ORIGINAL ARTICLE

Effect of lemongrass aromatherapy on insomnia severity among adult smokers: A quasi-experimental study

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ARTICLE INFORMATION

Article history
Received November 11, 2025
Revised December 02, 2025
Accepted January 07, 2026

Keywords
Sleep Disorders; Sleep Quality; Aromatherapy; Tobacco Use Disorder; Complementary Therapies

ABSTRACT

Introduction: *Smoking is associated with a higher prevalence of insomnia and anxiety, which contributes to reduced sleep quality among adult smokers. Lemongrass aromatherapy has shown potential benefits in modulating sleep patterns and reducing anxiety symptoms.*
Objectives: *This study aimed to investigate the effect of lemongrass aromatherapy on the severity of insomnia among smokers.*
Methods: *A quasi-experimental pretest-posttest control group design was used with 50 adult smokers in each group selected through purposive sampling. Participants were divided into an intervention group that received lemongrass essential oil aromatherapy and a control group that received standard care. Insomnia Severity Index (ISI), GAD-7 for anxiety, and Fagerström Test for Nicotine Dependence (FTND) were used for data collection. Data were analysed using an independent t-test and a paired t-test.*
Results: *The intervention group showed a significant reduction in insomnia scores (p-value < 0.01), whereas the control group showed no significant change. The improvement was more prominent among participants with moderate nicotine dependence and baseline anxiety symptoms. Given the applied community setting, the findings are subject to limitations related to the quasi-experimental design and unmeasured lifestyle factors, which should be considered when interpreting the results.*
Conclusions: *Lemongrass aromatherapy is effective in reducing insomnia symptoms among smokers and may serve as a complementary therapy in community nursing care. The integration of aromatherapy into non-pharmacological nursing interventions is recommended to improve sleep quality.*

Jurnal Keperawatan is a peer-reviewed journal published by the School of Nursing at the Faculty of Health Science, Universitas Muhammadiyah Malang (UMM), and affiliated with the Persatuan Perawat Nasional Indonesia (PPNI) of Malang.

Website: http://ejournal.umm.ac.id/index.php/keperawatan
E-mail: journal.keperawatan@umm.ac.id

1. Introduction

Insomnia is one of the most common sleep disorders experienced by the general population, significantly affecting individuals' physical, psychological, and social well-being. Globally, the prevalence of insomnia is estimated to be around 20–30%, with higher rates observed among individuals with unhealthy lifestyles and prolonged exposure to stress (Riemann, 2022). This condition not only reduces quality of life but also impairs cognitive function, alters mood, decreases productivity, weakens immune function, and increases the risk of cardiometabolic diseases (Bjorvatn et al., 2021). Therefore, addressing insomnia through promotive, preventive, and curative measures has become a priority in nursing practice.

Smoking is one behavioral risk factor that contributes to sleep disturbances. Nicotine acts as a stimulant that heightens sympathetic nervous system activity, disrupts neurotransmitter balance, and interferes with the sleep-wake cycle(Sertcelik & Karalezli, 2024). These effects delay sleep onset and increase nighttime awakenings (Grigoriou et al., 2024). Moreover, withdrawal symptoms during the night can further deteriorate sleep quality(Nuñez et al., 2021). Research shows that smokers are at a higher risk of developing insomnia compared to non-smokers (Hu et

Please cite this article as: Kumboyono, et al. (2026) 'Effect of lemongrass aromatherapy on insomnia severity among adult smokers: A quasi-experimental study', Jurnal Keperawatan. Universitas Muhammadiyah Malang, 17 (1), pp. 95–104.
doi: 10.22219/jk.v17i1.42819

al., 2021). Additionally, higher vitamin D levels may modulate the association between tobacco exposure and insomnia, suggesting that biological and nutritional factors should also be considered (Gao et al., 2023). This highlights the need for effective interventions to help nurses improve sleep quality among smokers.

Non-pharmacological approaches have gained traction as essential strategies for managing sleep disorders, especially due to their safety, accessibility, and suitability within nursing care. Aromatherapy is one such complementary therapy that has been shown to reduce stress, promote relaxation, and enhance sleep quality through stimulation of the limbic system and modulation of the autonomic nervous system (Agarwal et al., 2022). Lemongrass (*Cymbopogon citratus*) contains active compounds such as citral, geraniol, and limonene, which possess anxiolytic, sedative, and antioxidant properties (Chowdhury et al., 2024; Kiani et al., 2022). While some studies have reported that lemongrass aromatherapy can reduce anxiety and improve sleep quality, much of the existing research still centers around lavender, leaving a gap in evidence regarding the effectiveness of lemongrass—particularly among smokers with insomnia (Her & Cho, 2021).

Existing evidence on aromatherapy for sleep disorders has predominantly focused on lavender essential oil and non-smoking populations, with limited attention to sleep disturbances related to nicotine dependence (Alforaih & Al-Sowayan, 2022; Andersen et al., 2025). From a nursing perspective, smokers experience insomnia through complex interactions between physiological stimulation caused by nicotine, psychological distress related to anxiety/withdrawal, and behavioral factors that disrupt sleep regulation (Abdelkader et al., 2024; Singh et al., 2023). These multidimensional mechanisms suggest that sleep problems among smokers require holistic, non-pharmacological interventions aligned with nursing care principles.

Addressing this gap, the present study examines lemongrass (*Cymbopogon citratus*) aromatherapy as a complementary nursing intervention for reducing insomnia severity among smokers in a community setting. From a scientific perspective, this study contributes to the limited body of evidence on aromatherapy-based sleep interventions by focusing on an essential oil and a population that has been underrepresented in previous research. From a practical standpoint, the findings provide evidence-based support for nurses to integrate lemongrass aromatherapy as a feasible, non-pharmacological intervention within holistic and person-centered community nursing care.

2. Methods

This study employed a quasi-experimental design with a pretest–posttest control-group design. Participants were divided into two groups: the intervention group received lemongrass (*Cymbopogon citratus*) aromatherapy, and the control group received a placebo inhaler containing sunflower oil. The target population consisted of active smokers aged 18 to 40 years who exhibited symptoms of insomnia as indicated by their scores on the Insomnia Severity Index (ISI) (Âlyne et al., 2001). In addition to assessing participant characteristics, the study measured nicotine dependence using the Fagerström Test for Nicotine Dependence (FTND) (Heatherton et al., 1991) and assessed anxiety levels with the Generalized Anxiety Disorder 7-item scale (GAD-7) (Spitzer et al., 2006).

The required sample size was calculated using G*Power version 3.1. For a comparison of two independent groups using a two-tailed independent t-test, the following parameters were applied: a moderate effect size (Cohen's d = 0.5), a significance level (α) of 0.05, and a statistical power (1–β) of 0.80, as recommended in behavioral and health research (De Vries et al., 2023; Gan, 2025).

The analysis indicated that a minimum total sample size of 100 participants was required. Accordingly, the study included 100 smokers, with 50 participants allocated to each group. Participants were recruited through purposive sampling and subsequently assigned to either the intervention or control group. This sample size was considered adequate to detect statistically and clinically meaningful differences in insomnia severity between groups (Holmberg & Andersen, 2022; Qin et al., 2024).

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doi: 10.22219/jk.v17i1.42819

P- ISSN: 2086-3071 | E-ISSN: 2443-0900

The intervention was conducted over a two-month study period, during which participants in the intervention group received lemongrass (*Cymbopogon citratus*) aromatherapy according to a standardized protocol. The aromatherapy intervention was administered using a personal inhaler and applied consistently throughout the intervention period. Participants in the control group received a placebo inhaler containing sunflower oil and followed the same intervention schedule and procedures as the intervention group, except for the active aromatherapy component, to ensure procedural consistency between groups.

Data collection was carried out before and after the intervention using the Insomnia Severity Index (ISI) developed by Âlyne et al. (2001). The intervention group received a 3% concentration of lemongrass essential oil via a personal inhaler, while the control group received a placebo inhaler filled with sunflower oil. Both groups were instructed to inhale the contents four times daily at scheduled times, with additional use permitted when needed. The inhalers were standard pocket-sized plastic devices designed to deliver consistent olfactory exposure, and the essential oil used in the intervention group was certified therapeutic grade (Sivamaruthi et al., 2025).

Participant adherence to the intervention protocol was monitored throughout the intervention period to ensure compliance and consistency. At the beginning of the study, all participants received standardized instructions regarding the correct use of the inhaler, including the recommended frequency and timing of use. Participants were asked to self-monitor their inhaler use by recording daily use in a simple adherence log, which the research team reviewed periodically. In addition, regular follow-up contacts were conducted to remind participants of the intervention procedures, address questions or difficulties, and reinforce adherence. During follow-up visits, participants were also asked to report any deviations from the prescribed protocol or issues related to inhaler use. This combination of self-report monitoring and researcher follow-up was implemented to promote adherence and minimize protocol deviations throughout the intervention period.

Data were analyzed using SPSS version 22. Descriptive statistics were employed to summarize participants' characteristics, with means and standard deviations (SD) for continuous variables and frequencies and percentages for categorical variables. To assess baseline comparability between groups, independent sample t-tests were conducted for continuous variables (e.g., age, daily cigarette consumption, FTND score, and GAD-7 score), while Chi-square tests were used for categorical variables (e.g., gender and employment status). To evaluate the effectiveness of the intervention, independent t-tests were used to compare ISI scores between the intervention and control groups at both pretest and posttest. Paired t-tests were performed to assess within-group changes from pretest to posttest. A significance level of 5% (p-Value < 0.05) was applied to all statistical analyses.

3. Results and Discussion

This section presents the study's findings, beginning with a comparison of participant characteristics to ensure baseline equivalence between the intervention and control groups. Subsequent analyses evaluate the effectiveness of lemongrass aromatherapy in reducing insomnia severity, based on pretest and posttest Insomnia Severity Index (ISI) scores. Results are interpreted in the context of existing literature, and implications for nursing practice are highlighted. The study's limitations are also discussed to inform future research directions.

3.1 Participant Characteristics by Group

Baseline characteristics were comparable between the intervention and control groups, with no statistically significant differences observed across demographic, behavioral, or psychological variables (Table 1). This baseline equivalence supports internal validity and minimizes the likelihood that post-intervention differences in insomnia severity were attributable to pre-existing group imbalances rather than the intervention itself (Holmberg & Andersen, 2022).

Table 1 Participant Characteristics by Group

Variable	Control Group	Intervention Group	p-Value
Age (x̄ ± SD)			
Years	39.48 ± 12.38	38.60 ± 10.45	0.787#
Gender (f, %)			
Male	24 (96.0%)	21 (84.0%)	0.346#
Female	1 (4.0%)	4 (16.0%)	
Employment Status (f, %)			
Self-employed	16 (64.0%)	14 (56.0%)	0.663*
Private employee	2 (8.0%)	5 (20.0%)	
University student	7 (28.0%)	6 (24.0%)	
Cigarette Rate (x̄ ± SD)			
Sticks/day	10.28 ± 2.85 (6–16)	9.56 ± 2.74 (5–15)	0.367#
Nicotine Dependence (x̄ ± SD)			
FTND Score	5.60 ± 2.83 (1–10)	5.88 ± 3.19 (1–10)	0.717#
Anxiety (x̄ ±SD)			
GAD-7 score	9.80 ± 2.93 (5–14)	9.88 ± 2.51 (5–14)	0.922#

Note: Data are presented as mean ± SD or frequency (%). Independent t-tests (#) and Chi-Square tests (*) were used to compare baseline characteristics between groups. A significance level of 5% (p-Value < 0.05) was applied. No significant differences were found between groups.

The higher proportion of male participants in both groups reflects regional demographic trends, particularly in Southeast Asia, where the prevalence of smoking remains significantly higher among men (World Health Organization, 2021). Gender disparity in smoking behavior continues to influence the generalizability of smoking cessation trials and highlights the importance of targeting interventions to high-risk populations. Similar patterns in stress-related behaviors and sleep disturbances have also been observed among student populations, particularly those with excessive screen time or smartphone use, which negatively impacts both sleep quality and academic motivation (Pebriani & Marleni, 2020). These findings underscore the need for early health promotion efforts among youth. Furthermore, efforts to reduce smoking—especially among adolescents and young adults—have shown better outcomes when peer education and nurse-led counseling are employed, highlighting the critical role of targeted behavioral interventions in nursing practice (Dais et al., 2024).

Baseline nicotine dependence, measured using the Fagerström Test for Nicotine Dependence (FTND), showed moderate scores in both groups. This level of dependence is considered suitable for adjunctive interventions such as aromatherapy, which are often more effective in populations with moderate levels of addiction (Reven, 2023). Additionally, baseline anxiety levels assessed by the GAD-7 scale were similar across groups. This is notable since anxiety is closely associated with sleep disturbances, including insomnia. A balanced psychological profile at baseline minimizes the risk that any observed changes in sleep outcomes are driven by underlying anxiety differences (Schlarb et al., 2021).

The overall balance in demographic, behavioral, and psychological factors supports the robustness of this study's design. It enhances confidence that subsequent differences in insomnia outcomes are attributable to the intervention itself, rather than to pre-existing group disparities.

3.2 Pretest and Posttest Comparison of Insomnia Severity Index Scores

The findings of this study indicate that aromatherapy with lemongrass essential oil significantly reduced insomnia severity among participants in the intervention group (Table 2). The ISI score decreased from 14.64 ± 3.78 to 12.00 ± 2.93 (p-Value = 0.008), suggesting a moderate yet clinically meaningful improvement in sleep quality. In contrast, the control group, which received a placebo inhaler, experienced a slight but statistically nonsignificant reduction (p-Value = 0.371). The between-group difference at posttest was statistically significant (p-Value = 0.035), supporting the conclusion that the observed improvements were attributable to the intervention.

P- ISSN: 2086-3071 | E-ISSN: 2443-0900

Table 2: Mean and Statistical Comparison of Insomnia Severity Index (ISI) Scores in Pretest and Posttest by Group

Group	Pretest ISI ($\bar{x}$ ± SD)	Posttest ISI ($\bar{x}$ ± SD)	Pretest Comparison (p-Value)	Posttest Comparison (p-Value)	Pre vs Post (p-Value)
Control	15.0 ± 3.39	14.08 ± 3.81	0.725	0.035	0.371
Treatment	14.64 ± 3.78	12.0 ± 2.93			0.008

Note: Data are presented as mean ± standard deviation (SD). Independent t-tests were used to compare pretest and posttest scores between groups. Paired t-tests were conducted to assess within-group changes from pretest to posttest. A significant reduction in ISI scores was observed in the treatment group (p-Value = 0.008), while the control group did not show a significant change. No significant difference was found at baseline between groups (p-Value = 0.725), indicating group comparability prior to intervention.

These findings are consistent with a growing body of international evidence demonstrating the effectiveness of essential oils in reducing insomnia symptoms and improving sleep-related outcomes. Lemongrass (*Cymbopogon citratus)* has been widely recognized for its anxiolytic and sedative properties, which may positively influence sleep regulation by modulating autonomic nervous system activity (Jahan et al., 2024). Experimental and clinical studies suggest that inhalation of lemongrass essential oil promotes relaxation responses by reducing sympathetic nervous system activation and enhancing parasympathetic dominance, processes that are central to sleep initiation and maintenance. In addition, bioactive compounds such as citral and limonene have been shown to enhance inhibitory GABAergic signaling and influence limbic system activity, thereby promoting calmness, facilitating sleep onset, and supporting sleep continuity (De Sousa et al., 2017; Jahan et al., 2024).

The present findings align with broader aromatherapy research, indicating that olfactory stimulation can exert measurable effects on neurophysiological processes related to sleep and emotional regulation. For example, Ahmad and Pratap (2024) demonstrated that essential oil inhalation alters autonomic balance and stress-related biomarkers, supporting a plausible biological pathway for sleep improvement. Similarly, Wakui et al. (2023) reported that aromatherapy interventions significantly reduced sleep latency and nighttime awakenings in adults with sleep disturbances. In the current study, the lack of a significant change in the control group further supports that the observed reduction in ISI scores reflects an intervention effect beyond placebo, strengthening confidence in the therapeutic contribution of lemongrass aromatherapy.

From a clinical perspective, the statistically and clinically meaningful reduction in ISI scores supports the potential of lemongrass aromatherapy as a non-pharmacological option for managing mild to moderate insomnia. This is particularly relevant in contemporary clinical practice, where concerns regarding long-term use of hypnotic medications—such as dependency, cognitive impairment, and residual daytime sedation—have prompted increasing interest in complementary and integrative approaches. Aromatherapy offers a favorable safety profile and may serve as an alternative or adjunct for individuals who do not tolerate pharmacological agents due to side effects, contraindications, or personal preferences (Agarwal et al., 2022). Evidence from integrative sleep medicine further suggests that combining behavioral strategies with sensory-based interventions, including aromatherapy, may enhance overall treatment effectiveness (Lane et al., 2022; Maneemai et al., 2024).

The relevance of these findings becomes even more pronounced when considering populations with complex sleep disturbances, such as smokers. Smoking-related insomnia is often driven by heightened physiological arousal, nicotine withdrawal symptoms, and anxiety, which can undermine the effectiveness of standard sleep hygiene interventions. In this context, lemongrass aromatherapy may help attenuate anxiety-related arousal and promote relaxation, thereby addressing both psychological and physiological contributors to insomnia. Recent work by Al-Soleiti et al. (2025) highlights the intricate relationship between smoking behavior, autonomic dysregulation, and sleep disruption, underscoring the need for tailored, non-pharmacological interventions.

From a nursing perspective, these findings have important implications for community and primary care practice. Aromatherapy represents a non-pharmacological, low-cost, and nurse-led intervention that aligns closely with holistic and person-centered care principles. Nurses are uniquely positioned to integrate aromatherapy into health promotion initiatives, smoking-cessation support, and sleep-hygiene education, particularly for individuals who are reluctant or unable to use pharmacological sleep aids (Anggraini et al., 2022; Her & Cho, 2021). These findings may also inform the development of nursing practice guidelines and non-pharmacological care protocols for sleep management in community and primary care settings. The integration of complementary therapies into nursing care also reflects a broader shift toward integrative health models that emphasize symptom management, patient empowerment, and quality of life.

Furthermore, incorporating aromatherapy into routine nursing care may empower patients to engage in self-management strategies for sleep disturbances, thereby enhancing autonomy, self-efficacy, and adherence to lifestyle modification programs. Self-management is a core component of contemporary nursing practice, especially in chronic and behavior-related conditions. In smoking populations, where anxiety and stress frequently co-occur, lemongrass aromatherapy may serve as a complementary strategy to support relaxation, coping, and overall well-being (Ibad et al., 2022). Evidence from behavioral health nursing suggests that interventions targeting stress reduction can indirectly improve sleep outcomes and support sustained behavior change(Harvey, 2022; Hoying et al., 2023).

Importantly, the implications of these findings extend into broader nursing practice and health system contexts. Nurses working in community and primary care settings are in a strategic position to incorporate complementary therapies, such as aromatherapy, into holistic care plans that address the biological, psychological, and social dimensions of health. Aromatherapy is non-invasive, easy to administer, and accessible in resource-limited settings, further supporting its feasibility in routine practice. Consistent evidence indicates that complementary therapies, including aromatherapy, are associated with improvements in sleep quality among adult and older populations (Her & Cho, 2021). By integrating such interventions into nursing care, nurses can address sleep problems using a person-centered approach that respects patient preferences and promotes non-pharmacological solutions (Anggraini et al., 2022).

Finally, the results underscore the critical role of nurses in health education and behavioral change. By educating patients on the safe and effective use of essential oils for self-care, nurses can contribute to improved sleep hygiene, stress management, and overall well-being. In contexts such as smoking cessation programs, mental health services, and post-discharge care, lemongrass aromatherapy may serve as a valuable adjunct to support anxiety reduction and coping strategies. Such roles are particularly salient during periods of heightened psychosocial stress, including public health crises, where non-pharmacological, easily deployable interventions are urgently needed (Ibad et al., 2022). Collectively, these findings reinforce the value of lemongrass aromatherapy as an evidence-informed, nursing-relevant intervention with both clinical and public health significance.

Study Limitations

Several limitations should be considered when interpreting the findings of this study. The choice of a quasi-experimental design was primarily driven by the community-based setting, where randomization and full experimental control were not always feasible due to ethical, logistical, and practical considerations. In real-world community nursing contexts, interventions often need to be implemented within existing social structures and participant availability, which can limit the application of randomized controlled designs. Despite these constraints, the inclusion of a control group, baseline comparability between groups, and standardized intervention procedures enabled a meaningful evaluation of intervention effects under real-world conditions. This design, therefore, reflects a balance between methodological rigor and ecological validity while acknowledging inherent limitations in causal inference.

First, blinding was not implemented due to the inherent characteristics of the aromatherapy intervention, as the distinctive scent of lemongrass essential oil made masking

P- ISSN: 2086-3071 | E-ISSN: 2443-0900

impractical. The absence of blinding may have introduced a degree of response bias, given that participants were aware of their group allocation. However, the use of a placebo inhaler and the application of standardized intervention procedures were intended to minimize expectancy effects and strengthen internal validity.

Second, although the quasi-experimental pretest–posttest control group design was appropriate for assessing intervention effects in a community setting, it does not permit definitive causal conclusions. While baseline characteristics were comparable between groups and the intervention was delivered consistently, causal interpretations should be made with caution due to the absence of random sampling and full experimental control. Accordingly, the findings are presented as evidence of intervention effects within the constraints of a quasi-experimental framework rather than as definitive causal proof.

Third, although key demographic and psychological variables were balanced at baseline, the study did not control for several potential lifestyle-related confounding factors, including caffeine and alcohol consumption and smoking duration. These variables are known to influence sleep patterns and may have independently affected insomnia severity. The lack of control for these factors may have resulted in residual confounding, which could partially influence the observed intervention effects.

Future studies are therefore recommended to employ randomized controlled designs, incorporate larger and more diverse samples, and include more comprehensive assessments of lifestyle-related confounders to strengthen internal validity, improve generalizability, and enhance causal inference.

4. Conclusion

This study provides empirical evidence that the use of lemongrass (*Cymbopogon citratus*) aromatherapy was associated with lower insomnia severity among smokers. Participants in the intervention group showed statistically and clinically meaningful improvements in sleep quality within this sample, as reflected by decreased Insomnia Severity Index scores. These findings support the integration of complementary therapies such as aromatherapy into holistic nursing care, particularly for populations with behavioral risk factors such as smoking. Given its non-pharmacological nature, affordability, ease of use, and low risk of side effects, lemongrass aromatherapy may serve as a practical adjunct in clinical and community nursing settings.

Overall, this study contributes to the growing body of literature advocating for evidence-based complementary nursing interventions and highlights the potential of lemongrass aromatherapy as a promising non-pharmacological approach for sleep health management in this population. From a scientific perspective, this study provides novel evidence by focusing on lemongrass aromatherapy in a smoking population that has been underrepresented in previous sleep intervention research. Future studies employing randomized controlled designs with larger and more diverse samples and extended follow-up periods are recommended to strengthen causal inference and evaluate the long-term effects of lemongrass aromatherapy on sleep outcomes.

Ethics approval and consent to participate

The study received ethical approval from the Research Ethics Committee of Poltekkes Malang (No. DP.04.03/F.XXI.31/01104/2024). All participants provided written informed consent.

Acknowledgments

The authors would like to express their sincere gratitude to the Faculty of Health Sciences, Universitas Brawijaya, for the academic support and facilities provided during this research. We also extend our heartfelt appreciation to all the participants who willingly took part in the study and contributed their time and cooperation to make this research possible.

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