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Inhalation Aromatherapy for Improving Sleep Quality in Adults: A Systematic Review and Meta-analysis of Trials Using the Pittsburgh Sleep Quality Index (PSQI)

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Abstract:

Adults frequently experience sleep disturbances, which add to their health burden. Although inhalation aromatherapy is an inexpensive, non-pharmacological approach, evidence based on standardized assessments remains inconsistent. We conducted a PRISMA 2020-guided systematic review and meta-analysis of controlled clinical trials in adults aged 18-65 years, searching PubMed and Google Scholar in December 2025. Eligible trials compared inhalation aromatherapy with a control condition and reported post-intervention Pittsburgh Sleep Quality Index (PSQI) total score. We pooled standardized mean differences using a random-effects model (Hedges' g). After screening 219 titles/abstracts and assessing 51 full texts, nine studies met inclusion criteria and five contributed to the meta-analysis. Aromatherapy improved sleep quality versus control (SMD = -0.83; 95% CI: -1.19 to -0.48; I^2 = 53.5%), where lower PSQI indicates better sleep. Most trials used lavender (Lavandula angustifolia) or damask rose (Rosa damascena) in clinical settings or among participants with insomnia. Certainty is limited by few trials, heterogeneity, and risk of bias. Larger, well-designed randomized trials with standardized dosing, adequate blinding, and longer follow-up are needed.

Keywords: Aromatherapy, Inhalation, Essential oils, Sleep quality, PSQI, Meta-analysis

1. Introduction

Insomnia and sleep disturbance are very common among working-age individuals and pose a significant public health concern. A recent systematic review reported that 16.2% of adults worldwide experience insomnia, and 7.9% have severe insomnia. This condition has significant negative effects on productivity, quality of life, and mental and physical health [1]. These costs drive the quest for practical, low-risk therapies that can be used in conjunction with behavioral and conventional sleep hygiene counseling. Poor sleep quality is also prevalent in work environments in Thailand. For instance, on the Thai version of the Pittsburgh Sleep Quality Index (T-PSQI), 345 inpatient professional nurses at a large academic hospital in Bangkok (mean age 34.8 ± 10.4 years) reported poor sleep quality with a mean score of 8.6 ± 4.3; poorer sleep was linked to younger age, limited exercise, shift patterns, and perceived workload [2]. Strategies that are practical for working adults with hectic schedules are especially important in the Thai context, given the proven connections between sleep deprivation, safety, and performance [2].

Validated patient-reported tools are frequently used to evaluate sleep quality in both clinical and research contexts. A popular 19-item survey that offers a global score that takes into account many aspects of sleep throughout the previous month is the Pittsburgh Sleep Quality Index (PSQI) [3]. Cross-study comparisons are made easier by the satisfactory reliability and validity of the Thai version of the PSQI, which supports its use in Thai-speaking populations [4].

Complementary methods, such as essential oil inhalation aromatherapy, are frequently employed to promote rest and sleep. Among the most frequently researched oils are lavender (*Lavandula angustifolia*) and damask rose (*Rosa damascena*). Lavender, linalool, and linalyl acetate have been associated with sedative/anxiolytic effects that may lessen presleep hyperarousal [5]. Volatile compounds may work through olfactory–limbic pathways with downstream modification of autonomic and neuroendocrine activities.

However, oil type, concentration, delivery technique, timing, and demographic context (e.g., baseline stress or comorbidities) are likely to influence clinical outcomes. Inference for inhalation-only aromatherapy is limited by the wide range of existing trials and the fact that previous syntheses frequently pooled various delivery routes (such as massage/topical application) and variable sleep outcomes. We concentrated on inhalation aromatherapy and a single primary outcome indicator, the PSQI total score, in order to produce a clinically interpretable estimate. In order to determine if inhalation aromatherapy enhances PSQI-measured sleep quality in individuals between the ages of 18 and 65, we carried out a systematic review and meta-analysis of randomized controlled trials.

2. Materials and Methods

2.1. Research question and PICO framework

Research question: Among adults aged 18–65 years, does inhalation aromatherapy improve sleep quality measured by the PSQI total score compared with a control condition?

PICO framework:

Population (P): Adults aged 18–65 years in any setting (healthy or clinical).

Intervention (I): Inhalation aromatherapy using essential oils (single oil or specified blend).

Comparator (C): Placebo, usual care, or no aromatherapy.

Outcome (O): PSQI total score (primary outcome).

2.2. Reporting guideline and protocol registration

This systematic review and meta-analysis was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. A review protocol was not registered (e.g., PROSPERO/OSF) prior to study initiation.

2.3. Eligibility criteria

Inclusion criteria:

1. Adults aged 18–65 years (or mean age within this range with no explicit inclusion of participants >65 years).

2. Inhalation aromatherapy with an essential oil (single oil or specified blend).
3. Comparator group (placebo/usual care/no aromatherapy).
4. PSQI total score reported at post-intervention (and/or pre–post enabling effect size calculation).
5. Clinical trial design (randomized, quasi-randomized, or controlled clinical trial).
6. Full text available.

Exclusion criteria:

1. Non-inhalation routes (e.g., massage, topical application, or oral products).
2. Pediatric populations or older-adult-only populations.
3. Sleep outcomes not including PSQI total score.
4. Non-controlled studies, reviews, protocols, case reports, or animal studies.

2.4. Information sources and search strategy

On December 19, 2025, PubMed was searched, and on December 21, 2025, Google Scholar. We filtered the top 200 items by relevance because Google Scholar can produce enormous result sets. Inhalation, PSQI/sleep quality, and aromatherapy/essential oils were all incorporated in the search phrases.

PubMed search strategy:

(aromatherapy OR "essential oil" OR lavender OR "*Rosa damascena*" OR "damask rose") AND ("Pittsburgh Sleep Quality Index" OR PSQI OR "sleep quality") AND (inhalation OR inhaled OR aroma).

Google Scholar search strategy:

(aromatherapy OR "essential oil" OR lavender OR "*Rosa damascena*" OR "damask rose") AND ("Pittsburgh Sleep Quality Index" OR PSQI) AND inhalation.

2.5. Study selection

Records were screened by titles/abstracts followed by full-text assessment. Duplicate full texts were removed at the eligibility stage. Screening and inclusion decisions were performed by a single reviewer, with repeated verification against eligibility criteria. This single-reviewer workflow is reported as a methodological limitation.

2.6. Data extraction

We extracted PSQI results as well as study parameters (population, setting, intervention, comparator, and duration). Studies were included in the qualitative synthesis, and where post-intervention PSQI means and standard deviations were available, they were extracted for meta-analysis.

2.7. Risk of bias assessment

Risk of bias for randomized trials was assessed using the Cochrane Risk of Bias 2 (RoB 2) tool across five domains [7]. Judgments were categorized as low risk, some concerns, or high risk.

2.8. Statistical analysis

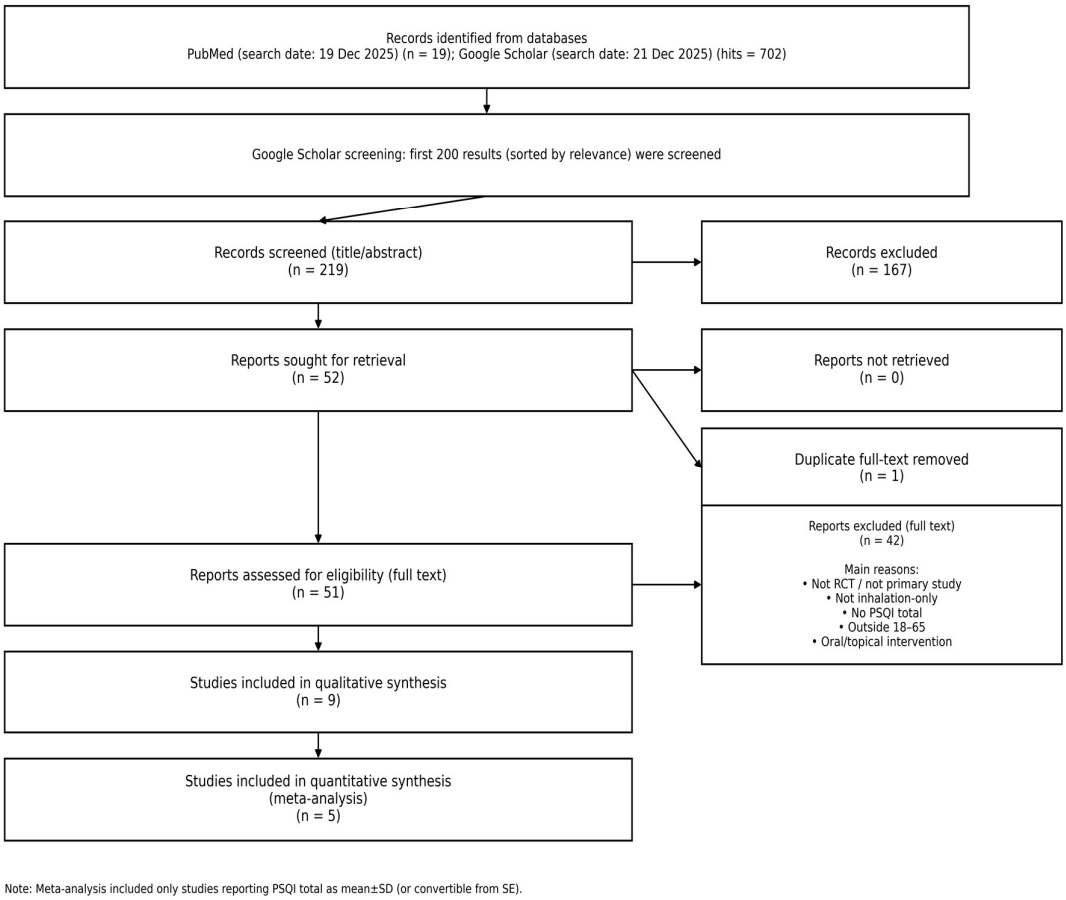
Standard meta-analytic techniques were used in the statistical study. Using post-intervention means and standard deviations, we computed standardized mean differences (SMDs; Hedges' g) for the PSQI total score. A random-effects model (DerSimonian–Laird) was used to pool effect sizes [8]. Cochran's Q test, the I^2 statistic, and the between-study variance τ^2 were used to assess statistical heterogeneity [9]. Standard procedures were followed to apply small-sample bias correction for Hedges' g where necessary [11]. R was used for the analyses (meta and metafor packages).

2.9. Certainty of evidence (GRADE)

The GRADE method was used to evaluate the degree of certainty of the evidence, which was categorized as high, moderate, low, or very low certainty [10], [12]. This method took into account the risk of bias, inconsistency, indirectness, imprecision, and publication bias.

3. Results

3.1. Study selection



Note: Meta-analysis included only studies reporting PSQI total as mean±SD (or convertible from SE).

Figure 1. PRISMA 2020 research selection flow diagram (first 200 Scholar records evaluated; PubMed searched December 19, 2025; Google Scholar searched December 21, 2025).

702 Google Scholar hits and 19 PubMed records were found through database searching (the first 200 results were filtered based on relevance). 167 of the 219 items that were checked by title or abstract were eliminated. After retrieving 52 full-text reports (one duplicate), 51 were assessed for eligibility. Table 3 summarizes the reasons for the exclusion of 42 reports. Five studies contributed to the quantitative synthesis (meta-analysis), while nine studies were part of the qualitative synthesis (Figure 1).

Table 3. Full-text exclusions with reasons (n = 42).

Reason for exclusion at full-text stage	n
Sleep outcomes did not include PSQI total score	28
Other eligibility reasons (see paragraph below)	14

Notes: Among the 51 full-text reports assessed, 42 were excluded. The most common reason was absence of PSQI total score (n = 28). Other eligibility reasons (n = 14) most commonly reflected non-inhalation aromatherapy (e.g., massage/topical/oral), no control/comparator group, ineligible age range (older-adult-only or mixed populations without separable 18-65 data), or non-trial designs (e.g., observational studies, reviews, protocols). A complete list of excluded full-text reports is available upon request.

3.2. Characteristics of included studies

Nine randomized trials assessed the effectiveness of inhalation aromatherapy for improving sleep quality in a variety of adult populations, such as patients in the coronary intensive care unit, patients undergoing heart surgery, cancer patients, postmenopausal women experiencing insomnia, medical staff during the COVID-19 pandemic, and other inpatient or clinical settings. Damask rose (*Rosa damascena*) was used in several trials, while lavender essential oil was used most frequently. The length of the interventions varied from five to thirty nights. Table 1 provides a summary of the main study characteristics [13]–[21].

The distribution of age and sex was not consistently calculated since these data were provided differently in each study.

Table 1. Characteristics of included studies.

Study	Country	n (I/C)	Setting / population	Intervention (inhalation)	Comparator	Duration	PSQI timing
Karadag et al. [13]	Turkey	60 (30/30)	Coronary ICU patients	Lavender EO 2%: 2 drops on cotton gauze attached ~12 inches below nose; inhaled 20 min nightly	No aromatherapy	15 days	Baseline and day 15
Emami-Sigaroudi et al. [14]	Iran	97 (3-arm RCT: 31/34/32)	CABG surgery patients	Lavender or damask rose: 3 drops on pillow nightly at 22:00	Usual care (no aromatherapy)	5 nights	Baseline and day 6
Heydarirad et al. [15]	Iran	54 (3-arm RCT: 18/18/18)	Cancer patients	Rosa damascena EO: 5 drops on cotton ball 4–5 cm from nose; inhaled 20 min before bed	No intervention	2 weeks	Baseline and end of intervention
Lucena et al. [16]	Brazil	35	Postmenopausal women with insomnia	Lavender kit: brief inhalations (2 min ×2, 10-min interval) plus cotton ball by pillow during sleep	Sunflower oil placebo	29 days	Pre and post intervention

Study	Country	n (I/C)	Setting / population	Intervention (inhalation)	Comparator	Duration	PSQI timing
Mahdood et al. [17]	Iran	80 (40/40)	Operating room personnel (COVID-19 period)	Damask rose: 2 drops inhaled 10 min at start of shift + 5 drops on cloth by pillow nightly	Paraffin oil placebo	30 nights	Baseline and day 31
Mahdavikian et al. [18]	Iran	105 (3-arm RCT: 35/35/35)	Cardiac patients	Peppermint vs lavender inhalation aromatherapy (protocol per study)	Control group	7 days	Baseline and post
Lillehei et al. [19]	United States	53	College students with sleep issues	Lavender patch (55 µL) worn on chest at night + sleep hygiene	Blank patch + sleep hygiene	5 nights (+2-week follow-up)	Baseline, post, and 2-week follow-up
Atashi et al. [20]	Iran	60	Athletes before competition	Red rose EO: 3 drops on pillow nightly; inhaled during sleep	No aromatherapy	4 nights	Pre-test and morning of competition
Hamzeh et al. [21]	Iran	120 (3-arm RCT: 40/40/40)	Cancer patients	Lavender or peppermint: 3 drops on cotton ball attached to collar for 20 min nightly	Aromatic distilled water placebo	7 days	Baseline and day 8

Abbreviations: CABG, coronary artery bypass graft; ICU, intensive care unit; EO, essential oil; OR, operating room; PSQI, Pittsburgh Sleep Quality Index; RCT, randomized controlled trial.

3.3. Risk of bias (RoB 2)

Table 2. Risk of bias (RoB 2) domain-level judgments for included randomized trials.

Study	Randomization	Deviations	Missing data	Outcome measure	Selective reporting	Overall
Karadag et al. [13]	Some concerns (concealment unclear)	Some concerns (no placebo)	Low	Some concerns (self-report)	Some concerns	Some concerns
Emami-Sigaroudi et al. [14]	Some concerns (room-based randomization)	Some concerns	Low	Some concerns	Some concerns	Some concerns
Heydarirad et al. [15]	Some concerns	High (no blinding; subjective outcome)	Low	Some concerns	Some concerns	High
Lucena et al. [16]	Low	Low (placebo-controlled, blinded)	Low	Low	Some concerns (protocol not publicly registered)	Low
Mahdood et al. [17]	Some concerns	Some concerns (odor may unblind)	Low	Some concerns	Some concerns	Some concerns
Mahdavikian et al. [18]	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns	Some concerns
Lillehei et al. [19]	Low	Low (placebo patch; investigator blinded)	Low	Low	Some concerns	Low
Atashi et al. [20]	High (randomization/blinding unclear)	High	Some concerns	Some concerns	Some concerns	High
Hamzeh et al. [21]	Some concerns	Some concerns	Low	Some concerns	Some concerns	Some concerns

3.4. Meta-analysis (PSQI)

Five trials provided sufficient numeric data to compute standardized mean differences (SMDs) for PSQI total score [13]–[17]. In a random-effects model, inhalation aromatherapy improved sleep quality compared with control (SMD −0.83; 95% CI −1.19 to −0.48; lower PSQI indicates better sleep), with moderate heterogeneity ($\tau^2 = 0.087$; $I^2 = 53.5\%$; $Q(4) = 8.60$, $p = 0.072$).

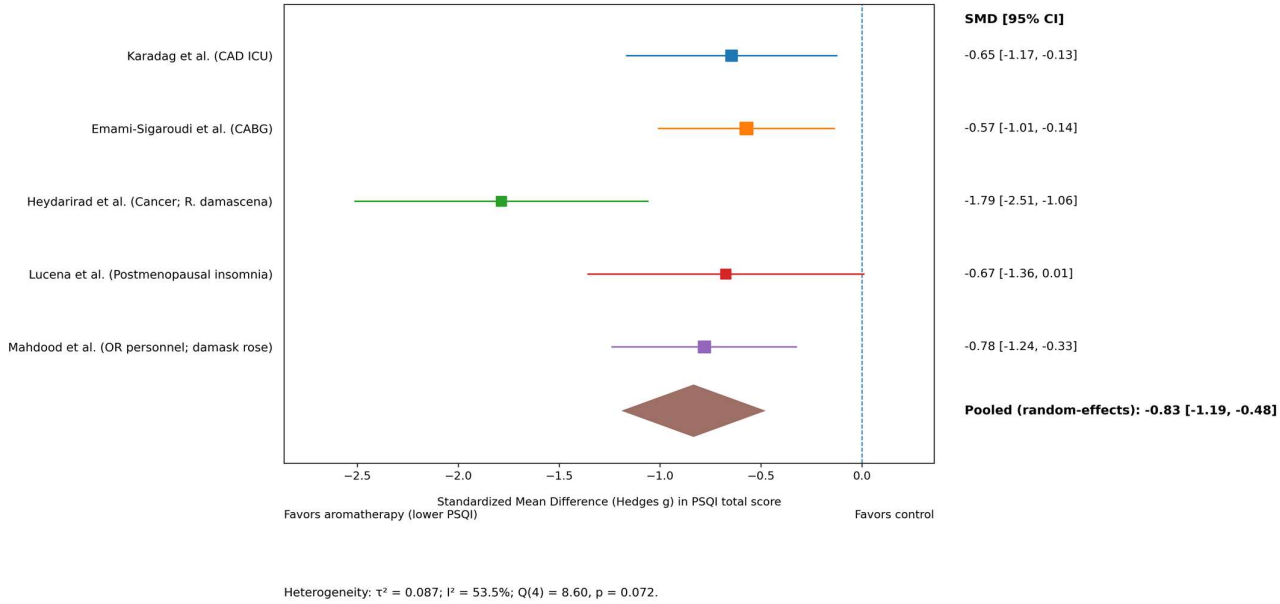


Figure 2. Forest plot (random-effects model) for PSQI total score (lower is better).

3.5. Certainty of evidence (GRADE)

Table 4. GRADE summary of findings for the primary outcome (PSQI total score).

Outcome	No. of studies (design)	n	Effect (SMD)	Certainty	Reasons for downgrading
PSQI total score	5 (randomized controlled trials)	257	−0.83 (95% CI −1.19 to −0.48)	Low	Downgraded for risk of bias and inconsistency (I^2 = 53.5%).

4. Discussion

According to this systematic review and meta-analysis, inhalation aromatherapy may enhance individuals' subjective sleep quality as assessed by the PSQI between the ages of 18 and 65. Although there was heterogeneity, the pooled effect size was moderate. Variability was probably caused by differences in demographics (healthy people vs. surgical or oncology settings), essential oil types (lavender vs. damask rose vs. mixtures), and dose methods (drops on pillow, cotton ball, or patch).

Mechanistically, it has been suggested that the main components of lavender, such as linalool and linalyl acetate, affect sleep and relaxation via autonomic and neurotransmitter pathways [5]. Although the relative efficacy of the various oils is unknown, damask rose includes volatile components that may also support relaxing effects.

The primary drawbacks are as follows: (1) a screening and extraction process that is limited to one reviewer; (2) incomplete reporting and limited blinding in multiple trials; (3) small sample sizes and brief follow-up; and (4) Google Scholar screening is limited to the first 200 records, potentially missing relevant studies. Nonetheless, openness and repeatability are improved by clearly disclosing this practical strategy.

In order to facilitate pooling, future trials should standardize inhalation doses, guarantee allocation concealment, use reliable placebos, and present PSQI data in extractable numerical format (means, SDs, and sample sizes).

5. Conclusions

Adults between the ages of 18 and 65 may benefit from inhalation aromatherapy in terms of PSQI-measured sleep quality; however, due to study limitations and heterogeneity, the certainty of the evidence is low. Strong clinical recommendations cannot be given until well-designed, well-powered, blinded randomized studies are completed.

Declarations

Ethics approval and consent to participate: Not applicable (systematic review).

Consent for publication: Not applicable.

Availability of data and materials: Extracted data and effect size calculations are available from the author upon reasonable request.

Disclosure Statement: The author declares no competing interests.

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Author contributions: Thirakit Vanichayakorn conceived the study, performed screening, extraction, risk of bias assessment, analysis, and drafted the manuscript.

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