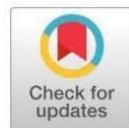# Inhaled lavender aromatherapy as an effective non-pharmalogical intervention for pain relief in the active phase of labour

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ARTICLE INFO

ABSTRACT

Labour pain is a physiological process that can cause significant anxiety, tension, and fatigue. Non-pharmacological interventions such as aromatherapy are increasingly considered to manage labour pain with minimal side effects. Lavender essential oil, known for its sedative and anxiolytic properties, has shown promise in reducing pain perception during childbirth. This study aimed to examine the effect of lavender aromatherapy on the level of labour pain among women in the active phase of the first stage of labour. A quasi-experimental study with a pretest-posttest control group design was conducted at Dirgahayu Hospital, Samarinda, Indonesia. A total of 36 women in the active phase of labour were recruited using purposive sampling and assigned to intervention (n = 18) and control (n = 18) groups. The intervention group received lavender aromatherapy via inhalation using a diffuser (4–5 drops of lavender oil in 20 ml of water) for 1 hour, while the control group was instructed in deep breathing relaxation techniques. Labour pain was assessed before and after the intervention using the Numeric Rating Scale (NRS). The intervention group showed a significant reduction in pain scores, from a mean of 6.33 to 5.56 (Δ = –0.77), while the control group showed a minimal increase from 6.06 to 6.11 (Δ = +0.05). Statistical analysis using a paired t-test revealed a significant difference in the intervention group (p = 0.001), indicating the effectiveness of lavender aromatherapy in reducing labour pain. Lavender aromatherapy significantly reduced the intensity of labour pain during the active phase of the first stage of labour. This non-invasive and cost-effective intervention can be considered as a complementary method in intrapartum care to enhance maternal comfort and support physiological childbirth.

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INTRODUCTION

Childbirth is both a physiological and psychological process that often causes significant labor pain, anxiety, and fatigue.(1) Labor pain arises from uterine contractions, cervical dilation, and stretching of pelvic tissues leading to activation of nociceptive pathways and emotional distress.(2)

Prolonged or unmanaged labor pain triggers a stress response, elevating catecholamines and cortisol. (3)These stress hormones induce vasoconstriction, diminish uterine blood flow, and may lead to placental ischemia and fetal hypoxia, increasing the risk of metabolic acidosis. Additionally, intense discomfort can precipitate hyperventilation, affecting maternal-fetal CO_2 exchange and resulting in fetal bradycardia.(4) Anxiety from pain also prolongs active labor by augmenting sympathetic tone, which further compounds uterine tension and fatigue.

Globally, the prevalence of moderate to severe labor pain remains high: recent estimates show that 75–85% of women experience moderate to severe pain during childbirth. Based on research conducted in the United States, 93.5% of maternity mothers reported experiencing sharp or bearable labour pain, while in Finland, as many as 80% reported experiencing severe pain that could not be restrained.(5) In Indonesia, a 2023 survey at several tertiary hospitals reported that 85% of mothers rated their labor pain as moderate to severe. Based on the Ministry of Health of the Republic of Indonesia (2019) the number of maternity mothers in Indonesia is 5,017,552 people. Of the total number of maternity mothers, as many as 90% of them feel pain during labour, and 7–14% do not experience pain during labor. Pain during childbirth, if not managed properly, will worsen the maternal mortality rate (MMR) in Indonesia.(6)

Given the limitations and potential side effects of pharmacological analgesia, there is increasing interest in non-pharmacological adjuncts for labor pain management.(7) Lavender aromatherapy delivered through inhalation is one such approach. It is rich in linalool and linalyl acetate, which exhibit anxiolytic and analgesic properties believed to activate the limbic system via the olfactory pathways. A recent randomized controlled trial in 2023 demonstrated that inhalation plus massage with lavender essential oil significantly reduced labor pain compared with controls ($p < 0.05$).(8) Despite promising findings, its efficacy in Indonesian settings during the active first stage of labor remains underexplored. Lavender aromatherapy has received increasing attention as a promising non-pharmacological intervention for managing labor pain. Recent systematic reviews and meta-analyses support the effectiveness of essential oil-based therapies, particularly lavender, in alleviating pain and anxiety during labor.(9) A systematic review of 33 randomized controlled trials (RCTs) reported that aromatherapy, especially using lavender, significantly reduced labor pain and maternal anxiety in most studies, particularly during the first stage of labor.(10) Lavender's main components, linalool and linalyl acetate, are known to exert sedative and anxiolytic effects by modulating the parasympathetic nervous system, which may promote uterine relaxation and pain relief.

Despite these promising findings, significant methodological gaps remain in the existing literature. Firstly, the method of lavender application varies widely across studies ranging from inhalation to massage and compress often without standardized dosages, delivery methods, or duration of administration. This inconsistency complicates the comparison and generalization of findings.(11) Moreover, few studies have isolated inhalation as a standalone intervention, with many combining it with other techniques such as massage or breathing exercises, thereby obscuring its direct effects.

Additionally, most aromatherapy studies have been conducted in Western or Middle Eastern countries, with limited evidence from Southeast Asian populations, particularly Indonesia. Given cultural, physiological, and environmental differences, there is a need for region-specific data to validate the generalizability of these findings.(12,13) Furthermore, long-term outcomes of lavender aromatherapy such as its effects on maternal psychological well-being postpartum or on neonatal health have received little attention in the literature.

A preliminary observational study conducted at Dirgahayu Hospital, Samarinda, in August 2023, found that among 10 women undergoing normal delivery, 70% reported experiencing severe labor pain. However, no standardized non-pharmacological

interventions were applied during labor, highlighting an opportunity to introduce evidence-based aromatherapy into routine practice.

This study aims to address these gaps by evaluating the isolated effect of inhaled lavender aromatherapy on labor pain levels during the active phase of the first stage of labor, using a standardized delivery protocol (four to five drops of lavender oil in 20 mL of warm water, inhaled for one hour). It also targets a local Indonesian population, thereby contributing regionally specific data. The findings are expected to enhance current understanding of lavender's analgesic potential and inform clinical guidelines on safe, effective, and culturally appropriate non-pharmacological labor interventions.

METHOD

This study employed a quasi-experimental pretest-posttest control group design conducted at Dirgahayu Hospital, Samarinda, Indonesia, from August to September 2023. The research aimed to evaluate the effect of lavender aromatherapy on labor pain among women in the first stage of active labor. The study population consisted of maternity mothers in the first stage of active labor (cervical dilation of 4–9 cm). A total of 36 participants were selected using purposive sampling and were divided equally into two groups: 18 in the intervention group and 18 in the control group. Inclusion criteria: willingness to participate, physiological vaginal delivery, term gestational age (≥37 weeks), cervical dilation of 4–9 cm, parity: primigravida or multigravida. Exclusion criteria: presence of labor complications (e.g., fetal distress, dehydration, infection), allergy to lavender essential oil, impaired sense of smell (e.g., due to flu or nasal obstruction). Participants in the intervention group received lavender aromatherapy via inhalation. The essential oil was prepared by mixing 4–5 drops of lavender essential oil into 20 ml of water, placed in a diffuser, and administered continuously for 1 hour during active labor. The lavender oil used was 100% pure-grade and was administered in a private labor room to ensure consistency. Participants in the control group did not receive aromatherapy but were guided to perform deep breathing relaxation techniques during contractions, as part of standard care. Pain levels were assessed before and after the intervention in both groups using two validated pain scales: Numeric Rating Scale (NRS): a 0–10 scale where 0 indicates no pain and 10 indicates the worst possible pain. Wong-Baker Faces Pain Rating Scale: a visual scale used to assess subjective pain intensity based on facial expressions. Both tools are widely used and have demonstrated good validity and reliability in obstetric populations. Data were analyzed using SPSS version 29. univariate analysis using descriptive statistics. A paired t-test was used to compare pre- and post-intervention pain levels within each group. An independent t-test was applied to compare pain levels between the intervention and control groups. A significance level of $p < 0.05$ was considered statistically significant.

RESULTS

A total of 36 respondents participated in this study, with 18 assigned to the intervention group and 18 to the control group. Most participants were between 20 and 35 years old (73.8%), had a senior high school education (45.2%), and worked as housewives (69.0%). Most were primiparous women (47.6%) and were accompanied by their husbands during labor (78.6%) (Table 1). These demographic characteristics indicate that the participants represent the most common reproductive age group and sociocultural background in the study setting.

Table 1. Characteristics of Respondents (n = 36)

Characteristics	Category	Frequency (f)	Percentage (%)
Age (years)	< 20	3	7.1
	20–35	31	73.8
	> 35	2	4.8

Characteristics	Category	Frequency (f)	Percentage (%)
Education level	Primary school	3	7.1
	Junior high school	3	7.1
	Senior high school	19	45.2
	College	11	26.2
Occupation	Housewife	29	69.0
	Private employee	4	9.5
	Honorary	2	4.8
	Midwife	1	2.4
Parity	Primiparous	20	47.6
	Multiparous	16	38.1
Birth companion	Husband	33	78.6
	Biological mother	1	2.4
	Cousin	1	2.4
	Nephew	1	2.4

Table 2 shows that the mean labor pain score in the intervention group before receiving lavender aromatherapy was 6.33 (SD = 1.19). After the administration of lavender aromatherapy, the mean pain score decreased to 5.56 (SD = 1.15). The mean reduction in pain intensity was 0.77 points, and the *paired t-test* result indicated a statistically significant difference ($p = 0.019$, $\alpha < 0.05$). This finding suggests that lavender aromatherapy effectively reduced the perception of labor pain among mothers in the intervention group.

Table 2. Mean Pain Intensity Before and After Intervention in the Intervention Group (n = 18)

Variable	Mean	SD	t	Sig. (p)
Before intervention	6.33	1.188	2.54	0.019*
After intervention	5.56	1.149		
Mean difference (Δ)	0.77			

In contrast, the control group showed no significant change in pain levels before and after the observation period. The mean pain score before the intervention was 6.06 (SD = 1.39), and after the same observation period without aromatherapy, it slightly increased to 6.11 (SD = 1.64). The mean difference was −0.05 points, and the statistical test showed a non-significant result ($p > 0.05$), indicating that no meaningful change occurred in the absence of the aromatherapy intervention (Table 3).

Table 3. Mean Pain Intensity Before and After Observation in the Control Group (n = 18)

Variable	Mean	SD	t	Sig. (p)
Before observation	6.06	1.392	0.28	0.78
After observation	6.11	1.641		
Mean difference (Δ)	−0.05			

A comparative analysis was conducted to determine the effect of lavender aromatherapy on labor pain intensity between the two groups. The mean change (Δ) in the intervention group was 0.77, while in the control group it was −0.05, showing a greater reduction in pain in the intervention group. Statistical analysis demonstrated a significant difference between

the two groups (p = 0.01), confirming that lavender aromatherapy had a meaningful effect in lowering pain levels compared with standard care alone (Table 4).

Table 4. Comparison of Lavender Aromatherapy Effect on Labor Pain Between Groups

Group	Time	Mean Pain Score	SD	Δ (Difference)	Sig. (p)
Intervention	Before	6.33	1.188	0.77 ↓	0.01*
	After	5.56	1.149		
Control	Before	6.06	1.392	–0.05	>0.05
	After	6.11	1.641		

Overall, the results demonstrate that lavender aromatherapy effectively reduces labor pain among mothers in the first stage of labor compared with the control group. The decrease in pain intensity, although modest, was statistically significant and clinically meaningful. These findings support the potential role of lavender aromatherapy as a simple, non-invasive, and acceptable complementary approach to pain management during labor.

DISCUSSION

This study examined the effect of lavender aromatherapy on labor pain levels among women in the active phase of the first stage of labor. The findings revealed a significant reduction in pain scores among women who received lavender aromatherapy compared with those who practiced deep breathing relaxation. In the intervention group, the mean pain level decreased from 6.33 to 5.56 (Δ = –0.77, p = 0.01), whereas in the control group, the mean score changed minimally from 6.06 to 6.11 (Δ = –0.05). Although the reduction in the intervention group was modest in absolute terms, the difference between groups was statistically significant and clinically meaningful, indicating that lavender aromatherapy contributed to reduced pain perception and improved maternal comfort during labor. In contrast, the control group that practiced deep breathing relaxation showed minimal reduction in pain intensity. While deep breathing is known to facilitate oxygen delivery and reduce muscle tension, its effectiveness depends heavily on proper timing, technique, and prior maternal training.[14] In this study, most participants were primiparous, which may have influenced the pain response due to physiological and psychological factors. Primiparous women generally experience longer labor durations, more intense contractions, and heightened anxiety, which collectively increase pain perception. Cervical dilation mechanisms also differ between primiparous and multiparous women, as the internal os opens earlier in primiparas, leading to greater discomfort. These findings align with prior research by Ghamgosar (2024), which indicated that maternal pain perception is influenced by individual coping capacity, emotional preparedness, and prior birth experiences.[15]

The use of lavender essential oil during labor enhances maternal coping mechanisms by modulating the limbic system, a brain region central to emotional regulation and pain processing. Inhaled linalool as the main active component of lavender activates the olfactory bulb, sending signals to key limbic structures such as the amygdala, anterior cingulate cortex (ACC), insula, and hippocampus. These areas orchestrate emotional responses to stress and pain. Neuroimaging studies in humans demonstrated that inhalation of (-)-linalool significantly reduces cerebral blood flow in the ACC and insular cortex regions associated with anxiety and pain perception suggesting a direct calming and analgesic action.[16] On a molecular level, linalool has been shown to interact with GABAA and NMDA receptors, exert cholinergic and opioid-like modulatory effects, and inhibit substance P release from nociceptive pathways. These interactions contribute to reduced neuronal excitability and enhanced inhibitory neurotransmission, dampening pain signaling.

Additionally, lavender essential oil exhibits moderate inhibition of the serotonin transporter (SERT), which may increase serotonergic tone and confer mood-stabilizing and analgesic effects. Preclinical models also suggest that linalool modulates the endocannabinoid system by inhibiting FAAH and MAGL enzymes, thereby elevating endogenous anandamide levels and exerting antinociceptive and anxiolytic effects.(17)

Aromatherapy via inhalation engages the central olfactory-limbic pathway more directly than topical massage. When inhaled, lavender's volatile compounds (largely linalool) travel through the olfactory bulb into limbic regions including the amygdala, insula, and anterior cingulate cortex, areas critical for emotional response and pain modulation. This pathway mediates psycho-physiological effects such as reduced anxiety and enhanced relaxation.(16) In contrast, massage-based application introduces lavender through cutaneous absorption, combining tactile stimulation activating mechanoreceptors and enhancing vagal tone with slower uptake of essential oil via the skin.(18) A recent randomized trial by Karatopuk et al. (2022) compared inhalation, massage, and combined lavender application in primiparous laboring women. Both inhalation and massage groups experienced significant pain reduction, but no significant difference was observed between techniques, suggesting both modalities can be beneficial if applied appropriately.(8) Another Indonesian quasi-experimental study compared direct inhalation versus diffuser-based inhalation, finding that diffuser delivery produced significantly greater pain reductions ($p = 0.001$) compared to direct inhalation.(19) These findings suggest that inhalation methods especially via diffuser may offer faster onset, more consistent exposure to active compounds, and reduced variability in dosage than massage. Massage, however, may confer additional benefits such as increased physical support and oxytocin release, which may aid relaxation and uterine function when combined with lavender.

Our findings of significant labor pain reduction with inhaled lavender aromatherapy align with several recent studies but also differ in methodological nuances and magnitude of effects. For example, Ardela et al. (2022) conducted a pretest–posttest study among 20 primiparous women at 6 cm dilation and reported a significant decrease in pain intensity ($p < 0.05$); however, this study lacked a control group, limiting causal inference.(20) In contrast, our study included a control group receiving deep-breath relaxation, enabling stronger comparative analysis. Similarly, Karningsih et al. (2022) performed a quasi-experimental study with three groups lavender oil inhalation, aromatherapy candles, and control with 60 participants. They found that inhaled lavender oil (not candles) produced a greater mean reduction in pain (score ~3.50) compared to candles (~5.05), both significantly different from controls ($p = 0.001$).(21) The greater pain reduction observed in that study may relate to longer intervention duration or higher exposure if participants were exposed repeatedly or earlier in labor. However, Rohimah et al. (2021) compared lavender inhalation to endorphin massage in primiparous women and found no statistically significant difference between groups ($p = 0.31$), despite a greater numerical reduction in the aromatherapy group (from 6.70 to 4.90 vs. 7.30 to 5.60).(22) This suggests that combining techniques rather than inhalation alone might be necessary in certain contexts, or that sample size and statistical power were insufficient to detect differences. More comprehensive evidence from meta-analysis by Kaya et al. (2023) included 14 RCTs evaluating inhalation and massage modalities. They reported that lavender aromatherapy significantly reduced labor pain in 11 studies, while three did not show effect highlighting variability across settings, administration methods, and participant characteristics.(9) Our study's effect size ($\Delta = -0.77$) falls within the modest but clinically relevant range, consistent with methods using controlled inhalation volumes and defined exposure times.

The statistically significant reduction in labor pain observed in our intervention group (mean score decreased from 6.33 to 5.56, $p = 0.01$) suggests a real effect unlikely due to chance (assuming adequate statistical power). While we did not conduct a formal power analysis post-hoc, with 18 participants in each group and a consistent reduction across

individuals, the finding is likely robust, though confirmation in larger samples would strengthen confidence. However, statistical significance does not directly equate to clinical significance. With a mean change of –0.77 points on a 0–10 Numeric Rating Scale (NRS), it is crucial to consider whether this represents a minimally clinically important difference (MCID). Many pain studies suggest MCIDs on NRS range from 1.0 to 1.5 points in acute pain settings, which may indicate our observed reduction is modest and might not be perceived as meaningful by all patients or healthcare providers.(23) Yet, many mothers reported subjective feelings of relaxation, reduced anxiety, and enhanced sense of control, which suggests benefit beyond the numerical score. When compared with other non-pharmacological interventions, lavender aromatherapy exhibits favorable effects. While aromatherapy appears highly promising, combining it with other methods such as massage, music therapy, or acupressure may yield additive effects on both pain relief and emotional comfort.

The present findings hold important implications for midwifery and maternal care. Lavender aromatherapy represents a safe, simple, inexpensive, and non-invasive intervention that can be readily implemented in clinical and community settings to complement existing pain management strategies. Integrating aromatherapy into standard intrapartum care protocols may improve maternal comfort, reduce the need for pharmacological analgesics, and enhance the childbirth experience. This is particularly valuable in resource-limited settings, where access to medical pain relief is restricted, and where cultural preferences often favor natural and holistic approaches.

This study has several limitations that should be acknowledged. The relatively small sample size and the single-site design may limit the generalizability of the findings to broader maternal populations and different clinical settings. Moreover, pain assessment relied on self-reported scales that are inherently subjective, and emotional or psychological factors could have influenced pain perception. The intervention was limited to the active phase of labor, which may have restricted the full potential benefit of lavender aromatherapy across the entire labor process.

Despite these limitations, the findings provide valuable evidence supporting the use of lavender aromatherapy as a safe, simple, and non-pharmacological method for reducing labor pain. Therefore, it is recommended that midwives and healthcare providers consider integrating lavender aromatherapy into standard intrapartum care, particularly in combination with other relaxation techniques. Implementation should be accompanied by appropriate training, dosage standardization, and antenatal education to ensure consistent application and maternal readiness. For future research, studies with larger and more diverse populations are encouraged to validate these findings and strengthen external validity. Further investigations should also examine the optimal timing, frequency, and delivery methods of lavender aromatherapy, as well as its comparative effectiveness with other complementary interventions such as massage, music therapy, or acupressure. Additionally, mixed-method designs that include qualitative exploration of maternal experiences may provide deeper insights into the emotional and cultural dimensions influencing the use of aromatherapy in childbirth.

CONCLUSION

This study provides evidence that lavender aromatherapy administered through inhalation is effective in significantly reducing labour pain intensity among mothers in the active phase of the first stage of labour. The observed decrease in pain scores was statistically significant (p = 0.01), suggesting a low probability that the findings occurred by chance. However, the clinical significance though modest in absolute value may offer meaningful relief, especially when integrated as part of a comprehensive, individualized labour management plan.

Beyond pain reduction, lavender aromatherapy may also contribute positively to maternal psychological well-being by lowering stress and anxiety levels, thus enhancing the overall childbirth experience. The findings underscore the importance of non-pharmacological approaches, particularly for mothers who seek natural and low-risk pain management alternatives. Future research should explore the integration of aromatherapy with other complementary techniques, such as breathing relaxation, massage, or music therapy, and investigate its effectiveness across different maternal profiles. Particular attention should be given to maternal psychological factors, including anxiety, personality traits, and parity, to optimize intervention outcomes through a personalized approach.

AUTHOR CREDIT STATEMENT
MM: Conceptualization, Methodology, Data Collection, Formal Analysis, Writing – Original Draft, Writing – Review & Editing, Visualization; **NS, DRA, JJ**: Supervision, Validation.

DECLARATION OF COMPETING INTEREST
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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