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Efficacy and Mechanism of Integrated Chinese-Western Aromatherapy for Sleep Disorders: A Systematic Review and Meta-analysis*

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Objective: To systematically evaluate the effect of aromatherapy on patients with sleep disorders, with a focus on the clinical value of integrating Chinese and Western aromatherapy approaches, and to elucidate its sleep-promoting mechanisms from an integrative medicine perspective. Methods: Databases including PubMed, EMBASE, the Cochrane Library, Web of Science, CNKI, Wanfang, and VIP were searched from inception to June 2025. Randomized controlled trials (RCTs) on aromatherapy for sleep disorders were included. Literature screening, data extraction, and risk of bias assessment were conducted according to the PRISMA 2020 statement. Meta-analysis, subgroup analysis, and sensitivity analysis were performed using a random-effects model. Mechanisms were explored by integrating Chinese and Western theoretical perspectives. Results: Thirty-one RCTs involving 2,786 participants were included. Meta-analysis showed that aromatherapy significantly improved sleep quality (SMD = -0.82, 95% CI: -1.01 to -0.63, $P < 0.001$), shortened sleep latency, prolonged total sleep time, and reduced nocturnal awakenings. Subgroup analysis indicated that inhalation was superior to massage, and blended formulas were superior to single essential oils. The integrated Chinese-Western approach, which combined Traditional Chinese Medicine (TCM) syndrome differentiation, acupoint application, and tranquilizing theory, demonstrated more stable effects, lower heterogeneity, and higher patient compliance. The overall methodological quality of the included studies was moderate, with no serious adverse events reported. Conclusion: Aromatherapy is an effective and safe adjunctive intervention for sleep disorders. The integration of Chinese and Western aromatherapy successfully combines modern essential oil pharmacology with the holistic theory, cultural wisdom, and individualized principles of TCM—such as “calming the mind with fragrance, regulating Qi, and harmonizing Yin and Yang”. This fusion offers unique value and provides an important framework for developing culturally informed, personalized sleep health interventions.

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Introduction

Sleep disorders are a highly prevalent global public health issue, causing long-term impairment to quality of life and physical and mental health (World Health Organization, 2024). While pharmacological treatments like sedative-hypnotics can provide short-term symptom relief, they carry risks of dependence, cognitive side effects, and rebound insomnia, fueling the demand for non-pharmacological interventions (Chinese Society of Psychosomatic Medicine, 2024). Aromatherapy, a natural, easily administered, and well-accepted complementary and alternative therapy, shows unique potential in improving sleep.

Modern Western aromatherapy is grounded in phytochemistry, focusing on the quantifiable modulation of the limbic system, the hypothalamic-pituitary-adrenal (HPA) axis, and neurotransmitters (e.g., GABA, serotonin) by essential oil constituents via the olfactory pathway. Its research paradigm emphasizes reproducible biological mechanisms (Lei, Smith, & Johnson, 2024; Oh, Park, & Kim, 2023). In contrast, Traditional Chinese Aromatic Therapy (TCAT) is deeply rooted in Chinese medical theory and cultural soil. Its core philosophy is the holistic view of "the unity of heaven and humanity" and the mind-body concept of "form and spirit as one". Traditional Chinese Medicine (TCM) views sleep disorders as stemming from a disharmony between Yin and Yang, restlessness of the mind, or imbalance of *Zang-Fu* organ Qi and blood. It emphasizes holistic regulation through aromatic herbs to "open the orifices", "calm the mind", "regulate Qi", and "harmonize Yin and Yang", with great emphasis on "treatment based on syndrome differentiation" and the synergistic use of meridians and acupoints (Wang, Sun, & Chen, 2023). This elevates TCAT beyond a mere technique to a mind-body regulatory practice imbued with natural philosophy and cultural value.

Although several systematic reviews have confirmed the positive effects of aromatherapy on sleep (Posadzki, Watson, & Alotaibi, 2023), existing syntheses have primarily focused on aggregating efficacy data from Western aromatherapy. They have largely failed to integrate and highlight the unique theoretical essence, cultural connotations, and individualized strategies of TCAT, and lack in-depth exploration of the mechanisms underlying an organically integrated Chinese-Western model. Therefore, this study aims to use systematic review and meta-analysis methods. While quantitatively assessing the overall efficacy of aromatherapy, it will particularly focus on analyzing the synergistic mechanisms and value of integrated Chinese-Western aromatherapy from a combined medical and cultural fusion perspective, clarifying the clinical advantages of the integrated model. The goal is to provide high-level evidence and a practical framework for developing sleep health promotion strategies that are more culturally appropriate, theoretically systematic, and individually tailored.

Methods

Study Design and Registration

This study is a systematic review and meta-analysis designed and reported in strict accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement (Page et al., 2021). The study protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO), registration number CRD42025335697.

Literature Search Strategy

Two researchers independently systematically searched the following Chinese and English databases:

PubMed, EMBASE, the Cochrane Library, Web of Science, China National Knowledge Infrastructure (CNKI), Wanfang Data Knowledge Service Platform, and VIP Chinese Journal Service Platform (VIP). The search timeframe was from the inception of each database to June 2025. Additionally, the reference lists of included studies were manually searched to identify potentially missed literature.

The English search employed a combination of subject headings and free-text terms. Key search terms included: “aromatherapy”, “essential oil*”, “fragrance”, “odor*”; “sleep disorder*”, “insomnia”, “sleep quality”, “sleep initiation and maintenance disorders”, “randomized controlled trial”, “RCT”. Chinese search terms included: aromatherapy, essential oil, aromatherapy/fragrance, aroma, sleep disorder, insomnia, sleep quality, insomnia in TCM, randomized controlled trial. Specific search strategies were tailored to the rules of each database.

Inclusion and Exclusion Criteria

Inclusion criteria: (1) Study type: Randomized Controlled Trial (RCT), regardless of blinding. (2) Participants: Adults (age ≥18 years) diagnosed with or assessed as having a sleep disorder using internationally recognized scales (e.g., PSQI, ISI), regardless of race, nationality, or gender. (3) Intervention: The experimental group received any form of aromatherapy as a primary or adjunctive intervention, including but not limited to essential oil inhalation, diffusion, aromatic massage, or spray. No restrictions were placed on essential oil type, concentration, brand, or treatment duration. (4) Control: Blank control, usual care, placebo (e.g., odorless carrier oil, inactive scent), or other non-aromatherapy interventions. (5) Outcomes: At least one quantifiable sleep-related outcome, such as Pittsburgh Sleep Quality Index (PSQI) total score, sleep latency, total sleep time, sleep efficiency, or number of nocturnal awakenings.

Exclusion criteria: (1) Non-RCT designs (e.g., reviews, case reports, observational studies). (2) Animal studies. (3) Studies involving healthy populations or individuals without identified sleep problems. (4) Interventions where aromatherapy was not an independent factor (e.g., part of a complex intervention package where its effect could not be isolated). (5) Unavailable or non-extractable data. (6) Literature not published in Chinese or English.

Literature Screening and Data Extraction

Literature screening and management were performed using EndNote X9 software. After removing duplicates, two researchers independently screened titles and abstracts for initial exclusion of clearly ineligible studies. Full texts of potentially eligible studies were retrieved, and two researchers independently reviewed them for final inclusion. Disagreements were resolved through discussion or by consulting a third researcher.

A pre-designed data extraction form was used. Two researchers independently extracted data and cross-checked the results. Extracted information included: (1) Basic study information (first author, publication year, country). (2) Participant characteristics (sample size, age, gender, diagnostic criteria). (3) Intervention and control details (name/composition of essential oil/formula, mode of administration, concentration, frequency, single session duration, total course). (4) Use of an integrated Chinese-Western model (defined in this study as: the explicit combination of TCM theory guidance—such as selecting formulas based on TCM syndrome differentiation or applying oils to specific acupoints/meridians—with the use of plant essential oils). (5) Outcome data (means, standard deviations, sample sizes at various time points). (6) Safety information. (7) Methodological details (randomization, allocation concealment, blinding, etc.).

Risk of Bias Assessment

The risk of bias for each included RCT was assessed using the Cochrane Collaboration's recommended Risk of Bias tool (RoB 2.0) (Sterne et al., 2019). This tool evaluates five domains: randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result. Each study was judged as having "low risk", "high risk", or "some concerns" in each domain by two independent researchers, with consensus reached.

Statistical Analysis

Meta-analysis was performed using RevMan 5.4 software. For continuous outcome measures, the standardized mean difference (SMD) and its 95% confidence interval (CI) were used as the effect size. When studies used the same scale, the weighted mean difference (WMD) was also calculated. The I^2 statistic was used to assess heterogeneity among studies: $I^2 \leq 25\%$ indicated low heterogeneity, $25\% < I^2 \leq 50\%$ moderate heterogeneity, and $I^2 > 50\%$ high heterogeneity. A random-effects model was used for meta-analysis if $I^2 \geq 50\%$; otherwise, a fixed-effects model was applied.

To explore sources of heterogeneity and the impact of the integrated model, the following subgroup analyses were pre-planned: (1) Mode of administration (inhalation vs. massage/topical application). (2) Formula type (single essential oil vs. blended formula). (3) Treatment duration (≤4 weeks vs. >4 weeks). (4) Use of the integrated Chinese-Western model. Publication bias was assessed visually using funnel plots and quantitatively using Egger's regression test. Sensitivity analysis was conducted by sequentially removing individual studies to test the robustness of the pooled results.

Results

Literature Screening Flow and Results

The initial database search yielded 3,864 records. After removing duplicates, 2,419 records remained. Screening of titles and abstracts excluded 2,150 records. Full texts of 269 articles were assessed, resulting in the final inclusion of 31 eligible RCTs. The literature screening process and reasons for exclusion are detailed in the Following analysis.

Characteristics of Included Studies

The 31 studies were published between 2010 and 2024, involving countries such as China, South Korea, Japan, Iran, and the United States, with a total sample size of 2,786 participants. Study populations included primary insomnia, perimenopausal insomnia, insomnia comorbid with chronic diseases (e.g., hypertension, coronary heart disease), hospitalized patients, and sleep disorders in middle-aged and older adults. Regarding interventions, inhalation via respiratory tract (using diffusers, humidifiers, or inhalers) was the most common (21 studies, 67.7%), followed by dermal massage or topical application (8 studies, 25.8%), with 2 studies (6.5%) combining acupoint massage or application. The most frequently used single essential oil was lavender (18 studies), followed by chamomile (6 studies) and bergamot (5 studies). Some studies used blended formulas or formulas designed according to TCM theory (e.g., calming formulas, depression-relieving formulas). Nine studies (29.0%) explicitly adopted the integrated Chinese-Western model, incorporating TCM syndrome differentiation (e.g., selecting formulas for "Liver Qi Stagnation Transforming into Fire" or "Heart-Spleen Deficiency" types) or stimulation of specific acupoints (e.g., Shenmen (HT7), Neiguan (PC6), Annian (EX-HN), Yongquan (KI1)) into the essential oil application.

Risk of Bias Assessment Results

The overall methodological quality of the included studies was moderate. In the "randomization process" domain, most studies were rated as low risk. However, in the "deviations from intended interventions" and "measurement of the outcome" domains, most studies were rated as high risk or had some concerns due to the inherent difficulty of effectively blinding participants and personnel to the distinctive odor of aromatherapy. In the "missing outcome data" and "selection of the reported result" domains, most studies were rated as low risk. A summary of the risk of bias is presented in following as.

Meta-analysis Results

Primary outcome: Overall sleep quality. Twenty-eight studies reported overall sleep quality (mostly assessed by PSQI total score or similar scales). Random-effects model meta-analysis showed that the aromatherapy group was significantly superior to the control group in improving sleep quality, with a pooled effect size of SMD = -0.82 (95% CI: -1.01 to -0.63, $P < 0.001$). A negative SMD indicates superiority of the aromatherapy group. There was high heterogeneity among studies ($I^2 = 68\%$). The forest plot is shown in following as.

Secondary outcomes.

- Sleep latency: Pooled analysis of 16 studies showed that aromatherapy significantly shortened sleep latency (SMD = -0.75, 95% CI: -0.92 to -0.58, $P < 0.001$).
- Total sleep time: Pooled analysis of 14 studies showed that aromatherapy significantly prolonged total sleep time (SMD = 0.69, 95% CI: 0.52 to 0.86, $P < 0.001$).
- Nocturnal awakenings: Pooled analysis of 12 studies showed that aromatherapy significantly reduced the number of nocturnal awakenings (SMD = -0.68, 95% CI: -0.84 to -0.52, $P < 0.001$).
- PSQI total score: Pooled analysis of 22 studies using the PSQI scale showed that aromatherapy significantly reduced the PSQI total score (SMD = -0.86, 95% CI: -1.05 to -0.67, $P < 0.001$).

Subgroup analysis. Subgroup analysis revealed several important trends:

- Mode of administration: The effect size for improving sleep quality was slightly larger for inhalation (SMD = -0.89, 95% CI: -1.12 to -0.66) than for massage/topical application (SMD = -0.65, 95% CI: -0.92 to -0.38).
- Formula type: The effect was slightly better for blended formulas (SMD = -0.94, 95% CI: -1.20 to -0.68) than for single essential oils (SMD = -0.67, 95% CI: -0.88 to -0.46).
- Integrated Chinese-Western model: This was a key finding of the analysis. The subgroup of nine studies using the integrated model had a pooled effect size of SMD = -0.91 (95% CI: -1.10 to -0.72) and significantly lower heterogeneity ($I^2 = 32\%$). In contrast, the subgroup of 22 studies not explicitly using the integrated model had an effect size of SMD = -0.75 (95% CI: -1.00 to -0.50) but higher heterogeneity ($I^2 = 75\%$). Results were more consistent within the integrated model subgroup.

Publication Bias and sensitivity analysis. The funnel plot for the primary outcome (overall sleep quality) showed that study points were roughly symmetrically distributed around the pooled effect size. Egger's test did not indicate significant publication bias ($t = 1.23$, $P = 0.22$). Sensitivity analysis showed that after sequentially removing any single study, the pooled SMD for overall sleep quality fluctuated between -0.78 and -0.85, with the lower limit of the 95% CI for all results remaining below zero, indicating that the meta-analysis results were robust.

Safety

None of the 31 included studies reported any serious adverse events related to aromatherapy. A few studies reported mild and transient adverse reactions, such as individual participants experiencing dizziness, mild nasal

or skin irritation, or discomfort with specific scents. These reactions resolved spontaneously after discontinuing the intervention or reducing the concentration, requiring no special treatment.

Discussion

This study synthesizes evidence from 31 RCTs up to 2025, confirming through meta-analysis the effectiveness and favorable safety profile of aromatherapy as an adjunctive intervention for sleep disorders, with an overall effect size ranging from moderate to large. This finding is generally consistent with previous international systematic reviews (Oh et al., 2023; Posadzki et al., 2023), further solidifying the evidence base for this therapy. However, the core contribution and unique insight of this study lie in the in-depth subgroup analysis, which for the first time quantitatively suggests a potential advantage of the integrated Chinese-Western aromatherapy model. This model not only showed a slightly higher effect trend but, more importantly, demonstrated significantly lower heterogeneity. This suggests that interventions under the integrated model may produce more consistent and predictable efficacy. It strongly implies that therapeutic benefits depend not only on the chemical constituents of the essential oils (the "material" level) but are also substantially enhanced by the individualized framework and cultural-cognitive context provided by TCM theory (the "mind-body" level). Their combination creates a more synergistic "healing environment".

The cultural value and practical wisdom of TCAT are central to the advantage of the integrated model. TCAT is not a simple "substance-receptor" model but is deeply rooted in the Eastern life philosophy of "correspondence between humanity and nature" and "nurturing both form and spirit" (Chen, 2024). It views "insomnia" as an external manifestation of an imbalanced overall life state, emphasizing the use of aromatic herbs to "dredge meridians, open pores, enliven the spleen, please the mind, and calm the spirit", thereby regulating Qi dynamic, balancing Yin and Yang, and restoring mental tranquility. The essence of "treatment based on syndrome differentiation"—for example, selecting liver-soothing and depression-relieving formulas like bergamot and mint for the "Liver Qi Stagnation Transforming into Fire" pattern marked by irritability and insomnia, or selecting Qi-invigorating and mind-calming formulas like sandalwood and ambergris for the "Heart-Spleen Deficiency" pattern marked by light sleep and easy awakening—enables precise individualization of the intervention (Wang et al., 2023). This "pattern-based" individualized strategy, just makes up for the relative shortcoming of Western aromatherapy's standardized protocols in considering individual differences, potentially explaining the higher patient compliance and more stable efficacy observed in the integrated model group (Zhang, Zhao, & Liu, 2024).

From the perspective of integrated mechanisms, the Chinese-Western fusion provides a multi-level, complementary explanatory framework. At the micro-physiological level, Western research elucidates the clear pathways by which specific aromatic molecules (e.g., linalool, linalyl acetate) modulate GABA_A receptors, enhance serotonergic activity, and inhibit cortisol secretion via the olfactory bulb-limbic system pathway (Lei et al., 2024). At the macro mind-body level, TCM theory uses concepts like "fragrance opens the orifices and refreshes the mind", "fragrance moves Qi and relieves depression", and "fragrance resolves turbidity and harmonizes the middle" to systematically describe how aroma influences a person's emotions, Qi dynamic, and *Zang-Fu* organ function. For instance, "moving Qi and relieving depression" corresponds to alleviating stress and improving anxious mood, which aligns with the modern mechanism of downregulating HPA axis activity and elevating mood state. "Refreshing and calming the mind" encompasses the complete psychophysiological process from alertness regulation to deep relaxation. The fusion of the two expands our understanding of "aroma-

assisted sleep" from isolated neurobiochemical targets to an integrative mind-body regulatory model encompassing biological, psychological, and socio-cultural factors.

Based on the above evidence and theory, we attempt to construct a practice framework infused with cultural wisdom, which can be summarized as: "Pre-sleep inhalation as the core, syndrome-differentiated aroma selection as the guiding principle, acupoint massage as an adjunct, breath guidance as synergy, and a cultural context as the foundation". Specifically, it is recommended that during the evening wind-down period, one selects a blended aroma that matches the user's current primary pattern or mind-body state (e.g., lavender + bergamot for liver constraint, sandalwood + ylang-ylang for heart-kidney imbalance), diffusing it at a low concentration via a diffuser. This can be combined with gentle massage of calming acupoints such as Shenmen (HT7), Neiguan (PC6), and Sanyinjiao (SP6). Guided, slow, deep abdominal breathing should be encouraged, focusing attention on the aroma and bodily sensations. The entire process should take place in a quiet, comfortable, and dimly lit environment, transforming it into a conscious pre-sleep relaxation ritual. This framework emphasizes "Western quantification ensuring safety, TCM pattern differentiation enhancing precision, and cultural integration improving compliance", aiming to shift the intervention from a passive receipt to an active, participatory mind-body conditioning practice.

This study has several limitations. First, the included studies generally had difficulties in implementing blinding, potentially introducing performance and detection bias. Second, substantial variations in the variety, origin, extraction process, concentration, and course of treatment of essential oils across studies constitute an important source of clinical heterogeneity. Third, the number of studies that clearly adopted a high-standard, well-specified integrated model remains relatively limited (9/31), and the specific methods and depth of integration varied, which may affect the strength of the subgroup analysis conclusion. Fourth, the vast majority of studies had short follow-up periods (≤ 8 weeks), lacking data on long-term efficacy and sustained safety. Finally, this study primarily relied on subjective scale outcomes; future research needs to incorporate more objective measures (e.g., polysomnography, actigraphy, salivary cortisol).

Future research directions should include: (1) conducting large-scale, multi-center, high-quality RCTs with active placebo controls (e.g., low-concentration or inactive scents) and long-term follow-up, specifically to verify the efficacy and safety of integrated Chinese-Western aromatherapy, (2) utilizing technologies such as neuroimaging (e.g., fMRI), electrophysiology (EEG), and metabolomics to deeply reveal the mechanism networks of the integrated therapy from a multi-omics perspective, (3) strengthening qualitative research to gain an in-depth understanding of patient experiences, cognitions, and cultural identification during the integrated therapy process and their impact on efficacy, (4) based on evidence and expert consensus, gradually developing standardized operational guidelines applicable to different populations and patterns, promoting its standardized application in clinical nursing, community health management, and integrative medicine centers.

Conclusion

In summary, current evidence indicates that aromatherapy is an effective and safe non-pharmacological intervention option for improving sleep disorders. The innovative finding of this study is that subgroup analysis suggests the integrated Chinese-Western aromatherapy model, which incorporates TCM's dialectical treatment thinking and cultural wisdom, may achieve more stable and consistent efficacy and enhance patient acceptance by strengthening individualized targeting and mind-body integration. This fusion path of "culture as the essence, science as the application" not only offers a new optimized strategy for the clinical management of sleep disorders

but also provides a valuable example for inheriting and developing traditional medical wisdom in a modern context and constructing an integrative health model that combines scientific rigor with humanistic care. Deepening research and practice in this field is of great significance for enriching the non-pharmacological intervention repertoire of global sleep medicine.

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