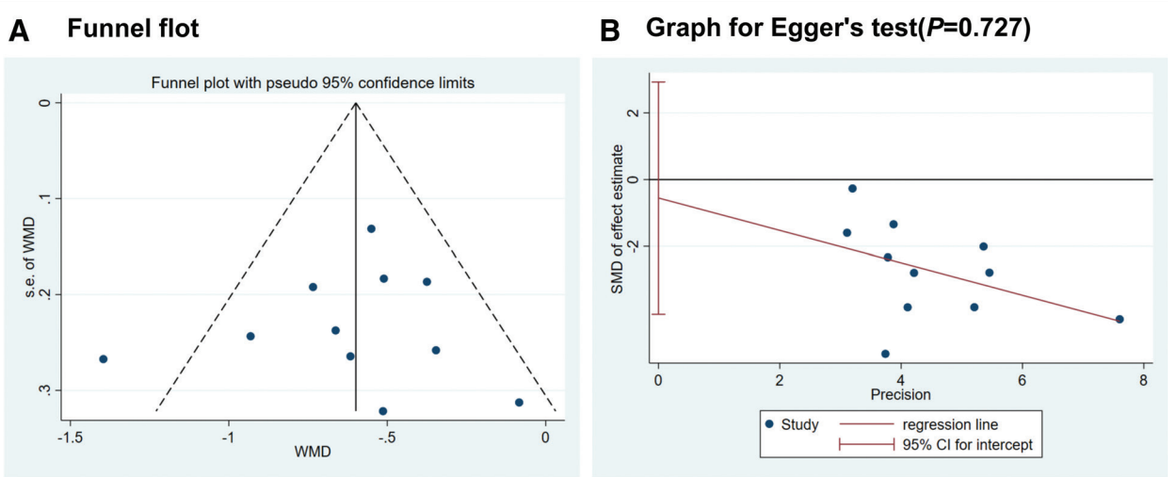


Figure 4. Publication bias for the Pittsburgh Sleep Quality Index among individuals with substance use disorder. CI: Confidence interval; se: Standard error; SMD: standardized mean difference; WMD: weighted mean difference.

sleep quality. Similarly, EA and WA demonstrate potential therapeutic benefits, showing comparable or statistically superior efficacy to conventional medicine. Subgroup analysis indicated that there may be differential effects of acupuncture procedures on SUD subtypes. Although the review included various acupuncture modalities (MA, EA, and WA), the primary focus was on MA because of the larger number of studies and higher-quality evidence. EA and WA studies were included to provide a comprehensive overview; however, their results were analyzed separately in pre-specified subgroup analyses to account for differences in intervention types. Because a substantial proportion of the studies did not adequately implement blinding or allocation concealment, performance and selection biases may have been present, potentially leading to optimistic estimates of the treatment effects.

Thirty-eight studies identified 38 acupoints, among which PC6 (Neiguan), HT7 (Shenmen), ST36 (Zusanli), SP6 (Sanyinjiao), and DU20 (Baihui) were the most frequently used. The results revealed that acupoints in the limbs (PC6, HT7, SP6, and ST36) are commonly used to treat insomnia symptoms in addictive diseases. However, clinical evidence remains scarce regarding the comparative efficacy of diverse acupuncture modalities beyond MA for patients with concurrent insomnia and SUD. Furthermore, the specific secondary impacts of these therapies on anxiety, depression, and detailed architectural sleep parameters have yet to be thoroughly elucidated.

Explanation of the results

Acupuncture has been used in China for centuries to treat insomnia in individuals with SUD. Understanding the pathophysiological mechanisms is crucial for developing an effective and comprehensive treatment protocol. Our meta-analysis supports the clinical efficacy of acupuncture in improving sleep in patients with SUD. However, neurobiological mechanisms underlying these effects remain unclear. Preclinical studies suggest that acupuncture may modulate sleep- and addiction-related neurotransmitters (eg, gamma-aminobutyric acid, dopamine, serotonin, β-endorphin) and influence brain regions *via* the microbiota-gut-brain axis[51–55]. The selection of acupoints (eg, HT7, PC6, and SP6) has also been theorized to regulate nervous system function and autonomic balance[56]. It is important to note that these mechanistic insights were derived primarily from external preclinical or theoretical studies, as the clinical trials included in this systematic review did not directly assess neurochemical or neuroanatomical changes. Therefore, although the clinical effectiveness is evident, the specific pathways involved constitute a plausible yet hypothetical explanation. Future clinical trials incorporating objective neurobiological measurements are required to directly validate these mechanisms and bridge the gap between clinical efficacy and biological understanding.

Direct neurobiological evidence clarifying how acupuncture alleviates sleep disturbances in SUD populations remains incomplete. Accumulating preclinical data indicate that acupuncture potentially modulates core neurotransmitter systems governing sleep and addiction, including gamma-aminobutyric acid, dopamine, serotonin, and β-endorphin, potentially through the microbiota-gut-brain axis[51–56]. Additionally, specific acupoint selections, such as HT7, PC6, and SP6, are hypothesized to optimize autonomic balance and neural networks[56]. Because the clinical trials aggregated in this systematic review lacked direct neurochemical or neuroanatomical assessments, these mechanistic insights serve as a plausible theoretical framework rather than definitive pathways. Consequently, prospective clinical trials utilizing multimodal data–driven frameworks and objective neurobiological markers are indispensable to validate these underlying mechanisms, thereby leveraging interpretable computational models to bridge the gap between observed clinical efficacy and systemic biological verification[57–58].

Comparisons with other studies

These findings align with prior literature[59–60], confirming that MA substantially enhances sleep quality and exerts sustained, reproducible therapeutic benefits among individuals with SUD. However, because this study evaluated multiple acupuncture modalities, the definitive clinical superiority of EA over conventional medicine requires

HM9_V6N3.indb 368 26-Sep-26 15:38:16

cautious interpretation. Although current pooled data statistically favor EA, high-quality evidence remains scarce to conclusively demonstrate that EA provides a sustained, clinically meaningful advantage over conventional therapies or SA for sleep quality improvement in individuals with SUD. These discrepancies likely stem from heterogeneities in treatment protocols, sample sizes, and the powerful placebo responses inherent to acupuncture interventions. Because of this contextual placebo effect, both genuine and sham acupuncture frequently yield superior clinical improvements compared with usual care or non-treatment controls. In addition, the pooled PSQI scores indicated that MA was associated with a mild-to-moderate improvement compared with sham controls. Additionally, the quantitative synthesis suggested a statistical benefit of MA over no-treatment controls. However, given the generally poor methodological quality and potential bias across the included trials, these findings should be interpreted with caution and treated as tentative rather than definitive evidence of clinical efficacy[61]. Furthermore, the lack of standardized acupuncture protocols across aggregated trials creates pronounced clinical and statistical heterogeneity. Diverse technical modalities, variable needle retention periods, divergent acupoint selections, and fluctuating treatment regimens collectively confound the pooled findings[62]. These methodological discrepancies ultimately obscure the true therapeutic precision when evaluating acupuncture interventions for sleep quality improvement.

Implications for clinicians and researchers

These outcomes emphasize the clinical utility of acupuncture as a viable adjunct for managing insomnia within SUD populations, demonstrating pronounced efficacy specifically among opioid-dependent cohorts. Consequently, incorporating acupuncture modalities into structured clinical protocols offers a practical strategy to optimize sleep quality.

While EA and MA have shown promise in treating their respective addictions, the existing evidence is largely derived from small-sample clinical trials, and rigorous meta-analyses and summary studies remain lacking. Therefore, more RCTs and long-term follow-up studies are required to verify the efficacy and safety of these treatments before they can be widely used. With further research on these therapies, more high-quality evidence is expected to support their use in addiction treatment. In addition, it is necessary to continue clinical research on SUD subtypes, explore the efficacy and advantages of different acupuncture therapies, optimize clinical plans, and increase the specificity of acupuncture interventions for SUD. Additionally, combining acupuncture with multi-omics approaches could provide deeper insights into its therapeutic potential and guide personalized treatment strategies[63].

Strengths and limitations

This systematic review and meta-analysis has several clinical and methodological strengths. First, this study was characterized by specific inclusion criteria, which targeted patients with comorbid SUD and insomnia to evaluate the effects of acupuncture on this specific subpopulation. Second, the observed effect size was clear, with a quantified improvement in the PSQI scores extending beyond the established MCID, indicating a measurable change in sleep quality. Third, the comprehensive subgroup analyses performed in this study provided detailed data across different acupuncture modalities and treatment frequencies, offering specific evidence to support the clinical protocol design. Finally, direct and indirect quantitative syntheses were reinforced by TSA, which effectively controlled for type I errors and evaluated the adequacy of the cumulative sample size, thereby ensuring the statistical reliability and transparency of the synthesized findings.

Several limitations inherent to this study warrant consideration. Primary methodological vulnerabilities across the aggregated trials include high risks of bias arising from inadequate sequence generation, suboptimal allocation concealment, and a lack of formal sample size estimations or inert placebo controls. Furthermore, notable clinical and statistical heterogeneity persisted across cohorts, largely driven by divergent acupuncture protocols, treatment durations, and participant characteristics[64–66]. Although pre-specified subgroup analyses identified acupuncture modality as a key moderator, a proportion of this variance remains unexplained. Evaluating secondary outcomes such as specific sleep architectural parameters and mood dimensions was further constrained by the limited number of eligible trials and a low certainty of evidence, rendering these insights exploratory rather than definitive[67–69]. Geographically, the synthesized evidence originates exclusively from cohorts in China, restricting the immediate generalizability of our findings to diverse ethnic groups, international healthcare infrastructures, or alternative cultural contexts. Regarding longitudinal data, constraints within the primary literature precluded a comprehensive assessment of long-term sustainability. While a single robust trial provided preliminary durability data over a 12-week follow-up, extended validation through global multicenter trials is essential. Finally, although individual susceptibility to insomnia within SUD populations could not be isolated due to data scarcity, the balanced baseline characteristics across the enrolled cohorts likely minimized prospective confounding.

Conclusions

This study provides evidence that MA may be more beneficial than SA in treating insomnia in individuals with SUD. Given that most of the included studies exhibited a moderate-to-high risk of bias, the strength of the conclusions should be interpreted with caution. While further high-quality RCTs (especially outside China) are needed to establish the efficacy and mechanisms, acupuncture holds promise as a complementary therapy for addiction treatment. Future studies should address these limitations and explore the potential of acupuncture in a broader clinical context.

Conflict of interest statement

Hye Won Lee is an editorial board member of Acupuncture and Herbal Medicine. The article was subject to the journal's standard peer-review procedures, with peer review handled independently of these authors and their research group. The other authors have no conflicts of interest to disclose.

HM9_V6N3.indb 369 26-Sep-26 15:38:16

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Author contributions

Liming Lu and Jingchun Zeng organized and conceived the study. Miaomiao Li, Puchen Huang, Yunshan Liang, and Kaisong Ji searched and screened the studies and assessed the risk of bias. Miaomiao Li, Yunshan Liang, Fuyuan Deng, and Mengyu Yang performed the data analysis. Jingchun Zeng, Miaomiao Li, and Kaisong Ji drafted the manuscript. Chao Liu, Peijing Rong, Hye Won Lee, and Ling Chen reviewed the manuscript. Jingchun Zeng and Liming Lu supervised the entire research process. All the authors read and approved the final manuscript.

Ethical approval of studies and informed consent

Not applicable.

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None.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request.

Declaration of generative AI in scientific writing

During the preparation of this manuscript, the authors utilized generative AI tools solely for the purpose of language editing, grammatical correction, and enhancing readability. After using these services, the authors thoroughly reviewed, verified, and edited the content to ensure scientific accuracy and logical consistency. The authors accept full responsibility for the final integrity and scientific validity of the entire manuscript.

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HM9_V6N3.indb 370 26-Sep-26 15:38:16

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HM9_V6N3.indb 371 26-Sep-26 15:38:16