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Short-Communication

Lavender essential oil aromatherapy in modulating psychological and clinical factors in smokers: a randomized double-blind clinical trial

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Abstract

Objective: Smoking is one of the major health issues in Iran and the rest of the world. Smokers deal with a number of medical problems. This study looked at how aromatherapy with lavender essential oil (*Lavandula angustifolia*) affected smoker's physiological and psychological markers.

Materials and Methods: This double-blind clinical trial included 80 smokers between the ages of 18 and 49. Participants were allocated at random to an intervention group receiving lavender essential oil and a control group receiving a placebo. They inhaled the assigned substance each night for 15 consecutive nights before bedtime. Primary outcomes included boredom, sleep quality, anxiety levels, and cognitive function, while secondary outcomes comprised physiological parameters like heart rate and blood pressure. All outcomes were assessed prior to and following the intervention.

Results: The findings indicated that the intervention group exhibited a significant decrease in anxiety, as quantified by the Hamilton Anxiety Rating Scale (HARS) (p=0.01), and an enhancement in sleep quality, as evaluated by the Pittsburgh Sleep Quality Index (PSQI) (p=0.01). A notable reduction in systolic blood pressure was recorded in the intervention group (p=0.03). No significant changes were observed in heart rate, diastolic blood pressure, or other indices.

Conclusion: The findings of this research indicated that lavender essential oil can significantly alleviate anxiety and enhance sleep quality in smokers. This remedy can be considered a safe and effective alternative to pharmaceutical supplements for the psychological and physiological problems of smokers.

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Introduction

Smoking is recognized as a significant public health issue and an important factor of preventable death, accounting for approximately 6 million fatalities each year. In 2019, an estimated 1.14 billion people worldwide smoked, with tobacco use causing 7.69 million deaths. Despite a decrease in smoking globally, tobacco use still affects 20% of adults. In Iran, smoking prevalence was 11.14% in 2015, nearly half the global average. The World Health Organization (WHO) predicts a decrease in tobacco users from 1.38 billion in 2000 to 1.2 billion in 2024. However, regional disparities remain, and further preventive measures are essential to curb this epidemic (Zi, Shahmohamadi et al. 2026; Shahmohamadi et al. 2023; World Health Organization 2025)

In addition to its strong association with the development of various diseases including lung cancer, gastrointestinal cancer, and cardiovascular diseases, smoking directly affects an individual's overall well-being and mental health (Loretan et al. 2022; Lizarraga, Valderrama et al. 2021)

Cigarette nicotine, an active component, is known to induce sleep disturbances, irritability, and heightened anxiety in smokers (Hata et al. 2022). Smokers typically experience insufficient sleep which adversely affects their overall well-being and is associated with an increased risk of obesity, as well as cognitive and emotional impairments (Liao et al. 2019). Nicotine can impact various regions of the brain, initially enhancing cognitive activity and attention, but leading to a decline in long-term cognitive performance (Deal et al. 2020; Pandey et al. 2017). Thus, the dual effects of nicotine on the brain further complicate its overall impact on health. Anxiety, a common psychological concern among smokers, can stem both from the act of smoking itself and from its use as a self-medication to alleviate anxiety (Slomp et al. 2019; Fluharty et al. 2017). Additionally, smoking can function as a stimulant, particularly in individuals experiencing severe fatigue, helping to increase alertness and energy levels (Pettiford et al. 2007). Another effect of nicotine is the immediate elevation of heart rate and blood pressure, which can impair vascular function and increase the likelihood of developing vascular disorders and heart-related complications (Babic et al. 2019).

After quitting, smokers often experience symptoms such as restlessness, mood disturbances, and behavioral changes which increase the need for psychiatric support and pharmacological treatment (Cunningham et al. 2016). Although these medications can be effective, they are commonly linked to detrimental consequences including dependency and cognitive deficits (Kasper et al. 2018). Conversely, non-medication strategies such as aromatherapy offer a safe and accessible alternative (Karadag et al. 2017).

Lavender oil *(Lavandula angustifolia),* a widely investigated aromatic plant, exhibits anxiolytic, antidepressant, and anti-stress effects mainly attributed to its monoterpenes linalool and linalyl acetate which modulate GABAergic, serotonergic, and glutamate-related neural signaling (López et al. 2017; Harada et al. 2018; Wang et al. 2018). Systematic reviews and experimental studies have demonstrated that lavender essential oil therapy has a significant effect on alleviating anxiety and depression, with modest improvements in physiological measures including blood pressure (Donelli et al. 2019; Kim et al. 2021; Tan et al. 2023; Yoo et al. 2023). The standardized oral preparation Silexan has demonstrated comparable efficacy to conventional anxiolytics in generalized anxiety disorder with fewer side effects (Kasper et al. 2014).

Moreover, several clinical investigations report that lavender aromatherapy alleviates preoperative anxiety, menopausal symptoms, and physiological stress during dental and cardiac procedures, indicating broad

psychophysiological benefits (Stanley et al. 2020; Jokar et al. 2020; Tahmasebi et al. 2019; Wang et al. 2022). Beyond its psychological effects, lavender possesses anti-inflammatory and immunomodulatory actions: *Lavandula stoechas* extract reduces airway inflammation and cytokine levels (Tumor Necrosis Factor Alpha and Interleukin-6) in asthma models (Erfanian et al. 2025), while clinical trials in Iran indicate that lavender syrup as a supplementary treatment alleviates cough, enhances the sense of smell, and improves overall well-being in COVID-19 patients (Qaraaty et al. 2023; Hashem, Dabaghian et al. 2022)Although there have been many studies investigating the therapeutic benefits of lavender oil for a range of diseases and psychological issues, there has yet to be a clinical trial that specifically explores the effects of aromatherapy with lavender on physiological and psychological conditions of smokers. This study was designed to explore the impact of lavender aromatherapy on primary outcomes which encompass boredom, sleep quality, anxiety severity, and cognitive function, alongside secondary outcomes related to heartbeat and blood pressure in smokers.

Materials and Methods

Study design

This research, documented in the Iranian Clinical Trials (IRCT20230320057758N1), was a randomly assigned, double-blind, placebo-treated clinical trial involving 80 willing smokers aged 18 to 49 years in Kashan, Iran. The procedure was comprehensively explained to all attendees prior to their involvement. All intervention techniques were performed following the acquisition of signed informed permission from the subjects and under the oversight of the investigator. The Ethics Committee of IR.KAUMS.MEDNT.REC.1401.245 approved this study.

The group of participants comprised current smokers (scoring 4 on the Fagerström test) or individuals who had recently quit smoking. All participants were selected randomly. The attendees were arbitrarily assigned to two groups using Stat Trek software and the random number table method. The group receiving the intervention (n = 40) was administered aromatherapy with lavender over a period of 15 days, in contrast to the control group (n = 40), which was given a placebo treatment. As a double-blind study, neither the participants nor the researchers were aware of the group assignments (Karadag et al. 2017).

Criteria for inclusion and exclusion

The criteria for inclusion were: 1. Readiness for participation in a trial, 2. Age between 18 and 49 years, 3. Absence of chronic conditions including mental health disorders, diabetes, hypertension, cardiovascular disease, and hepatitis, 4. Individuals who are current smokers or have recently quit, with a Fagerström score of at least 4.

The exclusion criteria included: 1. Unwillingness to participate in the study (non-cooperation), 2. Use of any medications, 3. Newly diagnosed chronic physical conditions such as diabetes or hypertension that could affect the study outcomes, 4. Use of illicit substances (including opium and other drugs), 5. Use of water pipes.

Description of lavender and placebo

One of the aromatherapy essential oils that is most commonly utilized is lavender, recognized for its calming and anxiety-reducing properties. It contains primary active compounds which are responsible for its therapeutic properties. The lavender oil utilized in this investigation was obtained from Barij Essence Pharmacy Company (Under Batch No 9208051) in Iran and selected for its high quality and purity. The chosen aromatherapy blend included 10% lavender oil in a sesame carrier oil base,

while the placebo group received only the carrier oil. In this study, placebo (Barij Essential Company) with aromatherapy characteristics was designed. Lavender oil and placebo was used during the 15-day intervention. To maintain blinding for both the researchers and participants, the placebo and lavender oil was placed in separate containers labeled with codes 1 and 2.

Methodology

The study procedure was as follows: Initially, all participants were assessed for boredom, anxiety, cognitive function, sleep quality, and clinical factors (heart rate and blood pressure) using questionnaires. A random assignment was made to place individuals into either the lavender essential oil group or the placebo group. For 15 consecutive nights, they were advised to place two drops of the given substance on a cotton ball before bedtime and inhale it for 20 min. The cotton ball, measuring 2×2 cm, was placed approximately 30.48 centimeter below the participant's nose to facilitate inhalation during sleep. An identical procedure was likewise applied to the control group. This dosage was based on previous research and established safety guidelines for lavender oil use in aromatherapy (Karadag et al. 2017). Upon completion of the research, participants inhaled the relevant substance 20 min prior to retaking the assessments, which included evaluations of boredom, anxiety, cognitive function, sleep quality, and clinical factors.

Measurement of primary and secondary outcomes

Blood pressure measurements (systolic and diastolic) were taken with a digital blood pressure monitor (Riester ri-champion N Digital Sphyg. Model: 1725-147, Riester GmbH, Jungingen, Germany) following the standard protocol. Participants were asked to sit in a relaxed sitting posture with feet flat on the ground and sufficient back support, remaining in this position for at least 5 min prior to the measurement. The assessment was conducted on the right arm utilizing a cuff that was suitably calibrated to match the arm circumference of each participant. Blood pressure measurements were taken on two occasions: initially at baseline, prior to the intervention, and subsequently at the conclusion of the 15-day treatment period. The analysis utilized the mean of the two readings. All measurements were taken by a trained nurse to ensure consistency and accuracy.

Assessment instruments

Hamilton created the 14-item Hamilton Anxiety Rating Scale (HARS) in 1959; each item represents a distinct symptom of anxiety. Higher scores indicate more severe anxiety, and the total score ranges from 0 to 56, with each question being assessed on a 5-point Likert scale from 0 to 4 (Thompson 2015).

In 2005, Shiffman and Sayette, created the Nicotine Dependence Syndrome Scale (NDSS), a multi-item instrument that measures nicotine dependence according to the DSM-IV-TR criteria. Smoking arousal, tolerance, preferences, stereotypical behavior, and commitment are the five pillars upon which the 19-item scale rests. The reliability of the scale was assessed, with a total score reliability of 0.84, and subscale reliabilities of 0.76 for arousal, 0.69 for preference, 0.55 for tolerance, 0.63 for adherence, and 0.70 for stereotypical behavior (Shiffman and Sayette 2005).

The Multidimensional State Boredom Scale (MSBS), created in 2013 by Fahlman et al. was used in this research. Featuring 29 items across 5 dimensions, the scale is the first all-inclusive tool for measuring ennui. The dimensions include non-participation (10 items), inattention (4 items), high arousal (5 items), time perception (5 items), and low arousal (5 items) (Fahlman et al. 2013).

The MoCA (Montreal Cognitive Assessment) is a comprehensive seven-item test that evaluates visuospatial abilities, memory, attention, spatial

awareness, and delayed recall. Executive functioning, advanced language skills, memory, and complex visuospatial processing are among the many cognitive areas assessed, and the exam covers a wider range than the Mini-Mental State Examination (Nasreddine et al. 2005).

The Pittsburgh Sleep Quality Index (PSQI) has 19 items rated on a scale with four options: no sleep issues (0), moderate sleep problems (1), severe sleep problems (2), and extremely severe sleep problems (3). Participants were divided into two groups after integrating scores. A total score of 5 or greater indicated poor sleep quality, whereas less than 5 indicated adequate sleep (Buysse et al. 1989).

Several studies have examined and confirmed the reliability and validity of these surveys among Iranians (Aghili et al. 2022; Emsaki et al. 2011; Farrahi et al. 2009; Moloudi et al. 2022; Shahidi et al. 2007; Soleimani et al. 2017).

Data analysis and statistical evaluation

Data are expressed as mean ± standard deviation (SD) and as percentages. The analysis of data was performed utilizing SPSS version 17, developed by IBM SPSS, Inc., located in Armonk, NY, USA. The Chi-square test was utilized for the analysis of qualitative data, whereas multiple regression models were applied for the analysis of quantitative data. The Kolmogorov-Smirnov test was applied to assess the normality of the data. A p-value of less than 0.05 was deemed statistically significant.

Results

Initially, 100 participants were evaluated for eligibility and subsequently recruited in the study. Among these, 80 smokers were randomly allocated to either the essential oil of lavender group or the placebo group. Four individuals in the group receiving placebo and two from the intervention group were excluded due to their refusal to participate. Consequently, 74 subjects (intervention group: n = 38 and placebo group: n = 36) were incorporated into the final phase of analysis (Figure 1).

Table 1 indicates that there were no significant disparities in demographic variables and smoking-related behaviors between the intervention and placebo groups. This signifies that both of the groups were equivalent concerning these parameters.

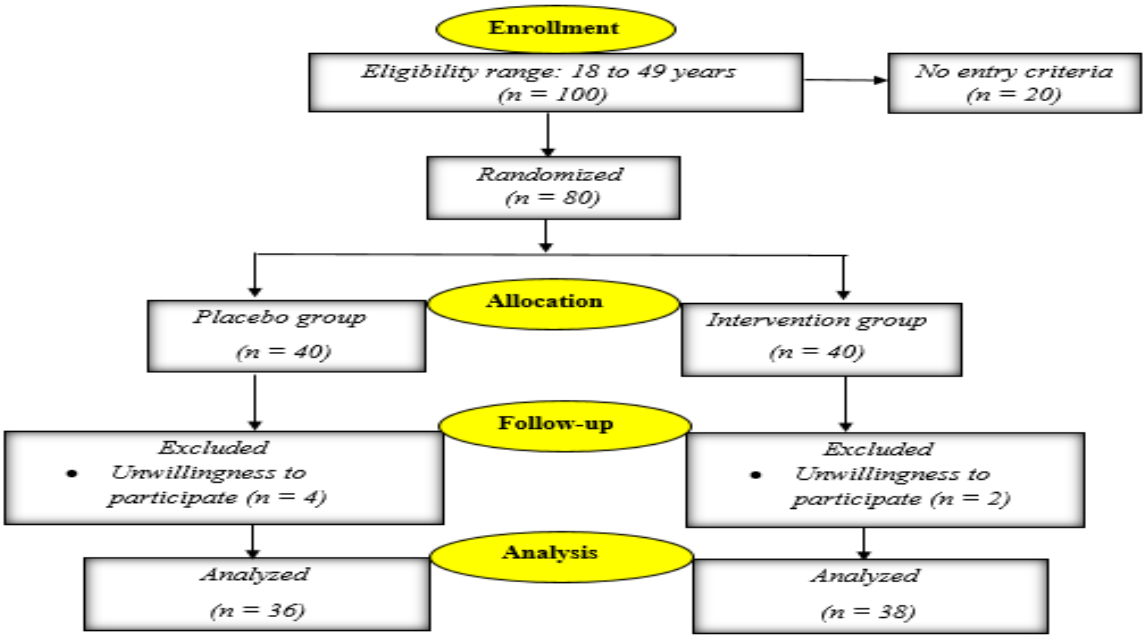

Figure 1. Flowchart of the clinical trial

Table 1. Demographic information

Variables	Placebo group (n=36)	Intervention group (n=38)	p value[1]
Age (year)	33.50 ± 6.22	33.18 ± 7.58	0.84
Age at first use (year)	18.72 ± 2.39	18.10 ± 2.44	0.27
Gender (%)			
Male	29 (80.6)	35 (92.1)	0.14[2]
Female	7 (19.4)	3 (7.9)	
Education (%)			
Elementary	2 (5.6)	3 (7.9)	
Intermediate	9 (25)	8 (21.1)	0.96[2]
Diploma	15 (41.7)	16 (42.1)	
College	10 (27.8)	11 (28.9)	
Marital Status (%)			
Single	11 (30.6)	17 (44.7)	
Married	20 (55.6)	17 (44.7)	0.45[2]
Widowed/Divorced	5 (13.9)	4 (10.5)	
Job (%)			
Unemployed	6 (16.7)	10 (26.3)	
Employee	4 (11.1)	6 (15.8)	0.43[2]
Others	26 (72.2)	22 (57.9)	
Duration of cigarette smoking (year)	11.69 ± 6.40	11.68 ± 6.58	0.99
Packs per day (%)			
One pack	25 (69.4)	26 (68.4)	
Two packs	9 (25)	11 (28.9)	0.77[2]
Three packs	2 (5.6)	1 (2.6)	

1: paired t-test, 2: chi-square test.

Primary outcomes

Notable differences are observed across various variables within the two study groups (Table 2). The intervention population demonstrated a significant reduction in the Hamilton Anxiety Rating Scale (HARS) (p=0.01). The intervention population also showed a significant improvement in sleep quality, as measured by the Pittsburgh Sleep Quality Index (PSQI) (p=0.01). No significant differences were observed between the two groups regarding nicotine dependence (NDSS) or boredom (MSBS) (p>0.05). Additionally, the changes in cognitive test scores (MoCA) approached significance (p=0.055). Overall, lavender essential oil demonstrated a positive impact on alleviating anxiety and improving sleep quality. However, regarding within-group comparisons, a significant difference was observed only in the MoCA variable between the first and fifteenth days in the placebo group. In contrast, the intervention group exhibited this significant difference between the HARS and PSQI variables.

Secondary outcomes

Comparisons between the intervention and placebo groups revealed notable differences in certain physiological variables (Table 3). A significant decrease in systolic blood pressure (SBP) was observed in the intervention group (p=0.03), based on measurements taken following the procedure described in the Materials and Methods section. However, no meaningful alterations were observed in diastolic blood pressure (DBP) between the groups (p=0.36). Furthermore, heart rate (PR) showed no noteworthy differences between the groups (p=0.58). Overall, the findings indicate that lavender essential oil has a notable effect on lowering SBP. However, other physiological measures did not exhibit significant alterations. Furthermore, within-group comparisons revealed no significant difference between the secondary outcomes variables in the placebo and intervention groups.

Table 2. Primary outcomes

Variables	Placebo Group (n=36)		p value[1]	Intervention Group (n=38)		p value[1]	Difference in outcome measures	p value[2]
	Day 1	Day 15		Day 1	Day 15		β (95% CI)	
HARS	22.83 ± 7.33	22.69 ± 7.41	0.34	22 ± 5.96	21.05 ± 5.34	0.004	-0.89 (-1.56, -0.22)	0.01
NDSS	57 ± 5.08	56.83 ± 5	0.20	57.31 ± 5.77	57.23 ± 5.84	0.54	0.11 (-0.23, 0.46)	0.51
PSQI	5.25 ± 2.48	5.33 ± 2.43	0.52	5.1 ± 2.19	4.65 ± 2.08	0.02	-0.56 (-0.98, -0.13)	0.01
MSBS	132.72 ± 20.91	132.77 ± 20.79	0.76	117.68 ± 21.01	117.44 ± 20.89	0.36	-0.46 (-1.12, 0.19)	0.16
MoCA	26.41 ± 1.71	26.72 ± 1.56	0.01	26.55 ± 1.76	26.06 ± 1.77	0.32	-0.23 (-0.48, 0.005)	0.055

HARS: Hamilton anxiety rating scale, NDSS: Nicotine dependence syndrome scale, PSQI: Pittsburgh sleep quality index, MSBS: Multidimensional state boredom scale, MoCA: Montreal cognitive assessment, 1: Based on independent t-test (Within group), 2: Obtained from multiple regression models.

Table 3. Secondary outcomes

Variables	Placebo group (n=36)		p value[1]	Intervention group (n=38)		p value[1]	Difference in outcome measures β (95% CI)	p value[1]
	Day 1	Day 15		Day 1	Day 15			
SBP (mmHg)	116.94±5.44	117.36±3.97	0.48	115.67±5.06	115.21±4.14	0.38	-1.36 (-2.61, -0.12)	0.03
DBP (mmHg)	78.03±5.79	78.89±4.75	0.13	78.93±2.92	78.88±3.26	0.90	-0.58 (-1.84, 0.67)	0.36
PR (BPM)	69.74±4.68	69.65±4.23	0.92	68.63±4.78	68.68±4.88	0.95	-0.53 (-2.47, 1.4)	0.58

SBP**:** Systolic blood pressure, DBP**:** Diastolic blood pressure, PR**:** Pulse rate, BPM: Beats per Minute, mmHg: millimeters of mercury, 1: Based on independent t-test (Within group), 2: Obtained from multiple regression models.

Discussion

This research sought to investigate the impacts of lavender scent on primary outcomes including boredom, sleep quality, anxiety severity, and cognitive function, as well as secondary outcomes including indicators like heartbeat and blood pressure in individuals who smoke. After 15 days of intervention, the findings demonstrated that the essential oil of lavender positively influenced anxiety reduction and enhanced sleep quality. However, no substantial alterations were noted in nicotine dependence syndrome, boredom, or cognitive performance within the intervention population in contrast to the placebo participants. Regarding physiological outcomes, lavender scent was significantly associated with a decrease in the systolic pressure, while no notable alterations were observed in DBP or the heart rate.

Numerous clinical investigations have explored the impact of lavender aroma on diverse physiological and clinical conditions. One such study by Sahebalzamani and colleagues, involving 260 students, showed that inhaling a blend of lavender and rose aromatherapy oils led to a significant reduction in anxiety and depression symptoms by the end of the second and fourth weeks of the treatment period (Sahebalzamani et al. 2010). In a controlled trial, 183 older individuals were randomly assigned to three groups, with 61 participants in each group: control, lavender, and chamomile selection. Over a period of 30 nights, all of the participants breathed in three drops of essential oil, either 1.5% lavender or chamomile. The findings indicated that the use of inhaling aromatherapy featuring lavender and chamomile essential oils led to a notable decrease in stress levels, anxiety, and depression among the elderly. This effect was observed both immediately after the intervention and one month later, particularly within the groups (Ebrahimi et

al. 2022). A meta-analysis that was carried out in 2019 by Kang and colleagues showed that lavender is beneficial in reducing both the physical and mental signs of anxiousness in healthy people and in patients who suffer from a variety of anxiety disorders (Kang et al. 2019). In another study, a total of 120 nurses were involved in a randomized clinical investigation carried out from 2018 to 2019. The study included three intervention groups: musical therapy and aromatherapy utilizing lavender-chamomile aromatic oils, and a composition of the first two interventions, along with a control group. The findings showed that aroma and music therapy both considerably lowered the nurses' anxiety levels (Zamanifar et al.2020). A 2021 study aimed at evaluating the effects of aromatic therapy on anxiety before surgery in adults by randomized controlled trials revealed that aromatherapy notably diminished preoperative anxiety in comparison to the control group (Huang et al. 2021). The process through which lavender oil alleviates anxiety can be linked to the compound linalool which interacts with Gamma-Aminobutyric Acid (GABA) A receptors, resulting in impacts comparable with those of the benzodiazepines. This binding enhances the inhibitory action of GABA in the brain, helping to alleviate nervous tension, reduce anxiety, and induce relaxation (Sayorwan et al. 2012).As previously noted, our investigation identified no evidence of statistical significance regarding the use of lavender essential oil and improvements in cognitive test scores (MoCA) in smokers. However, a study conducted on 20 healthy individuals, which examined the influence of the aroma inhaled on cerebral function related to cognitive flexibility, indicated that inhalation of lavender essential oil resulted in significant changes in brain oscillation strength and behavioral performance. These results from the field of neuroscience imply that smelling lavender essential oil might improve mental agility (Afghan et al. 2024). Lavender essential oil was shown by Malloggi et al. to decrease arousal when inhaled and it improved sustained attention in healthy individuals. However, the findings regarding memory were inconsistent. Overall, the modulation of the GABAergic pathway by linalool, a key component of lavender essential oil, may account for the observed improvement in cognitive performance (Malloggi et al. 2022). In this context, a meta-analysis conducted in 2025 included 888 individuals suffering from cognitive disorders discovered that aromatherapy inhalation enhanced cognitive performance while also decreasing homocysteine levels. According to these findings, inhaling aromatherapy has the potential to be a safe, effective, and inexpensive way to improve cognitive abilities in people with cognitive disorders (Su et al. 2025).

A study evaluating the impact of 12 weeks of aromatherapy with lavender on self-reported quality of sleep and heart rate variability (HRV) in middle-aged women with sleeplessness indicated that lavender inhaling might have a short-term beneficial influence on HRV by increasing parasympathetic control. Women who received aromatherapy showed significant improvements in the quality of sleep following the intervention. Nevertheless, the aromatherapy of lavender did not seem to offer long-term benefits on HRV at follow-up (Chien et al. 2012). A study conducted at a psychiatric clinic investigated the effectiveness of lavender essential oil aromatherapy on the quality of sleep in 80 people dealing with severe depression and concomitant sleep disturbances. Lavender oil was inhaled by the intervening group, while almond oil was given as a placebo to the control individuals. Comparing the group receiving the intervention to the control, the results showed a statistically significant enhancement in the quality of sleep. These results indicate suggesting lavender oil aromatherapy could be a useful herbal supplemental therapy for improving the quality of sleep in those suffering from

severe depression (Samadi et al. 2021). In a different investigation, (Hamzeh et al. 2020) assessed the effects of breathing in essential oils of peppermint and lavender on those suffering cancer quality of sleeping. One hundred twenty individuals were allocated at random to the following categories: control, peppermint, and lavender. Each group receiving intervention was administered three drops of their designated oil of essence for seven days in a row. In comparison to the control group, the results showed that patients who got aromatherapy had much better sleep quality (Hamzeh et al. 2020). Linalool binds to the N-Methyl-D-aspartate (NMDA) receptor and acts as an antagonist of the competition of glutamate. In the rat brain, exposure to lavender oil enhances the affinity of GABA for the GABA-A receptor, thereby reducing neuronal excitability and facilitating sleep onset. The stress-relieving effects of a brief sleep cycle are attributed to the reduction of cortisol levels. Consequently, napping may help alleviate the stimulation of both the sympathetic nervous and endocrine system, leading to an anti-stress response (Yogi et al.2021).

A study involving 80 patients undergoing coronary angiography investigated the impact of lavender inhalations on hemodynamic alterations. Post-intervention, significant decreases in both systolic and diastolic blood pressure, along with heart rate, were recorded in those in the intervention group (Ziyaeifard et al. 2017). In this context, Gultom et al. found that 32 hypertensive patients who participated in lavender aromatherapy showed a significant decrease in systolic and diastolic blood pressure (Gultom et al. 2016). The effect of lavender on lowering blood pressure is linked to one of its active compounds. A research investigation conducted on rats revealed that olfactory stimulation utilizing lavender essential oil led to a decrease in sympathetic nerve activity. Specifically, linalool, affects the hypothalamic suprachiasmatic nucleus and the central histaminergic nervous system, which in turn, reduces blood pressure and autonomic neurotransmission (Tanida et al. 2006). A further study corroborated these findings, demonstrating that linalool, lowered blood pressure in rats administered urethane for anesthesia by reducing sympathetic nerve activity associated with the adrenal glands and kidneys (Höferl et al. 2016; Nagai et al. 2014).

However, additional research has pointed out lavender aromatherapy has little significant effect on clinical and physiological factors, including anxiety levels, sleep quality, and blood pressure in individuals with various diseases and pathological conditions, and the observed effects were statistically insignificant (Jafarbegloo et al. 2020; Otaghi et al. 2017; Sebastian and Kear 2024; Tamaki et al. 2017).

Emerging evidence from both human and preclinical studies suggests that lavender and its bioactive components exert protective rather than adverse effects under cigarette-smoke exposure. A clinical trial demonstrated that inhalation of *L. angustifolia* essential oil significantly reduced cigarette craving in habitual smokers, indicating a potential neuromodulatory benefit (de Almeida Cunha et al. 2018) Consistently, experimental models have demonstrated that linalool reduces cigarette-smoke-induced pulmonary inflammation by inhibiting NF-κB signaling and suppressing pro-inflammatory cytokine production (Ma et al. 2015), indicating that extract from *L. stoechas* reduces acute lung damage via regulating the NF-κB pathway and oxidative stress (Al-Joufi et al. 2024). Together, these data reinforce the notion that lavender aromatherapy is unlikely to interact harmfully with cigarette smoke and may instead confer antioxidant, anti-inflammatory, and craving-reducing benefits.

The constraints of the investigation encompass the limited sample size and the focus on current smokers. Future research would benefit from examining individuals

who are in the process of quitting smoking. Additionally, withdrawal symptoms and cravings were not assessed, which should be considered in future studies. Additionally, water pipe smokers were not included in this study, which is considered one of the limitations and could be addressed in future research.

Lavender essential oil aromatherapy was shown to alleviate anxiety and improve the quality of sleep in this research. The significant reductions in HARS scores and improvements in the quality of sleep (PSQI) within the one receiving the intervention highlighted the potential role of this intervention in promoting mental health. However, there were no significant effects on nicotine dependence (NDSS) or boredom (MSBS), and although cognitive function (MoCA) showed some improvement, it did not attain significance in statistics. Regarding physiological measures, participants receiving the treatment exhibited a notable decline in systolic blood pressure, whereas heart rate and diastolic blood pressure remained statistically comparable between the groups. These findings suggested that lavender essential oil could serve as a low-cost and safe adjunct for reducing anxiety and improving sleep patterns. Nevertheless, additional studies are required to investigate its impact on other psychological and physiological factors. Future research involving expanded sample sizes and extended intervention durations would offer a deeper insight into the mechanisms underlying the effects of this compound.

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Conflicts of interest

The researchers state that they possess no competing interests.

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Ethics approval and consent to participate

Every individual involved provided written informed consent prior to participation. The study adhered to the principles outlined in the Declaration of Helsinki, and the study design and protocol were approved by the Ethics Committee of Kashan University of Medical Sciences (Project number: 401125; IR.KAUMS.MEDNT.REC.1401.245). The research is registered with the Iranian Registry of Clinical Trials (IRCT20230320057758N1). Any amendments to the clinical protocol will be submitted to the clinical trials registry after receiving approval from the relevant ethics review committee.

Authors' contributions

M.F, M.S and A. GH developed the conceptual framework of the investigation. Every author participated in the development of the study design and the acquisition of data. All authors shall participate in data interpretation, contribute to the final report, and collectively decide on submitting it for publication. Every author has reviewed and approved the protocol and the manuscript.

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