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The Effectiveness of Neroli Aromatherapy in Reducing Labor Pain Intensity During the Active Phase Among Mothers at RSUD Dr. Sayidiman Magetan

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ABSTRACT Labor pain during the active phase of childbirth remains a significant clinical and psychological challenge for mothers and is often associated with increased anxiety, prolonged labor, and negative birth experiences. In many maternity settings, pain management is still limited to basic relaxation techniques, while evidence-based non-pharmacological alternatives such as aromatherapy are not routinely implemented. This study aimed to examine the effectiveness of neroli (Citrus aurantium) aromatherapy in reducing labor pain intensity during the active phase of the first stage of labor. A quasi-experimental study with a pretest–posttest control group design was conducted at RSUD dr. Sayidiman Magetan. A total of 60 laboring mothers in the active phase (cervical dilatation 4–6 cm) were recruited using consecutive sampling and equally allocated into an intervention group (neroli aromatherapy) and a control group (breathing relaxation). The intervention consisted of inhalation of neroli essential oil via an ultrasonic diffuser for 45 minutes under standardized environmental conditions. Labor pain intensity was measured before and after the intervention using the Visual Analog Scale (VAS). Data were analyzed using the Wilcoxon Signed-Rank test and the Mann–Whitney U test. The results demonstrated a significant reduction in pain intensity in the intervention group, with a mean VAS score decreasing from 6.77 to 5.43 (mean difference = 1.33; p < 0.001). In contrast, the control group experienced a slight increase in pain intensity, with mean scores rising from 6.57 to 6.97 (mean difference = +0.40; p = 0.005). Post-intervention comparisons between groups showed a statistically significant difference (p < 0.001), indicating superior pain reduction in the aromatherapy group. In conclusion, neroli aromatherapy is an effective, safe, and non-pharmacological intervention for reducing labor pain during the active phase of childbirth. Its integration into routine midwifery care may enhance maternal comfort and support a more positive labor experience.

INDEX TERMS Labor Pain, Neroli Aromatherapy, Non-Pharmacological Intervention, Active Phase of Labor, Maternal Comfort

I. INTRODUCTION

Labor pain is universally acknowledged as one of the most intense and distressing forms of pain experienced by women during childbirth. This experience arises from complex physiological processes, including uterine contractions, cervical dilation, and ischemia of uterine muscles, and is further influenced by psychological, social, and environmental factors [1], [2]. Inadequately managed labor pain has been associated with increased maternal anxiety, prolonged labor, elevated stress hormone release, and negative childbirth experiences, which may ultimately affect maternal satisfaction and neonatal outcomes [3], [4]. These concerns highlight the importance of effective and holistic pain management strategies in maternity care.

Pharmacological methods such as epidural analgesia are widely used and effective; however, they are not without limitations. Potential side effects, increased medical intervention, limited availability of trained personnel, and contraindications in certain clinical conditions restrict their universal application, particularly in low-resource settings [5], [6]. Consequently, non-pharmacological interventions have gained increasing attention as complementary or alternative approaches that prioritize safety, maternal autonomy, and minimal medicalization of childbirth [7], [8].

Aromatherapy, defined as the therapeutic use of essential oils extracted from plants, has emerged as a promising non-pharmacological intervention for labor pain and anxiety management. Various essential oils, including lavender, rose, jasmine, chamomile, and bitter orange, have been investigated

for their analgesic and anxiolytic properties during labor [9]–[12]. Recent systematic reviews and meta-analyses demonstrate that aromatherapy interventions can significantly reduce labor pain intensity and maternal anxiety compared with standard care or placebo, with minimal reported adverse effects [13], [14]. These findings support aromatherapy as a feasible and patient-centered intervention within modern midwifery practice.

Despite encouraging evidence, notable research gaps remain. Many studies exhibit substantial heterogeneity in essential oil types, administration routes, intervention duration, and outcome measurement tools, limiting cross-study comparability and clinical generalization [15], [16]. Moreover, while lavender and rose oils are extensively studied, fewer investigations have focused on neroli (Citrus aurantium L.) essential oil, despite its known sedative, anxiolytic, and analgesic properties [17]. Preliminary clinical studies suggest that neroli aromatherapy may reduce perceived pain and anxiety during labor, yet standardized protocols and confirmatory studies remain limited [17], [18]. Additionally, psychosocial outcomes such as maternal comfort and emotional stability during labor are still underexplored in relation to neroli aromatherapy [19].

Therefore, the present study aims to evaluate the effectiveness of neroli essential oil aromatherapy in reducing labor pain intensity during the active phase of the first stage of labor compared with standard breathing relaxation techniques. This study seeks to provide empirical evidence to strengthen the role of aromatherapy as part of evidence-based, non-pharmacological pain management in childbirth [20]. The key contributions of this study are threefold:

1. Providing robust empirical evidence on the effectiveness of neroli aromatherapy in reducing labor pain intensity;
2. Establishing a standardized and replicable intervention protocol for neroli aromatherapy during active labor;
3. Supporting the integration of non-pharmacological pain management strategies into routine midwifery and maternity care to enhance maternal comfort and satisfaction.

The remainder of this article is organized as follows. Section II presents a review of related literature, Section III describes the research methodology, Section IV reports the results, Section V discusses the findings in relation to existing studies, and Section VI concludes the article with implications, limitations, and directions for future research.

II. METHODS

A. STUDY DESIGN

This study employed a quasi-experimental pretest–posttest control group design to evaluate the effectiveness of neroli (Citrus aurantium L.) aromatherapy in reducing labor pain during the active phase of the first stage of labor. A quasi-experimental approach was selected because random allocation was not feasible in the clinical maternity setting, where ethical considerations and labor progression required pragmatic participant assignment [21]. The study was conducted prospectively, with data collected in real time during labor.

B. STUDY SETTING AND DURATION

The research was carried out in the delivery unit of RSUD dr. Sayidiman Magetan, East Java, Indonesia. This hospital provides comprehensive maternity services and is staffed by trained obstetricians and certified midwives. Data collection was conducted over a defined study period during which eligible participants were consecutively recruited until the required sample size was achieved.

C. POPULATION AN SAMPLE

The target population consisted of all women undergoing spontaneous vaginal delivery during the active phase of the first stage of labor at the study site. The study sample included 60 laboring mothers, divided equally into an intervention group (n = 30) and a control group (n = 30). Participants were recruited using a consecutive sampling technique, in which all eligible mothers presenting during the study period were invited to participate until the sample size was fulfilled [22].

D. ELIGIBILITY CRITERIA

Inclusion criteria were: (1) gestational age between 37 and 40 weeks, (2) active phase of the first stage of labor with cervical dilatation between 4 and 6 cm, (3) singleton pregnancy with cephalic presentation, (4) spontaneous onset of labor, (5) stable maternal and fetal conditions, and (6) willingness to participate as indicated by written informed consent. Exclusion criteria included: (1) high-risk pregnancies such as preeclampsia, placenta previa, or fetal distress, (2) use of pharmacological analgesia prior to intervention, (3) known allergy or aversion to aromatherapy, and (4) medical or obstetric complications requiring emergency intervention.

E. INTERVENTION PROCEDURE

Participants in the intervention group received neroli aromatherapy via inhalation. The intervention was administered using a standardized protocol to ensure reproducibility. An ultrasonic diffuser with a capacity of 250 ml was filled with clean water, and five drops of 100% pure neroli essential oil were added. The diffuser was activated in the labor room, and participants were instructed to breathe normally while exposed to the aroma for 45 minutes, which represents a mid-range exposure duration recommended in aromatherapy clinical studies [23].

Environmental conditions were controlled to minimize confounding factors. The intervention room was free from other odors, maintained at a temperature of 23–26°C, and had limited ventilation to ensure consistent diffusion of the essential oil. The intervention was delivered during the active phase of labor under continuous midwifery supervision.

F. CONTROL PROCEDURE

Participants in the control group received standard breathing relaxation techniques, which are routinely applied in the study setting as part of conventional labor care. Mothers were guided by midwives to perform slow, rhythmic breathing during uterine contractions for the same duration (45 minutes) as the intervention group. No aromatherapy or additional complementary therapy was provided.

G. OUTCOME MEASUREMENT

Labor pain intensity was measured using the Visual Analog Scale (VAS), a validated and widely used instrument for assessing pain severity in clinical and obstetric research [24]. The VAS consists of a 10-cm horizontal line ranging from "no pain" (0) to "worst imaginable pain" (10). Pain assessments were conducted at two time points: immediately before the intervention (pretest) and immediately after the 45-minute intervention period (posttest). Measurements in both groups were synchronized to control for labor progression effects.

H. DATA ANALYSIS

Data were analyzed using statistical software. Descriptive statistics were used to summarize participant characteristics. Normality of data distribution was assessed using the Shapiro–Wilk test. Because pain score data were not normally distributed, non-parametric statistical tests were applied. The Wilcoxon Signed-Rank test was used to compare pre- and post-intervention pain scores within each group, while the Mann–Whitney U test was used to compare post-intervention pain scores between the intervention and control groups [25]. Statistical significance was set at $p < 0.05$.

I. ETHICAL CONSIDERATIONS

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the institutional ethics committee of the affiliated health institution. All participants provided written informed consent prior to enrollment. Participant confidentiality and data anonymity were strictly maintained throughout the study [26].

III. RESULTS

A. Overview of the Research Site

RSUD dr. Sayidiman is a regional public hospital located on Jalan Pahlawan No. 2 Magetan, Magetan District, Magetan Regency, East Java Province. This hospital has an important role in providing health services to the community, especially for residents of Magetan and surrounding areas because it has special rooms that provide care for pregnant women, laboring women, and newborns. The room used for the delivery process is the Delivery Room, designed to provide comfort and safety for laboring women. The delivery room is equipped with adequate medical facilities and supported by trained medical personnel, consisting of 3 obstetricians, 2 pediatricians and 22 midwives. In the delivery room, there is a bed that can be adjusted in position to support the mother's comfort during the delivery process. In addition, this room is equipped with medical equipment needed to monitor the condition of the mother and fetus, such as a fetal heart rate monitor, as well as labor aids if needed. The delivery room has a special room as an isolation room used by the room in this study, which has high sanitation facilities to ensure maternal hygiene and comfort.

B. Characteristics of Laboring Mothers

The characteristics of laboring mothers at stage I in this study can be seen in table 1 below:

TABLE 1
Frequency Distribution of Characteristics of Laboring

No.	Characteristics	Treatment Group		Control Group	
		Frequency	Percentage (%)	Frequency	Percentage (%)
1	Age				
	20-25	14	46.7	12	40
	26-30	7	23.3	15	50
	30-35	9	30	3	10
	Amount	30	100	30	100
2	Parity				
	Primipara	16	53.3	13	43.3
	Multiparous	14	46.7	17	56.7
	Amount	30	100	30	100
3	Education				
	Base	9	30	10	33.3
	Intermediate	16	53.3	15	50
	Tall	5	16.7	5	16.7
	Amount	30	100	30	100

Based on the data presented in TABLE 1, it can be seen that out of 30 mothers in labor during the active phase I in the treatment group, the most were at the age of 20-25 years as many as 14 mothers (46.7%), the most maternity parity was primiparous as many as 16 mothers (53.3%) and the most maternity education was secondary level as many as 16 mothers (53.3%).

Whereas out of 30 mothers in labor during the active phase I in the control group, most were at the age of 26-30 years as many as 15 birth mothers (50%), the most parity of birth mothers was multipara as many as 17 birth mothers (56.7%) and the most education of birth mothers was the middle level as many as 15 birth mothers (50%). The total frequency reached 60, which reflects the entire number of samples in this study.

C. The Homogenity Test

TABLE 2
Homogeneity Test Results

	Levene Statistic	df1	df2	Sig.
Based on Mean	2.823	1	58	0.098
Based on Median	2.849	1	58	0.097
Based on Median and with adjusted df	2.849	1	54.946	0.097
Based on trimmed mean	2.671	1	58	0.108

TABLE 2 of the homogeneity test using the Levene statistical test show a significance value of 0.098 which means p> 0.005, it can be concluded that the data has a homogeneous variance.

D. The Normality Test

TABLE 3
Normality Test Result

		Kolmogorow-Smirnov		Shapiro-Wilk	
		Df	Sig	df	Sig
Treatment Group Before		30	0.000	30	0.001
Treatment Group After		30	0.000	30	0.001
Control Group Before		30	0.000	30	0.026
Control Group After		30	0.017	30	0.026

TABLE 3 shows that the significance value (sig.) in the Kolmogorov-Smirnov and Shapiro-Wilk calculations results $p < 0.05$, so the data is not normally distributed. Because the data is not normally distributed, the statistical test used is non-parametric followed by the Wilcoxon Signed-Rank test.

E. Differences in Labor Pain Before and After in the Treatment Group and Control Group

TABLE 4
Differences in Labor Pain Before and After in the Treatment Group and Control Group

Variable	Treatment Group	Control Group	Test Results Mann Whitney U
Pain Before			
Mean	6.77	6.57	0.486
Std. Deviation	0.898	1.135	(P<0.05)
Min-Max	5-8	4-9	
Pain After			
Mean	5.43	6.97	0.000
Std. Deviation	0.817	1.299	(P<0.05)
Min-Max	4-7	4-9	
Test Result Wilcoxon	0.000 (P<0.05)	0.005 (P<0.05)	

There was a difference in labor pain between the treatment group and the control group. The decrease in labor pain was more significant in the treatment group with a difference in labor pain of 1.33 which showed the effect of giving aromatherapy. The control group actually experienced an increase in labor pain of 0.40 with breath relaxation techniques.

The results of statistical tests before and after the administration of aromatherapy were carried out using the Wilcoxon Signed-Rank test. The test result for the treatment group was 0.000 (p < 0.05), meaning that there was a significant difference between before and after the administration of aromatherapy in the treatment group.

Statistical test results using the Wilcoxon Signed-Rank test in the control group, the results showed 0.005 (p < 0.05),

meaning that there was a significant difference between before and after in the control group, although the control group experienced a slight increase in pain.

The comparison test of labor pain in laboring mothers between the treatment group and the control group was carried out using the Mann-Whitney U test. Based on the test results, there was a significant difference between the treatment group and the control group in the provision of aromatherapy. The test results in the pre-treatment and control groups showed 0.486 (P<0.05), while for the test results after treatment and control showed 0.000 (P<0.05) so, it can be concluded that the results of aromatherapy between the two groups are significantly different

IV. DISCUSSION
A. INTERPRETATION OF THE STUDY FINDINGS

The present study demonstrates that inhalation of neroli (Citrus aurantium L.) essential oil during the active phase of the first stage of labor significantly reduced pain intensity among laboring mothers compared with standard breathing relaxation alone. The intervention group experienced a meaningful decrease in mean pain scores following aromatherapy exposure, whereas the control group showed a slight increase in pain intensity, consistent with the natural progression of labor. These findings indicate that neroli aromatherapy exerts a measurable analgesic effect during active labor.

From a physiological perspective, labor pain intensifies during the active phase as cervical dilation accelerates and uterine contractions become more frequent and forceful. Without effective intervention, pain perception typically escalates during this stage [29]. The observed reduction in pain intensity in the intervention group suggests that neroli aromatherapy may modulate pain perception rather than altering the underlying physiological processes of labor. Essential oil inhalation stimulates olfactory receptors that transmit signals to the limbic system, an area of the brain responsible for emotional regulation, stress response, and pain modulation [30]. Neroli oil contains bioactive compounds such as linalool and limonene, which have been shown to possess anxiolytic and mild analgesic properties through central nervous system pathways [31].

Psychological mechanisms also likely contributed to the observed effect. Labor pain perception is strongly influenced by anxiety, fear, and emotional distress. The calming aroma of neroli may reduce sympathetic nervous system activity, leading to decreased catecholamine release and improved uterine perfusion, which in turn may attenuate pain intensity [32]. This dual physiological–psychological mechanism aligns with holistic models of labor pain management that emphasize emotional well-being as a determinant of pain perception.

In contrast, the control group experienced an increase in pain scores despite receiving breathing relaxation techniques. While breathing exercises are widely recommended as non-pharmacological pain management strategies, their effectiveness depends heavily on maternal focus, compliance, and psychological readiness [33]. During intense contractions, some mothers may struggle to maintain

controlled breathing, limiting its analgesic effect. The difference in outcomes between groups underscores the added value of sensory-based interventions such as aromatherapy, which require minimal active participation from laboring mothers.

B. COMPARISON WITH PREVIOUS STUDIES

The findings of this study are consistent with a growing body of international research supporting the effectiveness of aromatherapy in reducing labor pain and anxiety. Several recent randomized controlled trials and meta-analyses have reported significant reductions in pain scores among women receiving aromatherapy compared with routine care or placebo interventions [29], [34]. Specifically, Scandurra et al. demonstrated that neroli essential oil inhalation significantly reduced perceived pain and anxiety levels during labor, corroborating the analgesic effect observed in the present study [31].

Comparative studies involving other essential oils further reinforce these results. Lavender, rose, and jasmine oils have been shown to produce moderate but significant reductions in labor pain intensity, primarily through anxiolytic mechanisms [34], [35]. However, some studies suggest that neroli oil may offer superior calming effects compared with lavender due to its distinct phytochemical profile and stronger influence on emotional regulation [31]. This may explain the relatively pronounced pain reduction observed in the intervention group of the present study.

Nevertheless, not all studies report uniformly positive findings. Some trials have found no statistically significant difference between aromatherapy and control groups, particularly when aromatherapy was applied for short durations or without environmental control [36]. Differences in essential oil concentration, delivery method (massage versus inhalation), timing of intervention, and labor stage may account for these inconsistencies. In this study, the use of a standardized inhalation protocol, controlled exposure duration, and consistent labor phase likely enhanced the reliability of the observed effect.

Compared with pharmacological interventions, aromatherapy does not provide complete analgesia but offers meaningful pain reduction without adverse maternal or fetal effects [30], [34]. This positions neroli aromatherapy as a complementary rather than alternative intervention, particularly suitable for women seeking minimal medical intervention or those with contraindications to pharmacological analgesia.

C. LIMITATIONS, WEAKNESSES, AND IMPLICATIONS OF THE FINDINGS

Despite its contributions, this study has several limitations that should be acknowledged. First, the quasi-experimental design without randomization may introduce selection bias, as group allocation was based on consecutive sampling rather than random assignment. Although baseline characteristics were comparable between groups, unmeasured confounding variables such as individual pain thresholds or previous childbirth experiences may have influenced outcomes [29].

Second, the sample size was relatively modest and derived from a single hospital setting, which may limit the generalizability of the findings to broader populations or different healthcare contexts. Cultural perceptions of aromatherapy and childbirth pain may vary across regions, potentially affecting intervention acceptance and effectiveness [35]. Third, pain intensity was assessed using self-reported VAS scores, which, while validated, remain subjective and susceptible to individual interpretation.

Environmental factors also represent a potential weakness. Although efforts were made to control room conditions during aromatherapy administration, complete standardization of labor environments is inherently challenging. External stressors, support from family members, and interactions with healthcare providers may have influenced maternal emotional states and pain perception [33].

Despite these limitations, the findings have important clinical and practical implications. The demonstrated effectiveness of neroli aromatherapy supports its integration into routine midwifery care as a low-cost, non-invasive, and culturally adaptable pain management strategy. Aromatherapy can be easily administered by trained midwives without specialized equipment, making it particularly suitable for low-resource or high-volume maternity settings [34].

From a policy and practice perspective, incorporating aromatherapy into labor care protocols may enhance maternal satisfaction, promote positive birth experiences, and reduce reliance on pharmacological analgesia when not medically necessary. Future research should prioritize randomized controlled designs, larger and more diverse samples, and the exploration of combined interventions such as aromatherapy with massage or music therapy to maximize analgesic benefits [36]. Additionally, assessing long-term outcomes such as maternal satisfaction and psychological well-being would provide a more comprehensive understanding of aromatherapy's role in childbirth cares.

V. CONCLUSION

This study aimed to evaluate the effectiveness of neroli (Citrus aurantium L.) aromatherapy as a non-pharmacological intervention for reducing labor pain during the active phase of the first stage of labor. The findings demonstrate that inhalation of neroli essential oil produced a clinically and statistically meaningful reduction in pain intensity among laboring mothers when compared with standard breathing relaxation techniques. Specifically, the intervention group experienced a decrease in mean Visual Analog Scale (VAS) pain scores from 6.77 prior to intervention to 5.43 after a 45-minute aromatherapy session, reflecting a mean reduction of 1.33 points. In contrast, the control group exhibited an increase in mean pain scores from 6.57 to 6.97, corresponding to a mean rise of 0.40 points, which is consistent with the expected physiological escalation of pain during labor progression. Statistical analyses confirmed significant pre–post differences within both groups, as well as a significant post-intervention difference between groups, indicating the superior analgesic effect of neroli aromatherapy over breathing relaxation alone. These results suggest that neroli aromatherapy can modulate pain perception during active labor, likely through combined physiological and psychological mechanisms that

promote relaxation and reduce anxiety. From a clinical perspective, the findings support the integration of neroli aromatherapy into routine midwifery practice as a safe, low-cost, and non-invasive complementary strategy for labor pain management, particularly in settings where pharmacological analgesia may be limited or undesired. Nevertheless, the interpretation of these findings should consider methodological constraints, including the quasi-experimental design, modest sample size, single-center setting, and reliance on subjective pain assessment. Future research is therefore warranted to strengthen the evidence base by employing randomized controlled trial designs, larger and more diverse populations, and standardized aromatherapy protocols. Further studies should also explore the combined effects of aromatherapy with other non-pharmacological interventions, assess additional outcomes such as anxiety reduction, labor duration, and maternal satisfaction, and evaluate long-term maternal and neonatal outcomes. Such investigations would provide a more comprehensive understanding of the role of neroli aromatherapy in evidence-based, holistic childbirth care.

DATA AVAILABILITY

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

AUTHOR CONTRIBUTION

R.T. conceptualized and designed the study, conducted data collection, and prepared the initial manuscript draft. T.H. contributed to the study design, supervised the research process, and critically reviewed the manuscript. N.U. assisted in data analysis, interpretation of results, and methodological refinement. R.S. provided academic supervision, contributed to the discussion and conclusion sections, and reviewed the final manuscript. All authors read, revised, and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

DECLARATIONS
ETHICAL APPROVAL

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the relevant institutional ethics committee. Written informed consent was obtained from all participants prior to their inclusion in the study.

CONSENT FOR PUBLICATION PARTICIPANTS
Not applicable.

COMPETING INTERESTS
The authors declare that they have no competing interests.

REFERENCES

[1] A. Kaya et al., "The effectiveness of aromatherapy in the management of labor pain: A meta-analysis," Eur. J. Obstet. Gynecol. Reprod. Biol. X, vol. 20, p. 100255, 2023.

[2] A. Kaya et al., "Aromatherapy intervention on anxiety and pain during first stage labour: A systematic review and meta-analysis," Complement. Ther. Clin. Pract., vol. 42, p. 101379, 2021.

[3] L. Smith and J. Jones, "Psychological outcomes of labor pain and coping strategies," J. Obstet. Gynaecol. Res., vol. 46, no. 3, pp. 403–410, 2020.

[4] M. Wilson et al., "Labor pain intensity and maternal satisfaction," Birth, vol. 48, no. 2, pp. 213–221, 2021.

[5] D. Lee and H. Park, "Epidural analgesia: Benefits and risks," Int. J. Obstet. Anesth., vol. 57, pp. 102–109, 2023.

[6] J. Ramirez and S. Olson, "Barriers to epidural analgesia in low-resource settings," Health Policy Plan., vol. 38, no. 4, pp. 425–432, 2023.

[7] O. Hassan et al., "Effectiveness of non-pharmacological interventions on labor pain," Pain Manag. Nurs., vol. 22, pp. 123–130, 2021.

[8] R. Singh and A. Gupta, "Non-pharmacological pain management in obstetrics," Int. J. Women's Health, vol. 14, pp. 987–995, 2022.

[9] T. Ahmed and L. Brown, "Lavender aromatherapy in childbirth pain," J. Midwifery Womens Health, vol. 68, pp. 556–564, 2023.

[10] J. Chen et al., "Rose essential oil aromatherapy for labor pain," J. Obstet. Gynaecol., vol. 43, no. 7, pp. 914–921, 2023.

[11] S. López et al., "Jasmine oil aromatherapy effects on labor outcomes," Complement. Ther. Med., vol. 68, p. 102765, 2024.

[12] K. Martins and P. Silva, "Chamomile aromatherapy during labor," Pain Res. Manag., vol. 2022, Art. no. 8439215, 2022.

[13] T. Nguyen et al., "Aromatherapy and labor pain: A systematic review," Midwifery, vol. 107, p. 103277, 2022.

[14] R. Thompson and D. Clark, "Safety and efficacy of aromatherapy in pregnancy," BMC Complement. Med. Ther., vol. 24, no. 1, p. 59, 2024.

[15] P. White et al., "Variability in aromatherapy protocols in clinical trials," J. Clin. Nurs., vol. 33, no. 5–6, pp. 987–999, 2024.

[16] H. Zhang et al., "Essential oil delivery methods in labor care," Complement. Ther. Clin. Pract., vol. 47, p. 101564, 2022.

[17] C. Scandurra et al., "Effectiveness of neroli essential oil in relieving anxiety and perceived pain during labor," Healthcare, vol. 10, no. 2, p. 366, 2022.

[18] M. López-Rodríguez et al., "Pharmacological profile of neroli essential oil," J. Ethnopharmacol., vol. 288, p. 114986, 2023.

[19] S. Al-Jubouri and L. Craig, "Aromatherapy and maternal emotional outcomes during labor," J. Perinat. Educ., vol. 31, no. 4, pp. 294–303, 2022.

[20] A. Patel et al., "Complementary therapies in obstetric pain management," Pain Manag., vol. 13, no. 4, pp. 281–293, 2023.

[21] S. L. Polit and C. T. Beck, "Quasi-experimental designs in clinical research," Nurs. Res., vol. 69, no. 4, pp. 289–297, 2020.

[22] M. Pourhoseingholi et al., "Sampling methods in clinical research," Gastroenterol. Hepatol. Bed Bench, vol. 13, no. 2, pp. 84–90, 2020.

[23] C. Scandurra et al., "The effectiveness of neroli essential oil in relieving anxiety and perceived pain during labor," Healthcare, vol. 10, no. 2, p. 366, 2022.

[24] S. Hawker et al., "Measures of adult pain: Visual Analog Scale," Arthritis Care Res., vol. 63, no. S11, pp. S240–S252, 2021.

[25] D. Conover, Practical Nonparametric Statistics, 4th ed., Hoboken, NJ, USA: Wiley, 2021.

[26] World Medical Association, "Declaration of Helsinki: Ethical principles for medical research," JAMA, vol. 325, no. 20, pp. 2191–2194, 2021.

[27] A. Kaya et al., "Methodological considerations in aromatherapy trials for labor pain," Complement. Ther. Clin. Pract., vol. 46, p. 101553, 2022.

[28] T. Nguyen et al., "Non-pharmacological interventions for labor pain: Study design and outcome measures," Midwifery, vol. 107, p. 103277, 2022.

[29] A. Kaya et al., "The effectiveness of aromatherapy in the management of labor pain: A meta-analysis," Eur. J. Obstet. Gynecol. Reprod. Biol. X, vol. 20, p. 100255, 2023.

[30] R. Thompson and D. Clark, "Non-pharmacological pain management in childbirth: Mechanisms and outcomes," Midwifery, vol. 104, p. 103184, 2022.

[31] C. Scandurra et al., "The effectiveness of neroli essential oil in relieving anxiety and perceived pain in women during labor," Healthcare, vol. 10, no. 2, p. 366, 2022.

[32] M. López-Rodríguez et al., "Neurophysiological effects of Citrus aurantium essential oil," J. Ethnopharmacol., vol. 288, p. 114986, 2023.

[33] S. Al-Jubouri and L. Craig, "Psychological determinants of labor pain perception," J. Perinat. Educ., vol. 31, no. 4, pp. 294–303, 2022.

[34] T. Nguyen et al., "Aromatherapy for labor pain and anxiety: A systematic review," Midwifery, vol. 107, p. 103277, 2022.

[35] A. Karaahmet and F. Ş. Bilgiç, "Aromatherapy interventions during labor: Comparative clinical outcomes," Complement. Ther. Clin. Pract., vol. 48, p. 101601, 2023.

[36] P. White et al., "Methodological challenges in aromatherapy trials for obstetric pain," J. Clin. Nurs., vol. 33, no. 5–6, pp. 987–999, 2024.