The Effects of Aromatherapy on Sleep Quality in Menopausal Women: A Systematic Review and Meta-Analysis

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Abstract

Sleep disturbances frequently affect postmenopausal women, yet the evidence supporting the use of aromatherapy as a therapeutic intervention remains inconclusive. This systematic review and meta-analysis evaluated the efficacy of aromatherapy in improving sleep quality in postmenopausal women by analyzing data from randomized controlled trials (RCTs). Three RCTs comprising a total of 301 participants were included. Eligible studies compared aromatherapy with control conditions and reported sleep-related outcomes. The pooled analysis revealed no statistically significant difference in global Pittsburgh Sleep Quality Index (PSQI) scores between the aromatherapy and control groups (mean difference, -2.66; 95% CI -6.49 to 1.17; $p = 0.17$), with high heterogeneity ($I^2 = 98\%$). However, subgroup analyses demonstrated significant improvements in sleep latency (mean difference, -0.98; 95% CI -1.75 to -0.21; $p = 0.01$) and daytime drowsiness (mean difference, -0.79; 95% CI -1.30 to -0.28; $p = 0.002$). These findings suggest that aromatherapy may provide targeted benefits for certain aspects of sleep, particularly sleep latency and daytime dysfunction. Further high-quality RCTs with larger sample sizes, standardized aromatherapy protocols, and long-term follow-up are necessary to validate these outcomes and establish evidence-based clinical guidelines for the use of aromatherapy in managing sleep disturbances among postmenopausal women.

Keywords: aromatherapy; menopause; sleep quality; essential oils; sleep latency; daytime dysfunction; lavender oil; complementary therapies; non-pharmacological interventions; postmenopausal insomnia

1. Introduction

Menopause is a natural phase in a woman's life marked by the cessation of menstruation and a significant decline in estrogen production [1]. This hormonal shift has widespread effects on both physical and psychological health [2]. One of the most commonly reported symptoms during this period is insomnia [3], which substantially reduces quality of life and increases the risk of various chronic conditions, including cardiovascular diseases [4], depression [1], and osteoporosis [5]. A longitudinal, multi-ethnic epidemiological study found that the prevalence of insomnia among postmenopausal women is approximately 46–48%, compared to 38% in premenopausal women, highlighting the urgency of addressing sleep disturbances in this population [2,6].

However, aromatherapy is not universally applicable and should be used with caution, as responses to essential oils can be highly individualized. Consideration should be given to potential contraindications and sensitivities [7].

Current treatments for menopausal insomnia typically involve hormone replacement therapy (HRT) [8] or hypnotic medications [9]. While effective in some cases, these therapies have been associated with long-term adverse effects such as increased risk of breast cancer, thromboembolism, and stroke [10]. Consequently, there is a growing interest in non-pharmacological approaches that are perceived to be safer and more holistic [11,12]. Among these, aromatherapy has garnered attention as a low-risk, non-invasive complementary therapy [8,13–16].

Aromatherapy involves the use of essential oils extracted from herbs, flowers, and other plants, administered via inhalation or topical application [17–21]. Its benefits include ease of use, accessibility, and minimal side effects. Essential oils such as lavender [22] and chamomile [23] have shown potential in reducing stress, promoting relaxation, and enhancing sleep quality [8,14–16,22,24,25]. The proposed mechanism of action involves the olfactory system and the central nervous system [15,26–29]. When inhaled, the volatile compounds in essential oils stimulate the limbic system—an area of the brain that regulates emotions and stress responses. This stimulation results in reduced sympathetic nervous system activity and increased parasympathetic activity, thereby promoting relaxation and improving sleep initiation and maintenance [15,26–30].

Several studies suggest that essential oils can lower cortisol levels [31,32], a primary stress hormone, and enhance the action of gamma-aminobutyric acid (GABA), an inhibitory neurotransmitter that helps calm the brain [28,31–33]. Additionally, essential oils may boost serotonin production, which is involved in regulating the sleep–wake cycle and serves as a precursor to melatonin, the hormone responsible for inducing sleep [30]. Despite these promising findings, the overall efficacy of aromatherapy in postmenopausal populations remains inconsistent across the literature.

Therefore, this study aims to conduct a systematic review and meta-analysis to consolidate findings from randomized controlled trials (RCTs) that examine the effects of aromatherapy on sleep quality in postmenopausal women. By synthesizing evidence across multiple studies, this review seeks to clarify the extent of aromatherapy's effectiveness, identify patterns among interventions, and assess the strength of the supporting data. The ultimate goal is to provide clear, evidence-based guidance for integrating aromatherapy into clinical practice as a complementary approach to managing sleep disturbances in postmenopausal women.

The findings from this review may support safer treatment alternatives for this population, reduce reliance on pharmacologic therapies, and promote better overall well-being. Furthermore, this review may serve as a foundation for future research aimed at optimizing aromatherapy protocols and exploring long-term outcomes in diverse populations.

2. Results

2.1. Search Results

A search across five databases, including PubMed, Scopus, Ovid, The Cochrane Library, and Google Scholar, yielded 569 articles related to aromatherapy, sleep quality, and menopause. These included 31 articles from PubMed, 161 from Scopus, 17 from Ovid, 33 from The Cochrane Library, and 327 from Google Scholar. After removing 77 duplicates, 492 records were screened. A total of 375 articles were excluded due to language, non-aromatherapy content, or an irrelevant population. Of the 117 full-text articles assessed for eligibility, 111 were excluded for not being RCTs or lacking sleep quality

outcomes. Ultimately, six studies were included in the review, with three eligible for meta-analysis (Figure 1).
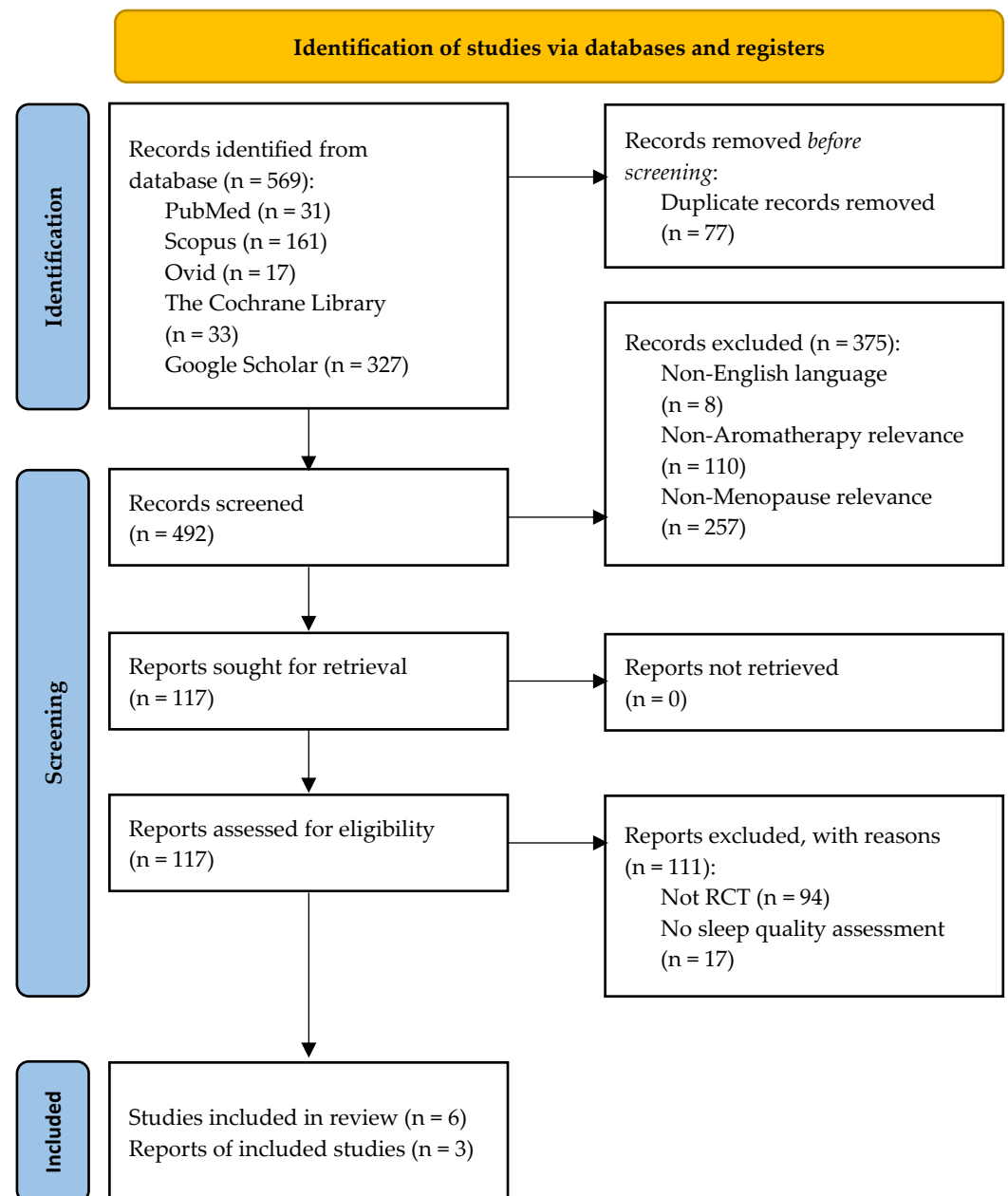
Figure 1. PRISMA flow diagram of literature search and study selection.

2.2. Study Characteristics

The six included studies, all designed as RCTs, were conducted between 2012 and 2024, and met the predefined eligibility criteria for this review. All studies included both intervention and control groups for comparison. Participants were postmenopausal women, with most studies enrolling individuals aged between 45 and 65 years. Eligibility criteria varied across studies: one trial selected participants based on chronic insomnia symptoms, one applied the Menopausal Rating Scale (MRS), another used the Epworth Sleepiness Scale (ESS), and three studies utilized the Pittsburgh Sleep Quality Index (PSQI) as a screening tool for poor sleep quality (Table 1).

Table 1. Characteristics of included studies.

Author, Year	Main Characteristics of Participants	Sample Size	Sleep Outcome Measurement	Outcomes
Abbaspoor et al., 2022 [34]	• Postmenopausal women aged 45–60 years with sleep disturbances (PSQI ≥ 5). • Amenorrhea for at least 12 months.	Total = 80 • Citrus aurantium = 40 • Control = 40	PSQI, PSQI subscale	Aromatherapy vs. control (post-intervention comparison) • PSQI score significantly lower in intervention group ($p < 0.001$). • Significant improvement in all PSQI domains.
Darsareh et al., 2012 [35]	• Postmenopausal women aged 45–60 years with menopausal symptoms, assessed via Menopause Rating Scale (MRS). • Amenorrhea for at least 12 months.	Total = 90 • Mixed essential oil = 30 • Placebo = 30 • Control = 30	MRS with sleeping problems assessment	Aromatherapy vs. control (post-intervention comparison) • MRS score reduced significantly ($p < 0.001$). Placebo massage group showed partial improvement ($p < 0.001$). • Aromatherapy massage was significantly more effective ($p < 0.001$).
Jokar et al., 2018 [36]	• Postmenopausal women aged ≥ 45 years, menopause occurred within 1–5 years.	Total = 70 • Lavender = 35 • Placebo = 35	Evaluated through menopausal symptoms, including insomnia	Aromatherapy vs. control (post-intervention comparison) • Lavender group showed significant improvements across all 11 symptoms, including hot flushes, insomnia, depression, and memory issues, etc. • Final KMI scores: intervention ($p < 0.001$).
Kamalifard et al., 2017 [37]	• Postmenopausal women aged 45–60 years, menopause occurred within 1–6 years.	Total = 156 • Lavender: $n = 52$ • Bitter orange: $n = 52$ • Placebo: $n = 52$	PSQI	Aromatherapy vs. control (post-intervention comparison) • Sleep quality improved significantly in both lavender and bitter orange groups ($p < 0.001$).
Lucena et al., 2021 [14]	• Postmenopausal women aged 48–65 years diagnosed with insomnia via DSM-5 criteria, menopause occurred within at least 1 year.	Total = 35 • Lavender = 17 • Placebo = 18	PSQI, PSQI subscale, ISI, Polysomnography, SOL, REM latency, TST, SE, WASO, Sleep Stages, AHI	Aromatherapy vs. control (post-intervention comparison) • No significant difference between groups for total PSQI score. • Aroma group had significant within-group improvements in sleep efficiency (+10.1%), WASO (−42.2 min), REM sleep %, and sleep latency.
Lucena et al., 2024 [16]	• Postmenopausal women aged 45–60 years, menopause occurred within 1–6 years.	Total = 35 • Lavender = 17 • Placebo = 17	Sleep diary: SOL, TST, SE, ESS	Aromatherapy vs. control (post-intervention comparison) • Aroma group showed significant improvement in overall MENQOL-I summary score ($p = 0.009$). • Sleep efficiency (SE) improved progressively in both groups over time.

(PSQI: Pittsburgh Sleep Quality Index, SOL: Sleep onset latency, TST: Total sleep time, SE: Sleep efficiency, ESS: Epworth Sleepiness Scale, ISI: Insomnia Severity Index, MRS: Menopausal Rating Scale, KMI: Kupperman Menopausal Index, MENQOL-1: Menopause-specific Quality of Life Questionnaire, WASO: Wake after sleep onset, and AHI: Apnea Hypopnea Index).

The aromatherapy interventions differed in modality and duration. Inhalation therapy was the most commonly used method, applied in four studies, while one study used aromatherapy massage and another used oral administration. The duration of interventions ranged from 2 to 12 weeks, with frequencies ranging from two to seven sessions per week. Control conditions included no intervention, usual care, or placebos such as base oils or simulated scents. Across all studies, sleep quality was the primary outcome, with most trials employing the PSQI to measure changes in sleep quality before and after the intervention period (Table 2).

Table 2. Characteristics of aromatherapy in included studies.

Author (Year)	Aromatherapy			
	Type	Route	Regimen	Duration
Abbaspoor et al., 2022 [34]	Citrus aurantium	Inhalation	Twice daily	4 weeks
Darsareh et al., 2012 [35]	Mixed (rose, rosemary, lavender, and rose geranium)	Massage, 30 min	Twice weekly	4 weeks
Jokar et al., 2018 [36]	Lavender, two drops on collar	Inhalation	Daily, before bedtime	4 weeks
Kamalifard et al., 2017 [37]	Lavender, bitter orange 500 mg	Oral	Twice daily	8 weeks
Lucena et al., 2021 [14]	Lavandular angustifolia	Inhalation	Daily, before bedtime	29 days
Lucena et al., 2024 [16]	Lavandular angustifolia	Inhalation	Daily, before bedtime	29 days

2.3. Quality Assessment of Included Studies

The quality assessment of the six included RCTs revealed that all studies were rated as having "some concerns" in the overall risk-of-bias judgment (Figure 2). This rating was primarily due to limitations observed in specific domains such as the randomization process and selective reporting. As shown in Figure 3, while most domains demonstrated low risk across studies, approximately one-third of studies had potential issues related to sequence generation or allocation concealment, leading to uncertainty about baseline comparability between groups.
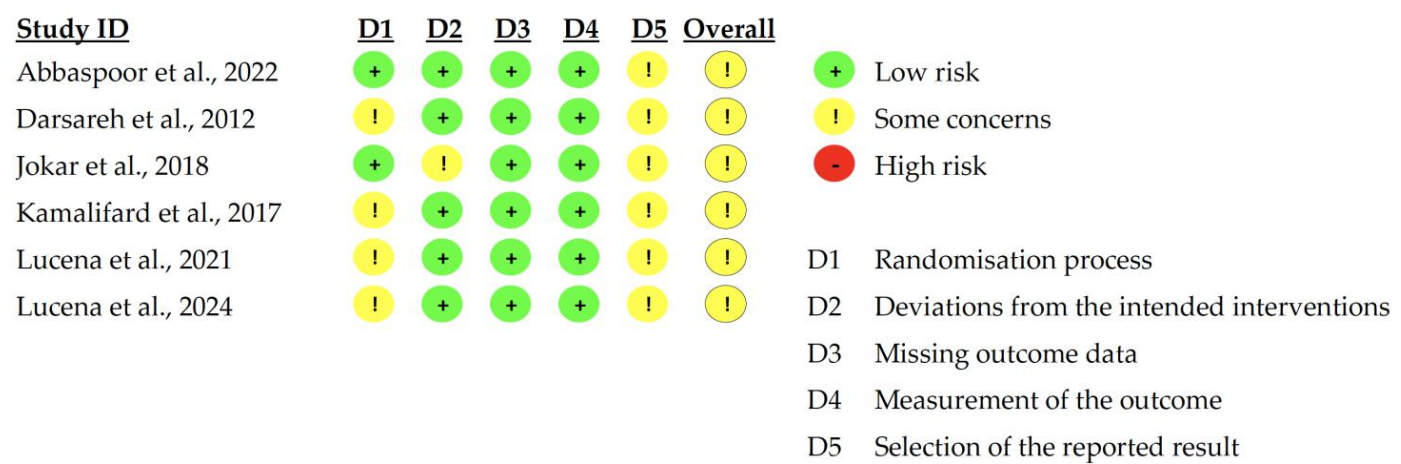
Figure 2. Quality assessment showing risk of bias in each included study.
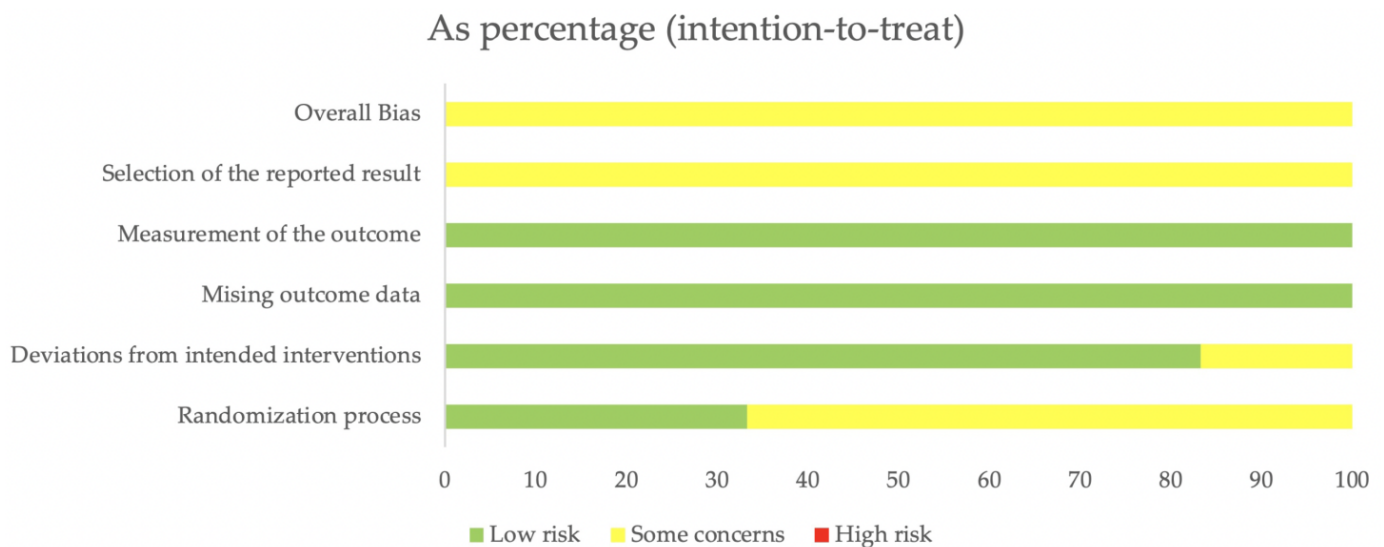
Figure 3. Quality assessment summary showing risk of bias in all included studies.

Concerns regarding the randomization process (Domain 1) were attributed to insufficient reporting on how randomization was performed or how allocation was concealed. These omissions make it difficult to assess whether random sequence generation was truly achieved. For deviations from the intended interventions (Domain 2), most studies reported consistent implementation of aromatherapy protocols, but a few lacked details on controlling external influences, such as participant behavior, use of sleep aids, or co-interventions.

Missing outcome data (Domain 3) and the measurement of outcomes (Domain 4) generally posed low risk. The majority of studies had complete data sets or accounted for dropouts adequately, and outcomes were measured using validated instruments such as the PSQI. However, due to the subjective nature of the PSQI, some degree of measurement bias remains possible.

Selective reporting bias (Domain 5) was present in several studies that did not clearly specify all the prespecified outcomes, or failed to report secondary results, limiting transparency. Overall, while no study was judged to be of high risk, these methodological concerns suggest that the findings should be interpreted with caution. Figures 2 and 3 illustrate the domain-specific assessments and proportional distribution of risk.

2.4. Meta-Analysis

Six RCTs [14,16,34–37] were included in the systematic review, of which three provided sufficient data for inclusion in the meta-analysis [14,34,37]. The remaining studies were excluded due to incomplete outcome data or inconsistency in reporting, which prevented statistical pooling.

2.4.1. Total PSQI Score

The analysis of four comparisons derived from three RCTs, including a total of 301 participants, evaluated the effects of aromatherapy on overall sleep quality using the PSQI. One study (Kamalifard, 2017) [37] contributed two intervention arms—lavender and bitter orange—analyzed separately. Although the pooled results demonstrated a reduction in the global PSQI scores in the aromatherapy group compared to controls, the difference was not statistically significant (mean difference, −2.66; 95% CI (−6.49, 1.17); p = 0.17) (Figure 4).

Study or Subgroup	Aromatherapy			Placebo			Weight	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Kamalifard (L) 2017	5.44	2.56	49	6.17	2.01	48	25.2%	−0.73 [−1.64, 0.18]
Kamalifard (B) 2017	5.48	2.48	48	6.17	2.01	48	25.2%	−0.69 [−1.59, 0.21]
Abbaspoor 2021	5.75	1.33	36	13	1.59	37	25.4%	−7.25 [−7.92, −6.58]
Lucena 2021	7.5	2.7	17	9.4	2.8	18	24.2%	−1.90 [−3.72, −0.08]
Total (95% CI)			**150**			**151**	**100.0%**	**2.66 [−6.49, 1.17]**

Heterogeneity: Tau² = 14.94; Chi² = 194.19, df = 3 (*p* < 0.00001); I² = 98%
Test for overall effect: Z = 1.36 (*p* = 0.17)

Figure 4. Forest plot showing a meta-analysis of the mean difference in total PSQI scores between the experimental group (aromatherapy) and the control group. IV, independent variable; SD, standard deviation; L, lavender; and B, bitter orange.

Nevertheless, a high degree of heterogeneity was observed (I² = 98%, *p* < 0.00001), indicating substantial variation in study designs, intervention types, and population characteristics, which may have influenced the results.

2.4.2. PSQI Subscales

This subgroup analysis examined the effects of aromatherapy on sleep quality based on two studies: Abbaspour (2021) [35] and Lucena (2021) [13], with a combined total of 108 participants. These studies reported PSQI component scores across six subdomains: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, and daytime drowsiness.

1. Subjective sleep quality subscale

The meta-analysis results indicated that aromatherapy tended to improve subjective sleep quality compared to in the control group. However, the difference between the aromatherapy and control groups was not statistically significant (mean difference, −0.84; 95% CI (−1.72, 0.03); *p* = 0.06). Nonetheless, the analysis revealed statistically significant heterogeneity (*p* < 0.0001), with a high degree of variability among studies (I² = 94%) (Figure 5).

Study or Subgroup	Aromatherapy			Placebo			Weight	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Abbaspoor 2021	0.22	0.42	36	1.51	0.9	37	49.8%	−1.29 [−1.61, −0.97]
Lucena 2021	1.2	0.4	17	1.6	0.5	18	50.2%	−0.40 [−0.70, −0.10]
Total (95% CI)			**53**			**55**	**100.0%**	**−0.84 [−1.72, 0.03]**

Heterogeneity: Tau² = 0.37; Chi² = 15.81, df = 1 (*p* < 0.0001); I² = 94%
Test for overall effect: Z = 1.89 (*p* = 0.06)
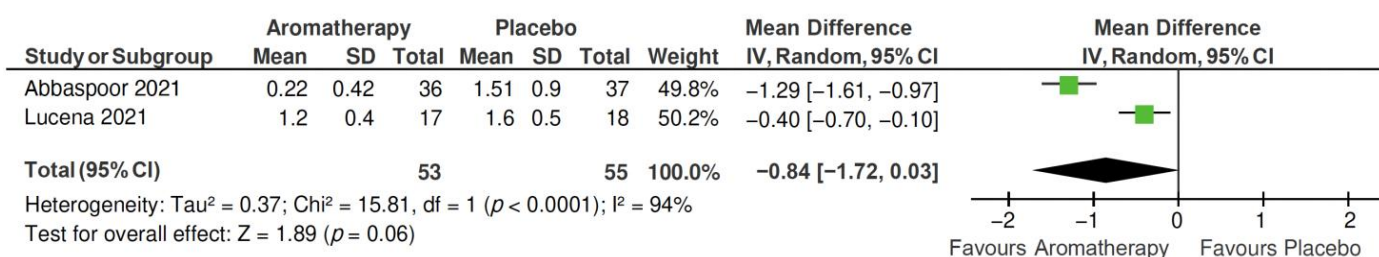
Figure 5. Forest plot showing a subgroup meta-analysis of the mean difference in subjective sleep quality scores from the PSQI between the aromatherapy group and the control group. (IV, independent variable; SD, standard deviation).

2. Sleep latency subscale

The meta-analysis results indicated that aromatherapy significantly reduced sleep latency compared to in the control group (mean difference, −0.98; 95% CI (−1.75, −0.21); *p* = 0.01). The analysis also revealed statistically significant heterogeneity (*p* = 0.04), with a moderate level of inconsistency among studies (I² = 75%) (Figure 6).

Study or Subgroup	Aromatherapy			Placebo			Weight	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Abbaspoor 2021	1.2	0.51	36	2.5	0.55	37	59.9%	−1.30 [−1.54, −1.06]
Lucena 2021	1.2	0.9	17	1.7	1.3	18	40.1%	−0.50 [−1.24, 0.24]
Total(95%CI)			**53**			**55**	**100.0%**	**−0.98 [−1.75, −0.21]**

Heterogeneity: Tau² = 0.24; Chi² = 4.08, df = 1 (*p* = 0.04); I² = 75%
Test for overall effect: Z = 2.50 (*p* = 0.01)
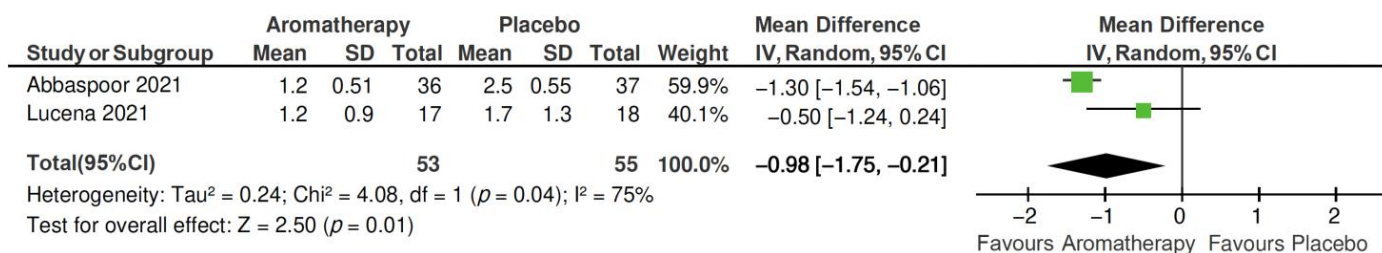
Figure 6. Forest plot showing a subgroup meta-analysis of the mean difference in sleep latency scores from the PSQI between the aromatherapy group and the control group. (IV, independent variable; SD, standard deviation).

3. Sleep duration subscale

The meta-analysis results indicated that aromatherapy tended to increase the total sleep duration compared to in the control group. However, the difference between groups was not statistically significant (mean difference, −1.03; 95% CI (−2.25, 0.20); *p* = 0.10). Nonetheless, the analysis revealed statistically significant heterogeneity (*p* = 0.004), with a high level of inconsistency among studies (I² = 88%) (Figure 7).

Study or Subgroup	Aromatherapy			Placebo			Weight	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Abbaspoor 2021	0.8	1.66	36	2.45	0.69	37	50.2%	−1.65 [−2.24, −1.06]
Lucena 2021	1.4	1	17	1.8	0.8	18	49.8%	−0.40 [−1.00, 0.20]
Total(95%CI)			**53**			**55**	**100.0%**	**−1.03 [−2.25, 0.20]**

Heterogeneity: Tau² = 0.69; Chi² = 8.50, df = 1 (*p* = 0.004); I² = 88%
Test for overall effect: Z = 1.64 (*p* = 0.10)
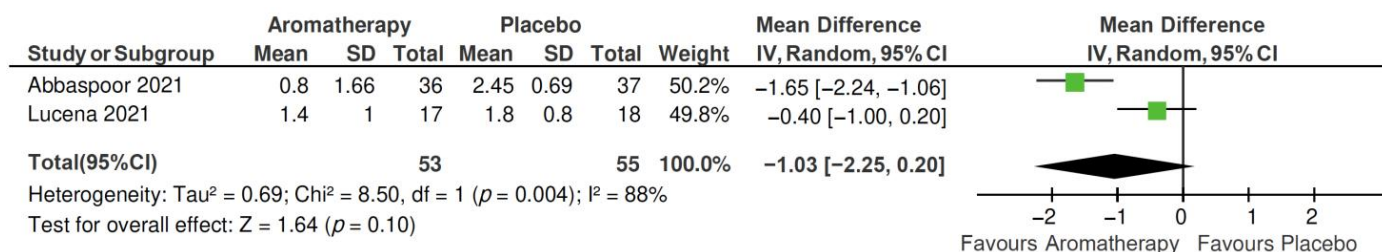
Figure 7. Forest plot showing a subgroup meta-analysis of the mean difference in sleep duration scores from the PSQI between the aromatherapy group and the control group. (IV, independent variable; SD, standard deviation).

4. Sleep efficiency subscale

The meta-analysis results indicated that aromatherapy tended to improve sleep efficiency compared to in the control group. However, the difference between groups was not statistically significant (mean difference, −0.34; 95% CI (−0.80, 0.12); *p* = 0.15). The analysis also showed no statistically significant heterogeneity (*p* = 0.22), with a moderate level of inconsistency among studies (I² = 34%) (Figure 8).

Study or Subgroup	Aromatherapy			Placebo			Weight	Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total		
Lucena 2021	1.4	1	17	1.4	1.1	18	32.8%	0.00 [−0.70, 0.70]
Abbaspoor 2021	0.55	0.6	36	1.05	1.05	37	67.2%	−0.50 [−0.89, −0.11]
Total(95%CI)			**53**			**55**	**100.0%**	**−0.34 [−0.80, 0.12]**

Heterogeneity: Tau² = 0.04; Chi² = 1.51, df = 1 (*p* = 0.22); I² = 34%
Test for overall effect: Z = 1.43 (*p* = 0.15)
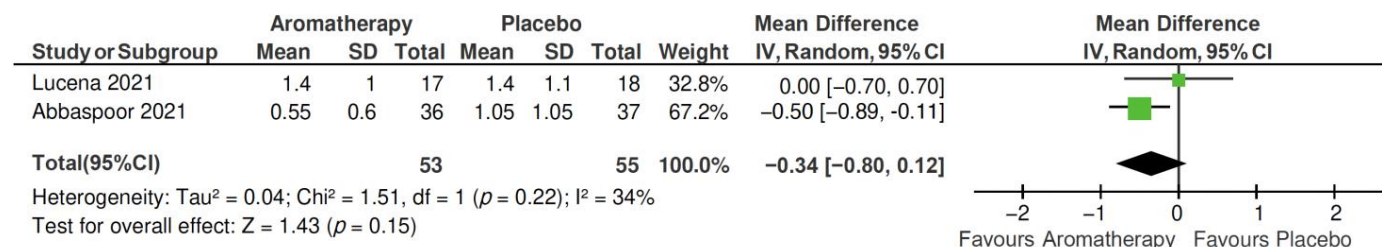
Figure 8. Forest plot showing a subgroup meta-analysis of the mean difference in sleep efficiency scores from the PSQI between the aromatherapy group and the control group. (IV, independent variable; SD, standard deviation).

5. Sleep disturbances subscale

The meta-analysis results indicated that aromatherapy tended to reduce sleep disturbances more effectively than in the control group. However, the difference between groups

was not statistically significant (mean difference, −0.85; 95% CI (−2.13, 0.42); *p* = 0.19). Nonetheless, the analysis revealed statistically significant heterogeneity (*p* < 0.00001), with a high level of inconsistency among studies (I² = 98%) (Figure 9).
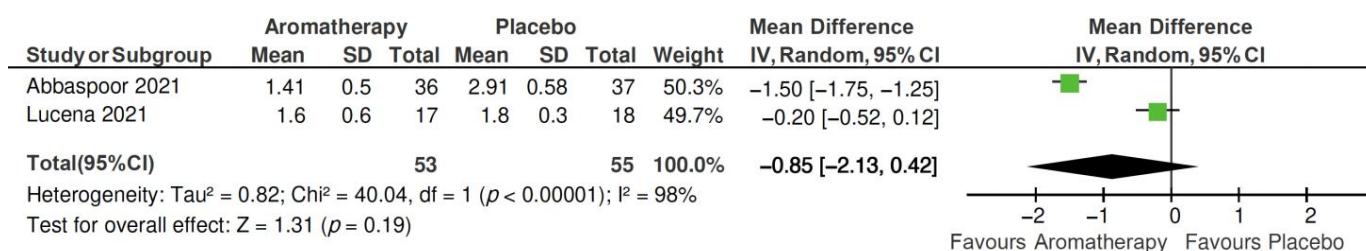
Figure 9. Forest plot showing a subgroup meta-analysis of the mean difference in sleep disturbance scores from the PSQI between the aromatherapy group and the control group. (IV, independent variable; SD, standard deviation).

6. Daytime drowsiness subscale

The meta-analysis results indicated that aromatherapy had a statistically significant effect in reducing daytime drowsiness compared to in the control group (mean difference, −0.79; 95% CI (−1.30, −0.28); *p* = 0.002). The analysis also revealed statistically significant heterogeneity (*p* = 0.004), with a high level of inconsistency among studies (I² = 76%) (Figure 10).
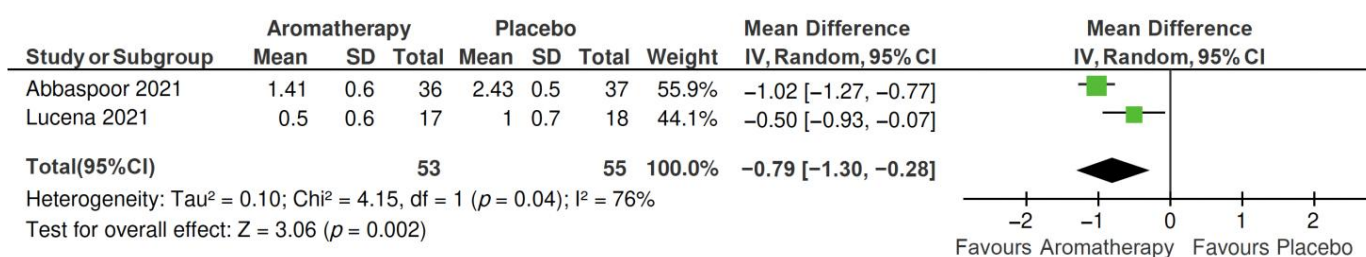
Figure 10. Forest plot showing a subgroup meta-analysis of the mean difference in daytime drowsiness scores from the PSQI between the aromatherapy group and the control group. (IV, independent variable; SD, standard deviation).

2.5. Publication Bias

The funnel plot assessment for publication bias revealed symmetry, with an equal distribution of studies around the pooled mean effect size, indicating a low risk of publication bias. This analysis was based on the effects of aromatherapy on overall sleep quality, as measured using the global PSQI scores. The symmetrical shape suggests that the findings are unlikely to be influenced by selective publication or reporting bias.

3. Discussion

Sleep disturbances are a common concern among menopausal women and are closely associated with hormonal changes, particularly declines in estrogen. These changes can disrupt the sleep–wake cycle, influence mood regulation, and impair mental well-being. Persistent poor sleep quality has been linked to increased risks of chronic health conditions, including hypertension, diabetes, and depression [1–4,15,38,39]. Therefore, identifying safe and effective interventions to manage insomnia in this population is clinically significant and underpins the rationale for this study.

Aromatherapy, as a non-pharmacological and non-invasive therapy, has emerged as a potential strategy for improving sleep quality [8,16,24,25,36,37,40]. Previous research suggests that essential oils such as lavender, chamomile, and bitter orange may support

relaxation and sleep initiation [14,16,24,27,33,36,41–43]. The physiological mechanism involves olfactory stimulation, which directly influences the limbic system—the brain region that governs emotional and autonomic responses. Compounds in essential oils are known to enhance GABAergic and serotonergic activity, reduce sympathetic arousal, and promote parasympathetic dominance, contributing to improved sleep onset and maintenance [15,26,28,29,31,33]. Table 3 provides a summary of essential oils, their active constituents, and proposed mechanisms of action in sleep physiology, to illustrate the biological plausibility of aromatherapy's effects on sleep outcomes.

Table 3. Summary of essential oils, bioactive components, and proposed mechanisms in sleep physiology.

Essential Oil	Key Bioactive Components	Proposed Mechanism	References
Lavender (Lavandula angustifolia)	Linalool, Linalyl acetate	Enhances GABAergic transmission; reduces sympathetic activity	Koulivand et al., 2013 [44]
Chamomile (Matricaria chamomilla)	Apigenin	Binds to benzodiazepine receptors; mild sedative effect	Srivastava et al., 2010 [45]
Bitter orange (Citrus aurantium)	Limonene, Linalool	Modulates serotonin receptors; anxiolytic effect	Faturi et al., 2010 [46]
Mixed oils	Various (e.g., lavender + sweet marjoram)	Combined calming and anxiolytic actions	Lee et al., 2011 [47]

A previous meta-analysis by Her et al. (2021) [48] demonstrated that aromatherapy significantly improved sleep quality in adult and elderly populations, with notable effects observed in inpatient and older adult groups. However, their study did not focus specifically on menopausal women, whose sleep disturbances are often hormonally driven and distinct in pathophysiology. The present meta-analysis addressed this gap by focusing exclusively on RCTs involving menopausal women. The findings contribute to a more targeted understanding of aromatherapy's role in this demographic, particularly its significant effects in improving sleep latency and reducing daytime drowsiness. These results highlight the clinical relevance of aromatherapy as a tailored non-pharmacological intervention for sleep disturbances in menopausal women.

In this meta-analysis of three RCTs (four intervention arms), aromatherapy demonstrated a trend toward improving overall sleep quality, as reflected by a reduction in the global PSQI scores, although the difference was not statistically significant. Importantly, subgroup analyses revealed statistically significant effects in two key domains: sleep latency and daytime drowsiness.

Specifically, aromatherapy significantly reduced the time required to fall asleep, supporting its calming effects on the nervous system. This is consistent with prior evidence showing that essential oils may lower cortisol levels and enhance GABA activity, both of which facilitate sleep induction. In addition, aromatherapy significantly alleviated daytime drowsiness, suggesting improved sleep quality at night and better daytime functioning. These findings highlight the specific domains of sleep in which aromatherapy may exert its most beneficial effects.

However, one major limitation of this meta-analysis is the high heterogeneity ($I^2 = 98\%$) observed in the global PSQI outcomes. This heterogeneity was anticipated due to variations in the types of essential oils used (e.g., lavender, bitter orange, and mixed oils), routes of administration (inhalation, massage, and oral), frequency, and intervention durations (ranging from 2 to 12 weeks) across the included studies. To address this, a random-effects model was employed to account for between-study variability, and subgroup analyses were conducted to explore the effects on individual PSQI domains. However, due to the

limited number of studies, further analysis methods such as sensitivity analysis or meta-regression were not feasible. This underscores the need for future RCTs with standardized aromatherapy protocols to improve comparability.

Furthermore, there was substantial variability in the dosage, frequency, duration, and route of administration of aromatherapy interventions across the included studies. These methodological inconsistencies may have contributed to the heterogeneity of the results and limited the comparability and generalizability of the pooled findings. The standardization of aromatherapy protocols in future RCTs is needed to facilitate clearer conclusions. The exclusion of three eligible studies from the meta-analysis due to incomplete data—despite attempts to contact the corresponding authors—represents a limitation that may have impacted the comprehensiveness of the pooled analysis.

Moreover, most of the included studies did not explicitly report whether participants were controlled for potential confounding factors such as caffeine intake, physical activity, or concurrent use of sleep aids. The absence of this information may introduce bias and limit the ability to isolate the specific effects of aromatherapy on sleep outcomes. Future studies should incorporate strategies to monitor or control for these variables to enhance internal validity and improve the interpretability of the findings.

Additionally, several of the included studies reported secondary outcomes related to menopausal symptoms beyond sleep, such as anxiety, mood disturbances, and vasomotor symptoms (e.g., hot flashes) [2,49]. While these outcomes were not the primary focus of our meta-analysis, they underscore the broader potential benefits of aromatherapy for menopausal women. Future trials should consider integrating multidimensional outcome measures to capture the full spectrum of therapeutic effects and provide a more holistic assessment of aromatherapy interventions.

Clinically, aromatherapy could serve as a valuable adjunctive option for menopausal women who experience insomnia [20,21,31,35,36,40,48], particularly for those who are unable or unwilling to use hypnotic medications or hormone replacement therapy. The approach is generally safe, affordable, and easy to implement, whether through inhalation or topical application via massage [14,20,21,27,35,48].

Clinicians may consider advising patients to use inhalation-based aromatherapy (e.g., lavender or bitter orange) before bedtime, or to incorporate aromatherapy massage sessions 2–3 times per week for 2–12 weeks, depending on patient preference and symptom severity. Although aromatherapy is generally regarded as safe, individual responses can vary significantly. Certain essential oils may cause allergic reactions or interact with underlying health conditions. Clinical supervision is recommended to ensure appropriate and personalized use.

To enhance comparability in future research, standardized aromatherapy protocols are recommended. Future trials should consider using a single, well-characterized essential oil (e.g., Lavandula angustifolia), applying a consistent administration route (preferably inhalation), and adopting fixed dosages (e.g., two to four drops per session) and treatment durations (e.g., 4–8 weeks). Ensuring consistency in outcome measurements, such as the use of the PSQI at standardized time points, would improve the validity of pooled analyses and facilitate stronger clinical recommendations.

Additionally, none of the included studies reported long-term follow-up after the completion of the intervention. As a result, it remains unclear whether the observed improvements in sleep latency and daytime drowsiness are sustained over time. Future RCTs should incorporate post-intervention follow-up periods (e.g., 3–6 months) to better understand the longevity of aromatherapy's effects and any potential rebound in sleep disturbances.

In summary, aromatherapy is a safe, accessible, and potentially effective adjunctive approach that can be integrated into holistic sleep care for menopausal women. Further high-quality, large-scale, and double-blinded RCTs are needed to validate these findings and to optimize dosage, frequency, and delivery methods for broader clinical application.

This study's strengths lie in its exclusive inclusion of RCTs and systematic methodology. Nonetheless, limitations include the small number of included studies, limited reporting on allocation concealment, and variability in intervention protocols. Future high-quality studies are needed to confirm and extend these findings.

Furthermore, several included studies exhibited methodological limitations, particularly in the randomization process and outcome reporting. These limitations, classified as "some concerns" in the Cochrane risk-of-bias assessment, may have introduced bias and should be taken into account when interpreting the results of this meta-analysis.

4. Materials and Methods

4.1. Protocol and Registration

This systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The study protocol was prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO), under the registration number CRD420251020194.

4.2. Search Strategy

A systematic and thorough literature search was performed in alignment with the PRISMA framework. Studies published before March 2025 were searched for by two reviewers (C.T. and C.S.) across five electronic databases: PubMed, Scopus, Ovid, The Cochrane Library, and Google Scholar. The search strategy involved combinations of keywords, MeSH terms, and phrases, including the following: "Aromatherapy" OR "Essential oils" OR "Herb" OR "Flower" AND "Sleep" AND "Menopause".

4.3. Eligibility Criteria and Study Selection

This systematic review and meta-analysis included only RCTs published in English that met the following eligibility criteria:

1. Population/participants: Postmenopausal women (defined as having no menstrual periods for at least 12 consecutive months) without restrictions on nationality or comorbidities;
2. Intervention: Aromatherapy using essential oils, without restrictions on type of oil, method of administration, dosage, frequency, or duration;
3. Comparison/control group: Participants receiving no treatment, placebo, or routine care not involving aromatherapy;
4. Outcomes: Sleep quality assessed using validated subjective or objective measurements.

4.4. Data Extraction

Two independent reviewers (C.T. and C.S.) systematically screened titles and abstracts to identify eligible studies. Full-text articles were retrieved for comprehensive evaluation. Data extraction encompassed study metadata (title, first author, publication year, and country) and key methodological characteristics (study design, sample size, mean age, menopausal status, and type of aromatherapy used). Details of the intervention protocol—including type of essential oil, method of administration, frequency, duration, and control conditions—were meticulously documented to allow for accurate comparisons across studies.

Outcome assessments focused primarily on subjective or objective measures of sleep quality. For studies with missing or incomplete data (e.g., means, standard deviations, or confidence intervals), attempts were made to contact the corresponding authors to obtain additional information and ensure data completeness for inclusion in the meta-analysis.

However, as no responses were received from the corresponding authors despite our attempts, these studies were excluded from the meta-analysis due to insufficient data.

4.5. Quality Assessment

Two reviewers (C.T. and C.S.) independently assessed the methodological quality of the included studies using the Cochrane risk-of-bias tool for randomized trials (RoB 2), following the guidelines outlined in version 6.5 of the Cochrane Handbook for Systematic Reviews of Interventions. The evaluation focused on five key domains: bias arising from the randomization process, bias due to deviations from intended interventions, bias resulting from missing outcome data, bias in the measurement of outcomes, and bias in the selection of reported results. Each domain was rated as having either "low risk of bias", "some concerns", or "high risk of bias". Disagreements between the reviewers were resolved through discussion or consultation with a third reviewer when necessary.

4.6. Data Analysis

The pooled effects of the included studies, comprising continuous data, were analyzed using mean differences (MDs) with a 95% confidence interval (CI) and a *p*-value set at p < 0.05 to determine statistical significance. A random-effects model, calculated using the DerSimonian and Laird method, was applied to account for potential heterogeneity among studies. Data entry and analysis were performed using Review Manager (RevMan) version 5.4.1, and the results were presented visually through Forest plots.

Statistical heterogeneity was assessed using the I^2 statistic, with significance defined at $p < 0.1$. The degree of heterogeneity was interpreted as low ($I^2 < 25\%$), moderate ($I^2 = 25$–75%), or high ($I^2 > 75\%$). When sufficient data were available, subgroup analyses were conducted to explore potential sources of heterogeneity, such as differences in essential oil types or methods of aromatherapy administration. Publication bias was assessed through the visual inspection of Funnel plots.

5. Conclusions

This study suggests that aromatherapy may be a potentially beneficial non-pharmacological intervention for improving specific aspects of sleep quality in menopausal women. Statistically significant improvements were observed in sleep latency and daytime drowsiness, indicating that aromatherapy may help reduce the time to sleep onset and enhance daytime functioning. Although the global PSQI scores did not reach statistical significance, the overall trend favored the intervention group. These findings are consistent with the proposed neurophysiological mechanisms of essential oils, such as enhanced GABAergic and serotonergic activity.

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Abbreviations

ESS	Epworth Sleepiness Scale
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSQI	Pittsburgh Sleep Quality Index
REVMAN	Review Manager
ROB 2	Risk of Bias 2 Tool
RCTs	Randomized controlled trials
MRS	Menopausal Rating Scale
HRT	Hormone replacement therapy
WASO	Wake after sleep onset
SOL	Sleep onset latency
TST	Total sleep time
SE	Sleep efficiency
ISI	Insomnia Severity Index
KMI	Kupperman Menopausal Index
MENQOL-1	Menopause-specific Quality of Life Questionnaire
AHI	Apnea Hypopnea Index
MD	Mean difference

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