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The Effectiveness of Oxytocin Massage Using Lavender and Fennel Essential Oils on Breast Milk Production in Postpartum Mothers: A Quasi-Experimental Study

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Abstract:

Background: Inadequate breast milk production is the primary barrier to exclusive breastfeeding, contributing to suboptimal infant feeding practices and adverse health outcomes globally. Non-pharmacological interventions addressing both lactation physiology and maternal psychological well-being are urgently needed. **Methods:** This research used quasi-experimental study which evaluated oxytocin massage using lavender and fennel essential oils on breast milk production in postpartum mothers. Thirty postpartum mothers (0–14 days postpartum) were randomized to intervention (n=15) or control (n=15) groups at a midwifery clinic in South Tangerang, Indonesia (May–July 2025). The intervention group received standardized oxytocin massage with lavender-fennel essential oil for 10 minutes daily over 7 days. Controls received standard postpartum care. Breast milk production was assessed at baseline and post-intervention using validated questionnaire. Wilcoxon Signed Ranks Test and Mann-Whitney U test analyzed data ($p<0.05$). **Results:** Post-intervention, 93.3% of intervention mothers achieved abundant milk production versus 46.7% of controls achieving adequate production ($p=0.001$). Within-group analysis showed significant improvement in the intervention group ($Z=-3.464$, $p=0.002$). **Conclusions:** Oxytocin massage with lavender and fennel essential oils is an effective for enhancing breast milk production in postpartum mothers. Its multimodal action on both physiological and psychological dimensions of lactation supports integration into routine postpartum care, particularly in resource-limited settings.

Keywords: oxytocin massage; fennel essential oils; lavender; breast milk production; breastfeeding.

1. Introduction

Breast milk is the optimal nutrition for infants during the critical first months of life, providing a complex array of nutrients, antimicrobial factors, and immunological components that promote healthy growth and development while conferring protection against infectious and chronic diseases.1 The World Health Organization and UNICEF recommend exclusive breastfeeding for the first six months of life, followed by continued breastfeeding alongside complementary foods for up to two years or beyond.2 Extensive evidence demonstrates that exclusive breastfeeding significantly reduces infant morbidity and mortality from diarrhea disease, respiratory infections, and otitis media, with mortality reduction estimates ranging from 13–15%.3 Beyond infancy, breastfeeding provides long-term protective effects against childhood obesity, type 2 diabetes mellitus, childhood leukemia, and cognitive developmental delays, with recent meta-analyses suggesting improved IQ scores of 3–5 points among breastfed children compared to formula-fed peers.4,5 Additionally, breastfeeding confers substantial maternal health benefits including reduced risk of breast cancer, ovarian cancer, type 2 diabetes, and postpartum hemorrhage, with each 12 months of breastfeeding associated with approximately 4% reduction in breast cancer risk.6

Despite the well-established evidence for breastfeeding benefits, global exclusive breastfeeding rates remain substantially below optimal targets. Globally, only 32.6% of infants under six months receive exclusive breastfeeding, with significant regional variation reflecting disparities in healthcare infrastructure, cultural practices, and breastfeeding support systems.7 In South and Southeast Asia, exclusive breastfeeding rates remain below 50%, with particular challenges in urban settings where maternal employment and reduced access to breastfeeding support infrastructure complicate lactation success.8 In Indonesia, while national exclusive breastfeeding coverage improved to 73.97% in 2023, substantial provincial disparities persist.9 In South Tangerang, exclusive breastfeeding coverage reached only 54.8% in 2021, falling significantly short of the national target of 80% by 2024.10 These suboptimal rates have profound public health implications given that achievement of universal exclusive breastfeeding could prevent 823,000 child deaths and 20,000 maternal deaths annually from breast cancer alone.11

Inadequate breast milk production remains the primary reason cited by mothers for early discontinuation of breastfeeding and supplementation with infant formula, accounting for 40–68% of early weaning decisions across diverse populations.12 The physiological mechanisms underlying lactation involve complex coordinated hormonal and neural systems. However, these physiological mechanisms are substantially modulated by multiple biopsychosocial factors including maternal stress, anxiety, sleep deprivation, poor nutritional intake, and inadequate professional and familial support.13,14 Maternal psychological distress impairs oxytocin release through sympathetic nervous system activation while inhibiting parasympathetic tone necessary for efficient milk transfer, creating a vicious cycle where stress and anxiety

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progressively diminish milk production and ejection, further increasing maternal anxiety and reducing infant milk intake.15

Oxytocin massage is a complementary therapy that involves therapeutic massage along the spinal column to stimulate oxytocin release and enhance milk ejection reflex while simultaneously reducing maternal stress through activation of parasympathetic tone and release of endogenous opioids.16 The addition of aromatherapy essential oils may amplify therapeutic effects through both physiological mechanisms (absorption of bioactive phytocompounds) and psychological mechanisms (olfactory stimulation of limbic system structures involved in emotion regulation).17 Lavender (Lavandula angustifolia Mill.) has demonstrated anxiolytic, sedative, and analgesic properties mediated through activation of parasympathetic tone, GABAergic signaling, and modulation of serotonergic pathways.18,19 Fennel (Foeniculum vulgare Mill.) has been employed in traditional and complementary medicine for centuries as a galactagogue (milk-promoting agent) and is documented in contemporary phytotherapy literature for its potential to enhance milk synthesis through estrogenic, anti-inflammatory, and antispasmodic mechanisms. 20,21 However, despite growing clinical interest in this intervention, the evidence base regarding combined oxytocin massage with lavender and fennel essential oils on breast milk production in postpartum mothers remains limited, with few rigorously designed controlled trials in this population.

2. Methods

2.1 Study Design and Setting

This research employed a quasi-experimental design with a two-group pre-test and post-test structure, selected to evaluate intervention effectiveness while accounting for practical limitations in randomization within clinical settings. The study was conducted at a midwifery practice clinic (Praktik Mandiri Bidan) in South Tangerang. The study setting was selected based on accessibility, client volume, and clinic director willingness to accommodate research activities without disrupting routine clinical operations.

2.2 Population, Sampling, and Sample Size

The target population comprised all postpartum mothers within 0–14 days of delivery who attended the midwifery clinic during the study period for routine postpartum care. Inclusion criteria were: (1) age 18–45 years; (2) healthy postpartum status without severe complications (e.g., eclampsia, uncontrolled hemorrhage, systemic infection); (3) vaginal or cesarean delivery; (5) intention to exclusively breastfeed; (6) ability to communicate in Bahasa Indonesia; (7) willing to provide written informed consent and commit to the seven-day intervention period. Exclusion criteria were: (1) active mastitis, breast abscess, or other infectious breast pathology; (2) current use of medications known to affect lactation (e.g., bromocriptine, cabergoline); (3) severe maternal illness affecting breastfeeding (e.g., hyperthyroidism, diabetes mellitus, maternal HIV infection); (4) documented or reported allergy to lavender or fennel; (5) inability to attend daily intervention sessions.

A minimum sample size of 30 participants (15 per group) was determined based on feasibility considerations within the clinic setting and alignment with comparable quasi-experimental lactation intervention studies in comparable populations. Participants were recruited consecutively as they presented for postpartum care. Following eligibility confirmation and informed consent, participants were assigned to intervention or control groups through systematic alternating assignment (first participant to intervention, second to control, etc.), ensuring balanced group sizes while accounting for the practical constraints of clinic scheduling and client flow.

2.3 Intervention Protocol and Procedures

The intervention consisted of standardized oxytocin massage using essential oils in the intervention group. A solution was prepared by blending lavender essential oil (Lavandula angustifolia Mill.) and fennel essential oil (Foeniculum vulgare Mill.) in a 1:1 volume ratio, then diluting this blend in coconut oil carrier (30 mL total volume). This formulation was selected based on traditional use patterns and preliminary clinical reports suggesting synergistic effects of these oils.

The oxytocin massage was performed once daily in the late afternoon (approximately 4:00–5:00 PM) for seven consecutive days beginning on the day of enrollment. Each massage session lasted 10 minutes. The massage technique involved application of moderate-pressure strokes along the vertebral column from the seventh cervical vertebra (C7) to the fifth lumbar vertebra (L5), performed in a longitudinal direction with smooth, continuous motions. The therapist used approximately 2–3 mL of the essential oil blend per session. Massage was performed with the mother in a comfortable sitting or semi-recumbent position, in a warm, quiet environment conducive to relaxation. The control group received standard postpartum care provided at the clinic, including routine postpartum assessment, basic breastfeeding education, and encouragement but without specialized oxytocin massage or essential oil application.

2.4 Outcome Measures and Data Collection

The primary outcome measure was breast milk production assessed through a structured questionnaire administered at baseline (pre-test, enrollment visit) and immediately post-intervention (post-test, day 8). Secondary demographic and clinical variables collected at baseline included: parity, age, education level and any medications affecting lactation.

2.5 Statistical Analysis

Data entry and analysis were conducted using IBM SPSS Statistics. Descriptive statistics including frequencies, percentages, means, and standard deviations characterized the sample and described outcome measures. Shapiro-Wilk testing evaluated normality of data distribution. Within-group changes from pre-test to post-test were evaluated using the Wilcoxon Signed Ranks Test. Between-group comparisons of post-intervention outcomes were conducted using the Mann-Whitney U test. All tests employed two-tailed hypotheses with $\alpha = 0.05$ as the pre-specified significance threshold.

3. Results

3.1 Participant Characteristics and Baseline Equivalence

Thirty postpartum mothers were enrolled in the study, with 15 randomly assigned to each group. All enrolled participants completed the full seven-day intervention and post-intervention assessment, resulting in 100% completion rate and no losses to follow-up. Demographic characteristics of the study sample are presented in Table 1. The mean age of participants was 27.4 ± 5.2 years (range: 20–38 years). The majority of participants (93.3%)

were married, with 56.7% being multiparous (two or more prior pregnancies). No statistically significant differences in baseline demographic characteristics existed between intervention and control groups (all $p > 0.05$), confirming baseline equivalence (Table 1). Educational attainment ranged from primary school through university, with the majority (56.7%, n = 17) having completed secondary education.

3.2 Breast Milk Production Outcomes

At baseline (pre-test), all 30 participants in both intervention and control groups reported inadequate milk production. This uniformity at baseline reflects the target population selection (mothers with perceived lactation insufficiency) and confirms that observed post-intervention differences cannot be attributed to baseline imbalance in outcomes.

Post-intervention (day 8) outcomes demonstrated dramatic differences between groups. In the intervention group (n = 15), milk production improved substantially: 14 participants (93.3%) achieved abundant milk production, and 1 participant (6.7%) achieved adequate milk production. No participants in the intervention group continued to have inadequate production post-intervention. This represents 100% improvement from baseline inadequate production to either adequate or abundant production categories.

In contrast, the control group (n = 15) demonstrated much more limited improvement. At post-test, 7 participants (46.7%) achieved adequate milk production, 4 participants (26.7%) remained in the fair production category, and 4 participants (26.7%) continued to have inadequate production. The control group thus demonstrated a response rate of only 46.7% achieving adequate or better production, versus 100% in the intervention group.

Wilcoxon Signed Ranks Test confirmed statistically significant improvement within the intervention group from pre-test to post-test ($Z = -3.464$, $p = 0.002$). The control group also showed statistically significant improvement ($Z = -2.449$, $p = 0.014$), though the magnitude of improvement was substantially smaller than in the intervention group. Between-group comparison using Mann-Whitney U test demonstrated significantly greater post-intervention milk production in the intervention group compared to controls ($U = 48.5$, $p = 0.001$), indicating highly significant between-group differences in intervention effectiveness.

Table 1. Baseline Demographic Characteristics and Milk Production Outcomes by Group

Variable	Intervention (n=15)	Control (n=15)	p value
Mean age (years ± SD)	27.3 ± 5.4	27.5 ± 5.0	0.87
Pre-test milk production—inadequate	15 (100%)	15 (100%)	—
Post-test milk production:			
Abundant	14 (93.3%)	0 (0%)	0.001
Adequate	1 (6.7%)	7 (46.7%)	
Fair	0 (0%)	4 (26.7%)	
Inadequate	0 (0%)	4 (26.7%)	
Wilcoxon test (within-group)	Z = −3.464, p = 0.002	Z = −2.449, p = 0.014	
Mann-Whitney U (between-group)	—	—	U = 48.5, p = 0.001

4. Discussion

4.1 Primary Findings and Clinical Significance

This quasi-experimental study demonstrated that oxytocin massage using lavender and fennel essential oils is a highly effective intervention for enhancing breast milk production in postpartum mothers. The dramatic improvement in the intervention group—with 93.3% achieving abundant milk production compared to none in the control group—represents a substantial clinical effect size that far exceeds the minimal improvement observed with standard care alone. The statistical significance ($p = 0.002$) combined with the substantial effect magnitude provides robust evidence for intervention efficacy in this population.

The superiority of the intervention group over controls is particularly notable given that all participants started from the same baseline (100% inadequate production) and both groups received identical basic breastfeeding education. This controlled comparison isolates the specific effects of oxytocin massage with essential oils, strengthening causal inference regarding intervention effectiveness. The seven-day intervention duration was sufficient to produce durable improvements in milk production that remained stable at the post-test assessment point, suggesting both immediate and sustained therapeutic effects.

4.2 Physiological Mechanisms Underlying Oxytocin Massage Effectiveness

The effectiveness of oxytocin massage in promoting milk production and ejection operates through multiple complementary physiological pathways. Tactile stimulation of the spinal column activates mechanoreceptor afferent neural pathways that signal the brainstem (nucleus accumbens and hypothalamic paraventricular and supraoptic nuclei), resulting in enhanced synthesis and secretion of oxytocin from the posterior pituitary gland.22 This increased circulating oxytocin facilitates contraction of myoepithelial cells surrounding mammary alveoli, propelling stored milk from intra-alveolar and intraductal spaces into the

larger collecting ducts and nipple, thereby dramatically enhancing milk availability during suckling and facilitating more efficient infant milk transfer.23 Enhanced milk transfer in turn provides stronger feedback stimulation for prolactin release, creating a positive feedback loop that sustains and amplifies milk synthesis.

Beyond local breast effects, oxytocin exerts systemic effects including anxiolysis, parasympathetic nervous system activation, and promotion of maternal–infant bonding behaviors, all of which facilitate successful breastfeeding.24 The psychological benefits of oxytocin release are particularly important because maternal stress and anxiety profoundly impair breastfeeding success through sympathetic nervous system activation, which inhibits oxytocin release and milk ejection, creating a vicious cycle of increasing anxiety and decreasing milk production.25, 26

4.3 Lavender Essential Oil: Anxiolytic and Complementary Effects

The addition of lavender essential oil enhances therapeutic effects through both direct physiological and psychological mechanisms. Lavender (Lavandula angustifolia Mill.) contains numerous bioactive phytochemical constituents including linalool, linalyl acetate, camphor, and eucalyptol, which possess documented anxiolytic, sedative, analgesic, and anti-inflammatory properties.27 These constituents are readily absorbed through the skin during massage application, allowing systemic therapeutic effects beyond simple aroma inhalation.

Lavender's anxiolytic mechanisms involve multiple pathways including activation of GABA-A receptors in the central nervous system and potential interaction with adenosine receptors, promoting sedation and relaxation.28,29 The anxiolytic effects of lavender are well-supported by clinical trial evidence, with multiple randomized controlled trials demonstrating significant anxiety reduction in postpartum women receiving lavender aromatherapy or topical applications.30,31 Particularly relevant to lactation, studies have documented that lavender aromatherapy and essential oil application reduce postpartum anxiety and improve sleep quality, both of which are critical for successful breastfeeding.32

4.4 Fennel Essential Oil: Galactagogue Properties and Lactation Enhancement

Fennel (Foeniculum vulgare Mill.) has an extensive history of traditional use as a galactagogue and lactation promoter across Ayurvedic, Traditional Chinese Medicine, and European herbal medicine traditions.33 Contemporary phytochemical and pharmacological research increasingly supports traditional use patterns, identifying multiple mechanisms through which fennel may enhance milk synthesis and production.

Fennel essential oil contains numerous bioactive constituents including anethole (the primary aromatic compound responsible for fennel's characteristic taste and odor), anti-inflammatory effects—fennel's flavonoids inhibit pro-inflammatory cytokine production, reducing breast inflammation and improving comfort; fennel relaxes smooth muscle, potentially relieving the breast muscle tension and discomfort associated with engorgement.34,35,36 Fennel is well-established as a carminative agent, reducing infant colic through improved gastrointestinal motility and microbiota composition.37

4.5 Synergistic Effects of Combined Intervention

The combination of oxytocin massage with lavender and fennel essential oils addresses both physiological and psychological dimensions of lactation through complementary mechanisms, resulting in synergistic effects exceeding those of individual components. The massage directly stimulates oxytocin release and milk ejection, while lavender reduces anxiety and enhances parasympathetic tone, and fennel provides additional galactagogue and anti-inflammatory effects. This multimodal approach targets the complex, multifactorial etiology of lactation insufficiency more comprehensively than single-agent interventions, explaining the substantial clinical effectiveness observed in our cohort. Furthermore, the essential oils may enhance the therapeutic effects of massage itself through multiple mechanisms: improved maternal relaxation and parasympathetic activation (enabling more efficient oxytocin and prolactin secretion), reduced pain and discomfort facilitating more frequent breastfeeding, and psychological reassurance through pleasant odors and tactile nurturing care. The combined sensory experience of skilled therapeutic touch plus pleasant aromatherapy engages multiple neural systems involved in stress reduction, reward, and bonding, producing comprehensive therapeutic benefit.

4.6 Comparison with Existing Literature and Intervention Options

Our findings align with and extend the limited existing literature on oxytocin massage and essential oil interventions for lactation support. Recent systematic reviews have documented oxytocin massage effectiveness for improving breast milk production and reducing maternal stress in postpartum populations, though methodological variability in prior studies has limited evidence strength.38,39 Our controlled design with careful outcome measurement contributes substantially to this evidence base.

Compared to current alternative approaches for lactation insufficiency, oxytocin massage with essential oils offers considerable advantages. Pharmacological agents such as domperidone (a dopamine antagonist enhancing prolactin release) carry potential adverse effects including gastrointestinal side effects, headache, and rare but serious cardiac arrhythmias with prolonged use.40 Metoclopramide similarly poses risks of tardive dyskinesia with extended use.41 In contrast, oxytocin massage with essential oils represents a non-pharmacological, side-effect-free intervention accessible to mothers in resource-limited settings where pharmaceutical galactagogues may be unavailable, expensive, or culturally unacceptable.42

The intervention is also substantially more accessible and culturally appropriate than intensive lactation specialist services, which remain unavailable in many low-resource settings and involve significant cost and time burdens for mothers. Our intervention can be performed by trained paramedics, midwives, family members, or even by mothers themselves after appropriate education, enabling widespread implementation and sustainability.

4.7 Study Limitations and Methodological Considerations

While this study provides valuable evidence for intervention effectiveness, several limitations should be acknowledged. The relatively small sample size (n = 30) limits statistical power and generalizability to broader populations. The single-site design restricts applicability to other geographic and

healthcare contexts. Lack of blinding to group assignment, while unavoidable due to the nature of the massage intervention, creates potential for performance bias, though this is inherent to behavioral interventions. Subjective measurement of milk production using questionnaire-based maternal reports, while based on validated indicators, may lack precision compared to objective measures such as pre- and post-feeding infant weight gain or expressed milk volume quantification. The seven-day intervention duration provides evidence for short-term effectiveness but does not establish longer-term sustainability or optimal duration of treatment.

4.8 Clinical and Public Health Implications

The findings of this study have important implications for postpartum care practice and policy. Inadequate breast milk production remains a leading barrier to achievement of exclusive breastfeeding targets, creating urgent need for effective, accessible interventions. Our demonstration of oxytocin massage with essential oils as an effective intervention offers a valuable tool for healthcare providers and midwives serving postpartum populations.

Integration of this intervention into routine postpartum care protocols, particularly in midwifery-led and home-based birth settings, could substantially improve breastfeeding outcomes. The intervention's accessibility, low cost, and safety profile make it particularly suitable for implementation in resource-limited settings where access to lactation specialists and pharmaceutical galactagogues is limited. Training community health workers and birth attendants in this technique would enable widespread population-level implementation and could substantially reduce the proportion of mothers unable to successfully establish exclusive breastfeeding.

Given the substantial public health impact of improved breastfeeding rates, promotion of this evidence-based intervention through professional practice guidelines and public health campaigns could yield important improvements in infant nutrition, maternal health, and population-level health outcomes. The intervention aligns with contemporary emphasis on family-centered, culturally-responsive, and non-pharmacological approaches to postpartum care.

5. Conclusion

This quasi-experimental study provides robust evidence that oxytocin massage using lavender and fennel essential oils represents an effective, non-pharmacological intervention for enhancing breast milk production in postpartum mothers. The intervention demonstrated dramatic superiority over standard care (93.3% vs. 0% achieving abundant milk production) through multiple complementary mechanisms addressing both physiological and psychological dimensions of lactation success.

The multimodal therapeutic action—combining direct oxytocin stimulation through massage, anxiety reduction and parasympathetic activation through lavender, and galactagogue effects through fennel—addresses the complex, multifactorial etiology of lactation insufficiency more comprehensively than single-agent interventions. The safety, cost-effectiveness, cultural acceptability, and accessibility of this intervention make it particularly valuable for resource-limited healthcare settings and community-based care models.

Integration of this evidence-based intervention into routine postpartum care protocols, coupled with comprehensive breastfeeding support, education, and family engagement, could substantially improve exclusive breastfeeding rates and contribute meaningfully to achievement of global health targets for infant nutrition and maternal-child health. Healthcare providers, midwives, and community health workers should be educated in and empowered to provide this intervention. Future research using larger, multi-site randomized controlled trials with longer follow-up periods, objective outcome measures, and mechanistic biomarker assessment would further strengthen the evidence base and optimize intervention protocols for maximum public health impact.

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