JURNAL PENDIDIKAN KEPERAWATAN INDONESIA
Journal Homepage: http://ejournal.upi.edu/index.php/JPKI

The Effect of Lemon Aromatherapy Inhalation on Pain Scale Reduction in Patients after Lower Extremity Fracture Surgery

Upik Rahmi, Lisna Anisa Fitriana, Syifa Fadhilah Anggraeni

Universitas Pendidikan Indonesia, Jawa Barat, Indonesia
***Corresponding email:** upikrahmi@upi.edu

A B S T R A C T

Introduction: Fractures are disruptions in the continuity of bone structure that may involve nerve injury, leading to postoperative pain and discomfort. Postoperative pain is a common and inevitable condition that requires effective management to prevent complications and enhance patient comfort. In addition to pharmacological therapy, non-pharmacological interventions such as aromatherapy are increasingly used as complementary approaches in pain management. Lemon aromatherapy is believed to have analgesic and relaxing properties that can help reduce pain perception after surgery. **Objective**: This study aimed to examine the effectiveness of lemon aromatherapy inhalation in reducing pain intensity among patients following lower extremity fracture surgery. **Methods**: A quasi-experimental study with a two-group pretest–posttest design was conducted at a hospital. A total of 20 postoperative patients with lower extremity fractures were recruited using a total sampling technique. The intervention involved inhalation of lemon aromatherapy by applying 5–6 drops of lemon essential oil onto a tissue placed on the patient's chest for 30 minutes, accompanied by deep breathing exercises. Pain intensity was measured using the Numeric Rating Scale (NRS). Data analysis included tests of normality and homogeneity, paired sample t-tests, independent sample t-tests, and n-gain analysis. **Results**: The results showed a significant reduction in pain intensity after the intervention ($p = 0.000$). The mean pain score decreased from 7.9 (severe pain) before the intervention to 4.6 (mild pain) after the intervention, indicating a clinically meaningful improvement. **Conclusion**: Lemon aromatherapy inhalation is effective in reducing postoperative pain intensity among patients after lower extremity fracture surgery and may be considered a complementary nursing intervention for postoperative pain management.

ARTICLE INFO

Article History:

Received: September 03rd , 2025
Revised: December 17 th, 2025
Accepted: December 24 th, 2025
First Available Online: December 26 th, 2025
Published: December 26 th, 2025

Keywords:
Postoperative Pain; Aromatherapy; Fractures, Bone; Essential Oils; Complementary Therapies

1. INTRODUCTION

Postoperative orthopedic pain due to a fracture of the lower extremity occurs when the continuity of bone structure is disrupted, caused by trauma resulting in nerve fiber damage and severe pain(Lakhan et al., 2016), so it requires effective pain management(Amananti, 2024). Pharmacological therapy is often the primary choice but complementary therapy can also optimize pain relief with minimal side effects(Rambod et al., 2023), that can optimize pain relief with minimal side effects(Kia et al., 2014). One of them is aromatherapy using essential oils extracted from plants. Aromatherapy with essential oils that have been widely recognized for their therapeutic properties, including its ability to relieve anxiety, depression, and pain(Lakhan et al., 2016), is lemon essential oil that has an analgesic and relaxing effecti(Gutiérrez Lombana & Gutiérrez Vidal, 2012).

Several previous studies have examined the use of lemon aromatherapy for a variety of conditions, including pain and anxiety(Hickey & de Mejía, 2014). Lemon inhalation aromatherapy was shown to significantly reduce pain intensity in patients with postoperative lower extremity fractures, resulting in lower pain levels compared to the control group(Rambod et al., 2023). These findings are in line with other studies in patients undergoing orthopedic surgery for wrist fractures, which showed that lemon aromatherapy was able to significantly reduce pain at 8 and 16 hours postoperatively(Özer et al., 2022). The analgesic effects of lemon essential oil are thought to be related to its ability to modulate the nerve control centers and neurotransmission systems that play a role in pain perception, primarily through the activation of the anterior cingulate cortex associated with dopamine as well as the mechanism of degenerative pain inhibition(Özer et al., 2022).

In addition, compared to aroma therapy in others such as lavender essential oil has been reported to be effective in lowering pain in a variety of clinical conditions, including postoperative pain after dysectomy and coronary artery bypass surgery(Azevedo & Medina-Ramírez, 2025). However, the effectiveness of lavender aromatherapy can vary, depending on the timing of administration and the severity of the pain the patient is experiencing. Meanwhile, *Citrus aurantium essential oil* has also been shown to be effective in reducing mild to moderate pain in orthopedic postoperative patients, although its analgesic effect is reported to be lower compared to lemon aromatherapy(Kia et al., 2014). In this literature, there is a gap in the specific understanding of the effectiveness of lemon aromatherapy inhalation as a sustained and standardized intervention to reduce pain scales in postoperative patients with lower extremity fractures with specific intervention protocols such as shorter duration of intervention, or varied methods of administration(Hickey & de Mejía, 2014). Therefore, this study aimed specifically to determine how lemon aromatherapy inhalation affected pain intensity in patients with postoperative lower extremity fractures(Rambod et al., 2023).

The novelty of this study is the effect of lemon aromatherapy inhalation on the reduction of pain scale in postoperative patients with lower extremity fractures(Gutiérrez Lombana & Gutiérrez Vidal, 2012). (Cheung et al., 2022)**,** dengan kata lain, kebaruan dari penelitian ini terletak pada pengujian sistematis dan terperinci tentang efektivitas inhalasi aromaterapi lemon.

DOI: https://doi.org/10.17509/jpki.v11i2.89936
e-ISSN 2477-3743 | p-ISSN 2541-0024

2. METHOD

This study employs a quasi-experimental design with a Group Pre-Test and post-test. The study population was all patients after surgery for lower extremity fractures who underwent treatment at the hospital in January, with a total of 20 people. Samples were taken using a total sampling technique, dividing patients into an intervention group (receiving lemon aromatherapy) and a control group (receiving standard care).

Pain scale measurement was carried out using *the Numeric Rating Scale*, with a range of 0 (no pain) to 10 (very severe uncontrolled pain). Data were collected before (*pre-test*) and after (post-test) interventions for three consecutive days. The lemon aromatherapy inhalation procedure involves dripping 5-6 drops of lemon essential oil on a tissue, which is then placed on the patient's chest for 30 minutes, accompanied by instructions to perform deep breathing techniques. Data analysis includes normality test, homogeneity test, *Paired* Sample T-Test, Independent Sample T-Test, and N-Gain test. This study has received ethical approval with approval number BND-073/XII/2023/ITD**.**

3. RESULT

The study data showed the characteristics of respondents that varied in age (11-70 years) and gender (45% male, 55% female), with the most fractures in the tibia and phalanx. All respondents received the analgesic drug ketorolac.

Table 1. Respondent Characteristics

Characteristics	n	Percentage (%)
Age (year)		
11–20	2	10
21–30	4	20
31–40	4	20
41–50	4	20
51–60	4	20
61–70	2	10
Gender		
Male	9	45
Female	11	55
Types of Fractures		
Femur	4	20
Patella	1	5
Tibia	6	30
Fibula	0	0
Metatarsal	2	10
Phalanges	7	35
Types of Analgesic Drugs		
Ketorolac	20	100

DOI: https://doi.org/10.17509/jpki.v11i2.89936
e-ISSN 2477-3743 | p-ISSN 2541-0024

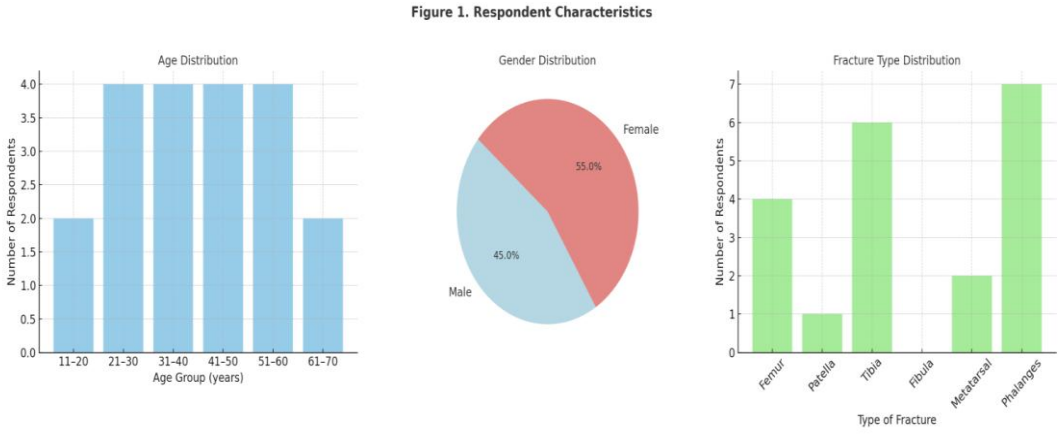

Figure 1. Characteristics of respondents

Figure 1 illustrates the characteristics of respondents in this study. Panel (a) shows that most respondents were within the 21–60 years age group (80%), while only a small proportion were in the youngest (11–20 years) and oldest (61–70 years) groups. Panel (b) demonstrates that the gender distribution was slightly dominated by females (55%) compared to males (45%). Panel (c) presents the distribution of fracture types, indicating that phalangeal fractures were the most common (35%), followed by tibia fractures (30%) and femur fractures (20%). Meanwhile, fibula fractures were not reported in this study.

Table 2 shows a gradual decrease in postoperative pain from Day 1 to Day 3. On Day 1, most patients reported severe pain (scale 7–9), with a slight reduction in mean pain score from 7.85 (pre) to 7.35 (post). Pain intensity continued to decrease on Day 2, as reflected by a reduction in severe pain cases and a decline in mean pain score from 7.15 to 6.80. The greatest improvement was observed on Day 3, with a marked decrease in severe pain (from 11 to 6) and the appearance of mild pain (scale 1–3) in the post-intervention phase. Overall, mean pain scores consistently decreased after the intervention, indicating progressive postoperative pain relief.

Table 2. Postoperative Pain

Pain Scale	Day-1		Day - 2		Day - 3	
	Pre	Post	Pre	Post	Pre	Post
Skala 0	-	-	-	-	-	-
Skala 1 – 3	-	-	-	-	-	1
Skala 4 – 6	2	3	5	6	9	13
Skala 7 – 9	18	17	15	14	11	6
Skala 10	-	-	-	-	-	-
Mean	7,85	7,35	7,15	6,8	6,6	5,65
Total	**20**		**20**		**20**	

Table 3. Effect of Lemon Aromatherapy Inhalation on Reduction of Pain Scale in Postoperative Lower Extremity Fracture Patients

Day	Lemon Aromatherapy Group n = 10		Control Group n = 10	
	Pre	Post	Pre	Post
1	7,90	7,40	7,80	7,30
2	7,10	6,80	7,20	6,80
3	6,40	4,60	6,80	6,70

DOI: https://doi.org/10.17509/jpki.v11i2.89936
e-ISSN 2477-3743 | p-ISSN 2541-0024

Table 4. Analysis of Pain Reduction

Analysis	Group	Mean Pain Score	p-value (Sig. 2-tailed)	Effectiveness
Paired Sample t-test	Intervention	–	< 0.001	Significant
	Control	–	0.007	Significant
Independent Sample t-test	Intervention	4.60	< 0.001	Between-group difference
	Control	6.70	< 0.001	
N-Gain Test	Intervention	–	–	61.45% (Moderate–High)

Table 3 shows the effect of lemon aromatherapy inhalation on pain reduction in postoperative lower extremity fracture patients. In the lemon aromatherapy group, mean pain scores decreased consistently from Day 1 to Day 3, with a more pronounced reduction on Day 3 (from 6.40 to 4.60). In contrast, the control group showed only minimal changes in pain intensity over the same period, particularly on Day 3 (from 6.80 to 6.70). Overall, patients receiving lemon aromatherapy experienced a greater reduction in postoperative pain compared to those in the control group.

Table 4 shows that Paired sample t-tests showed significant pain reduction in both groups, with a stronger effect in the intervention group ($p < 0.001$). An independent sample t-test revealed significantly lower post-intervention pain scores in the lemon aromatherapy group compared to the control group ($p < 0.001$). The N-Gain value of 61.45% indicates a moderate to high effectiveness of lemon aromatherapy in reducing postoperative pain.

4. DISCUSSION

Postoperative pain is influenced by age and gender factors(Wang et al., 2024). Women tend to report higher pain than men, influenced by hormonal factors and nerve density(Pereira & Pogatzki-Zahn, 2015). However, despite these factors, lemon aromatherapy shows significant potential as a non-pharmacological intervention.

The mechanism of action of lemon aromatherapy in reducing pain involves its effects on the autonomic nervous system and the olfactory system(Kia et al., 2014). The volatile molecules of lemons, when inhaled, affect the olfactory lobes connected to areas of the brain that regulate mood, behavior, and stress responses(Sun et al., 2025), thus helping to relax muscles, function as an antidepressant, and reduce blood pressure, all of which contribute to a decrease in pain perception. The advantages of lemon aromatherapy lie in its anti-infectious properties, immune-boosting abilities, and muscle-relaxing effects(Özer et al., 2022).

The study's significant findings, namely a greater reduction in pain scale in the lemon aromatherapy intervention group than the control group, are in line with several previous studies that indicated a positive effect of aromatherapy in pain management. Research by Masoume Rambod et al.(Rambod et al., 2023), although there is a difference in the duration of the intervention (120 minutes) and the focus of the intervention may be shorter (postoperative recovery space), also found that lemon aromatherapy inhalation was effective in reducing pain intensity in patients undergoing lower extremity fracture surgery. Similarities in the population of patients postoperatively with lower extremity fractures reinforce the validity of these findings.(Azevedo & Medina-Ramírez, 2025)

Although other research by Masoume Rambod et al(Rambod et al., 2023) and Parisa Yavari et al(Kia et al., 2014) having different focuses (e.g., anxiety in patients with acute myocardial

DOI: https://doi.org/10.17509/jpki.v11i2.89936
e-ISSN 2477-3743 | p-ISSN 2541-0024

infarction or nausea and vomiting in pregnancy), they nonetheless demonstrate the potential of lemon aromatherapy therapy in modulating physiological and psychological responses. This study specifically strengthens the evidence on the effects of lemon analgesics in the context of postoperative pain of lower extremity fractures, which is a crucial area in pain management.

The main difference in this study compared to previous relevant studies lies in the duration of the lemon aromatherapy intervention conducted for three consecutive days, compared to a single session or shorter duration in some other studies. This more sustained intervention approach suggests that the effects of lemon aromatherapy are not only temporary but can provide significant short-term benefits in the postoperative recovery process. The clear administration protocol, i.e., 5-6 drops of lemon essential oil on a tissue placed on the patient's chest for 30 minutes with deep breathing instructions, also provides a solid methodological basis for replication and implementation in clinical practice.

The results of *the Paired Sample T-Test* and *the Independent Sample T-Test* with a p-value of 0.000 showed a very significant difference between the intervention and control groups. Furthermore, the *N-Gain* value of 61.45% indicates a fairly strong effectiveness of the intervention, confirming that lemon aromatherapy inhalation is an effective modality to reduce pain in this patient population.

Overall, the study not only confirms findings from previous studies regarding the aromatherapy potential of lemons but also provides strong evidence for its effectiveness in the specific context of postoperative pain of lower extremity fractures with more sustained intervention protocols. This paved the way for the integration of lemon aromatherapy as part of comprehensive pain management in a clinical setting.

5. CONCLUSSION AND LIMITATION

This study concluded that lemon aromatherapy inhalation had a significant influence on lowering the pain scale in patients after surgery for lower extremity fractures. These findings are supported by a significant p-value ($0.000 < 0.05$) and an N-Gain score of 61.45% which indicates good effectiveness. Factors such as age and gender can affect pain response, but lemon aromatherapy remains an effective intervention modality. The results of this study have important implications for postoperative pain management, suggesting that lemon aromatherapy inhalation therapy can be an effective approach and can be considered in clinical practice. It is recommended to conduct further research by examining variations in aromatherapy delivery techniques and the use of pain scale measurement variations to enrich our understanding of the effectiveness of these interventions.

This study was limited by a small sample size, a quasi-experimental design without randomization, and a relatively short intervention period, which may affect internal validity and generalizability. The use of subjective pain assessment may also introduce perceptual bias, although repeated measurements and a standardized aromatherapy protocol were applied to minimize this limitation. Future studies are recommended to employ randomized controlled designs with larger samples, longer intervention durations, and varied aromatherapy delivery methods. Incorporating objective outcome measures and expanding to different surgical populations may further strengthen the evidence for lemon aromatherapy in postoperative pain management.

6. ACKNOWLEDGEMENT

The authors would like to express their deepest gratitude to the leadership of Universitas Pendidikan Indonesia (UPI) for the continuous support and encouragement throughout this research. We also extend our sincere appreciation to the Research and Community Service

DOI: https://doi.org/10.17509/jpki.v11i2.89936
e-ISSN 2477-3743 | p-ISSN 2541-0024

Division of UPI for providing valuable guidance, facilities, and assistance that greatly contributed to the completion of this study.

7. REFERENCES

Amananti, W. (2024). *No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析Title*. *4*(02), 7823–7830.

Azevedo, N., & Medina-Ramírez, R. (2025). Pain and the autonomic nervous system. The role of non-invasive neuromodulation with NESA microcurrents. *Frontiers in Pain Research*, *6*(February), 1–6. https://doi.org/10.3389/fpain.2025.1410808

Cheung, C. K., Adeola, J. O., Beutler, S. S., & Urman, R. D. (2022). Postoperative Pain Management in Enhanced Recovery Pathways. *Journal of Pain Research*, *15*, 123–135. https://doi.org/10.2147/JPR.S231774

Gutiérrez Lombana, W., & Gutiérrez Vidal, S. E. (2012). Pain and gender differences: A clinical approach. *Colombian Journal of Anesthesiology*, *40*(3), 207–212. https://doi.org/10.1016/j.rcae.2012.05.006

Hickey, T. M., & de Mejía, A. M. (2014). Immersion education in the early years: A special issue. *International Journal of Bilingual Education and Bilingualism*, *17*(2), 131–143. https://doi.org/10.1080/13670050.2013.866624

Kia, P. Y., Safajou, F., Shahnazi, M., & Nazemiyeh, H. (2014). The effect of lemon inhalation aromatherapy on nausea and vomiting of pregnancy: A double-blinded, randomized, controlled clinical trial. *Iranian Red Crescent Medical Journal*, *16*(3). https://doi.org/10.5812/ircmj.14360

Lakhan, S. E., Sheafer, H., & Tepper, D. (2016). The Effectiveness of Aromatherapy in Reducing Pain: A Systematic Review and Meta-Analysis. *Pain Research and Treatment*, *2016*. https://doi.org/10.1155/2016/8158693

Özer, Z., Teke, N., Turan, G. B., & Bahçecik, A. N. (2022). Effectiveness of lemon essential oil in reducing test anxiety in nursing students. *EXPLORE*, *18*(5), 526–532. https://doi.org/https://doi.org/10.1016/j.explore.2022.02.003

Pereira, M. P., & Pogatzki-Zahn, E. (2015). Gender aspects in postoperative pain. *Current Opinion in Anaesthesiology*, *28*(5), 546–558. https://doi.org/10.1097/ACO.0000000000000226

Rambod, M., Pasyar, N., Karimian, Z., & Farbood, A. (2023). The effect of lemon inhalation aromatherapy on pain, nausea, as well as vomiting and neurovascular assessment in patients for lower extremity fracture surgery: a randomized trial. *BMC Complementary Medicine and Therapies*, *23*(1), 1–12. https://doi.org/10.1186/s12906-023-04047-z

Sun, C., Fei, C., Lin, R., Qiu, X., Wang, W., Jiang, X., Sun, F., Wang, Y., & Tang, L. (2025). The Efficacy of Aromatherapy on Pain and Anxiety During Needle-Related Procedures in Adults: A Systematic Review and Meta-Analysis. *Journal of Pain Research*, *18*(July), 4053–4072. https://doi.org/10.2147/JPR.S533076

Wang, H., Luo, M., Yang, Y., Li, S., Liang, S., Xu, R., Zhu, J., & Song, B. (2024). Gender differences in postoperative pain, sleep quality, and recovery outcomes in patients undergoing visual thoracoscopic surgery. *Heliyon*, *10*(19), e39015. https://doi.org/10.1016/j.heliyon.2024.e39015

DOI: https://doi.org/10.17509/jpki.v11i2.89936
e-ISSN 2477-3743 | p-ISSN 2541-0024