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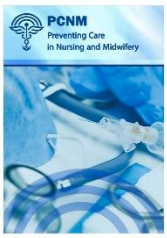

Original Article

Effect of Inhalation Aromatherapy with Neroli Oil on Pain Reduction of the Primary Dysmenorrhea: A Clinical Trial Study

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Abstract

Background: Primary dysmenorrhea, characterized by abdominal pain during menstruation resulting from uterine contraction and ischemia, affects approximately 50% of women.

Objectives: This study aimed to evaluate the effect of inhalation aromatherapy with neroli oil on the pain reduction of dysmenorrhea.

Methods: This two-group randomized clinical trial (non-blinded due to odor) was conducted in 2021 among 70 students of Zanjan University of Medical Sciences with primary dysmenorrhea. Participants were randomly assigned to the neroli oil or placebo group using numbers 1–70 generated at www.graphpad.com. Each was followed over four menstrual cycles: during the first two, pain intensity was recorded using a Visual Analogue Scale (VAS) without treatment; during the next two, inhalation aromatherapy with 2% neroli oil or placebo was applied once daily for 30 minutes on the first two days of menstruation. Data were analyzed in SPSS 26 using repeated measures ANOVA and independent t-tests.

Results: A significant difference in pain severity was observed between the two groups following the intervention, during both the first ($t = 3.77$, $p = .001$) and second cycles ($t = 4.07$, $p < .001$). In the intervention group, the mean pain intensity (SD) decreased from 6.58 (0.95) and 6.19 (0.98) before the intervention to 2.83 (0.68) and 2.32 (0.79) afterwards. Similarly, in the control group, pain scores reduced from 6.29 (1.18) and 6.16 (1.03) to 3.64 (1.14) and 3.35 (1.17), respectively.

Conclusion: In conclusion, Neroli oil aromatherapy appears to be effective in reducing the pain intensity associated with primary dysmenorrhea (PD).

Implications for Nursing and Midwifery Preventive Care

- Inhalation aromatherapy is an effective non-pharmacological method for managing menstrual pain.
- Complementary therapies help reduce dependence on pharmaceutical analgesics and their side effects.
- Safe and accessible pain management strategies improve daily functioning and overall quality of life.

Introduction

Dysmenorrhea is a common condition among women of reproductive age, characterized by cramping pain in the lower abdomen. It is classified into two types: primary dysmenorrhea, which occurs in the absence of gynecological abnormalities, and secondary dysmenorrhea, which is associated with pelvic pathology [1]. Primary dysmenorrhea is often accompanied by symptoms such as nausea, vomiting, headache, fatigue, diarrhea, dizziness, and lower back pain [2-4]. Menstrual cramps typically last for 2–3 days [4]. The prevalence of primary dysmenorrhea (PD) varies worldwide [5], affecting approximately 50% of women of reproductive age, while in Iran, it has been reported to be as high as 95% [6]. Dysmenorrhea can negatively impact daily activities, social interactions, and overall quality of life [5]. The release and production of prostaglandins not only increase uterine contractions but also induce uterine and myometrial ischemia, leading to pain [7]. In other words, increased prostaglandin production can activate uterine pain receptors [7].

Pain management for dysmenorrhea includes both pharmacological and non-pharmacological approaches. Pharmacological methods, such as nonsteroidal anti-inflammatory drugs (NSAIDs), are considered first-line treatment, as they inhibit prostaglandin synthesis and alleviate pain. However, NSAIDs may be associated with side effects including nausea, vomiting, gastrointestinal ulcers, hepatic or hematologic disorders, and bleeding [8, 9]. Non-pharmacological methods, including warm compresses, acupuncture, acupressure, aromatherapy, massage, exercise, and yoga, have also been employed to manage primary dysmenorrhea [4, 10, 11].

Aromatherapy involves the use of essential oils extracted from plants to relieve pain through either massage or inhalation [12]. It is believed to stimulate the hypothalamus, promote endorphin release, and consequently reduce the pain associated with dysmenorrhea [13, 14]. One of the medicinal herbs used in aromatherapy is Citrus aurantium, whose essential oil is known as Neroli oil. Citrus aurantium originates from Eastern Africa and Syria [15] and is commonly known as bitter orange, belonging to the Rutaceae family [16]. Neroli oil is extracted from the blossoms of Citrus aurantium through steam distillation [16, 17]. Neroli oil contains compounds such as limonene, flavonoids, pectin, and linalyl acetate, which exhibit antioxidant, anti-inflammatory, anxiolytic, analgesic, and sedative properties [15, 18].

Several studies have demonstrated the analgesic and anxiolytic effects of Neroli oil, particularly in reducing pain and anxiety during labor [19, 20]. Linalool, one of the key components of Neroli oil, exerts sedative activity by interacting with GABA receptors in the central nervous system. Additionally, it has been shown to reduce abdominal constriction by inhibiting prostaglandin production in animal models [21]. According to previous studies, aromatherapy with Neroli oil can be considered a safe therapeutic method [17].

Objectives

Dysmenorrhea is highly prevalent, and pharmacological treatments are often associated with side effects. Therefore, identifying safe and effective alternative interventions is essential. This study aimed to evaluate the effect of inhalation aromatherapy with Neroli oil on dysmenorrhea pain intensity.

Methods

Study Design

This study was a two-group randomized clinical trial and was not blinded. Due to the distinctive odor of Neroli oil, blinding was not feasible. The study was conducted over six months, from January to June 2021.

Participants

Samples for the present study were drawn from students residing in the dormitories of Zanjan University of Medical Sciences who suffered from primary dysmenorrhea and met the eligibility criteria. Initially, two dormitories of the university were randomly selected, and participants who met the inclusion criteria were recruited through convenience sampling.

Eligibility Criteria

The inclusion criteria were: being single, age between 18 and 25 years, pain intensity greater than 5 on the VAS, Iranian nationality, onset of menstruation before the age of 18, a menstrual cycle with an interval of 21–35 days and duration of 3–7 days, absence of systemic, genital, or mental disease, absence of anosmia, and willingness to participate in the study. Exclusion criteria included: intolerable dysmenorrhea, heavy bleeding during the study, allergy to essential oils, onset of dysmenorrhea after the age of 20, and development of systemic or genital disease during the study [22].

Sampling Methods

Based on the study by Seyyed-Rasooli et al. [23] Considering a 95% confidence level, 80% statistical power, and accounting for a 10% dropout rate, the sample size was determined to be 35 participants in each group.

Initially, two dormitories of Zanjan University of Medical Sciences were randomly selected, and students who met the inclusion criteria were recruited through convenience sampling. A total of 70 eligible students with primary dysmenorrhea and a pain severity score of 5 or higher on the VAS for two consecutive cycles were included in the study. Randomization was performed using numbers 1–70 generated on www.graphpad.com.

Participants were randomly assigned to two groups: Group A (Neroli oil) and Group B (placebo, sweet almond oil). Each participant was coded sequentially (e.g., NO1, NO2, and so on) until the end of the allocation process.

Data Collection Tools

Data were collected using a demographic and menstrual questionnaire and the Visual Analogue Scale (VAS). The demographic and menstrual questionnaire was designed to obtain information on weight, height, age at menarche, age at onset of dysmenorrhea, body mass index (BMI), menstrual cycle interval, menstrual duration, education level, marital status, and socioeconomic status. The VAS is a linear scale in which symptoms are scored from 0 (no pain) to 10 (most severe pain). The validity and reliability of the VAS have been previously established [22].

Study Procedure

Written informed consent was obtained from all participants before the study. Each participant was monitored for four consecutive menstrual cycles. During the first two cycles (before the intervention), participants recorded their pain intensity using the VAS. Those who reported a score of 5 or higher on the VAS were included in the study [23]. Following randomization, the intervention phase began in the third menstrual cycle, coinciding with the onset of dysmenorrhea. Participants were randomly assigned to either the intervention or placebo group. In the two consecutive cycles after the intervention, aromatherapy with Neroli oil or placebo was applied during the first two days of menstruation, and pain intensity was assessed on the third day of each cycle using the VAS. Because of the distinctive odor of Neroli oil, blinding was not possible. However, to minimize bias, both the Neroli oil and placebo were provided in identical bottles labeled with codes A and B. Neroli oil with a final 2% concentration (2 cc Citrus aurantium oil diluted in 100 cc sweet almond oil) was used. The Neroli oil was purchased from NARIN GOL Company, and the sweet almond oil from BARIJ Essence Company. Participants were instructed on how to perform the intervention and complete the questionnaires. They were asked to apply 10 drops of Neroli oil or a placebo onto a piece of cotton, place it approximately 30 cm from the nose, and inhale the aroma for about 30 minutes once daily during the first two days of menstruation. On the third day, they were required to record their pain intensity using the VAS. Participants' phone numbers were collected to provide reminders regarding the intervention schedule and instructions. Individuals who forgot to perform the intervention or were unwilling to continue were excluded from the study. Ultimately, four participants from the Neroli group (three due to unwillingness and one due to forgetting the intervention) and four participants from the placebo group (two due to unwillingness and two due to forgetting the intervention) were excluded.

Data Analysis

Data were analyzed using SPSS software, version 26. Statistical significance was defined as a P-value of less than 0.05.

Independent t-tests were applied to evaluate demographic and menstrual characteristics, as well as to compare the mean severity of dysmenorrhea before and after the intervention. Repeated-measure ANOVA was used to evaluate the mean pain intensity before and after intervention.

Results

A total of 70 students with primary dysmenorrhea initially participated in the study. Eight participants were excluded due to unwillingness to continue or failure to use the oil as instructed. Finally, data from 62 participants (31 in each group) were included in the statistical analysis (Figure 1).

Table 1 presents the demographic and menstrual characteristics of the participants. The mean age (SD) was 22.16 (1.88) years in the intervention group and 22.45 (1.91) years in the control group. The mean age at onset of dysmenorrhea was 14.00 (1.48) years in the intervention group and 14.06 (1.20) years in the control group. The mean duration of dysmenorrhea was 1.83 (0.63) days in the intervention group and 1.96 (0.75) days in the control group. Independent t-test analysis showed no significant differences between the two groups regarding demographic or menstrual characteristics ($p > 0.05$ for all variables; Table 1).

As shown in Table 2, the mean intensity of dysmenorrhea in the first and second cycles before the intervention did not differ significantly between the intervention and control groups (p = 0.294 and p = 0.900, respectively). Before the intervention, mean pain intensity scores (SD) were 6.58 (0.95) and 6.19 (0.98) in the intervention group, and 6.29 (1.18) and 6.16 (1.03) in the control group. After the intervention, pain intensity decreased to 2.83 (0.68) and 2.32 (0.79) in the intervention group, and to 3.64 (1.14) and 3.35 (1.17) in the control group.

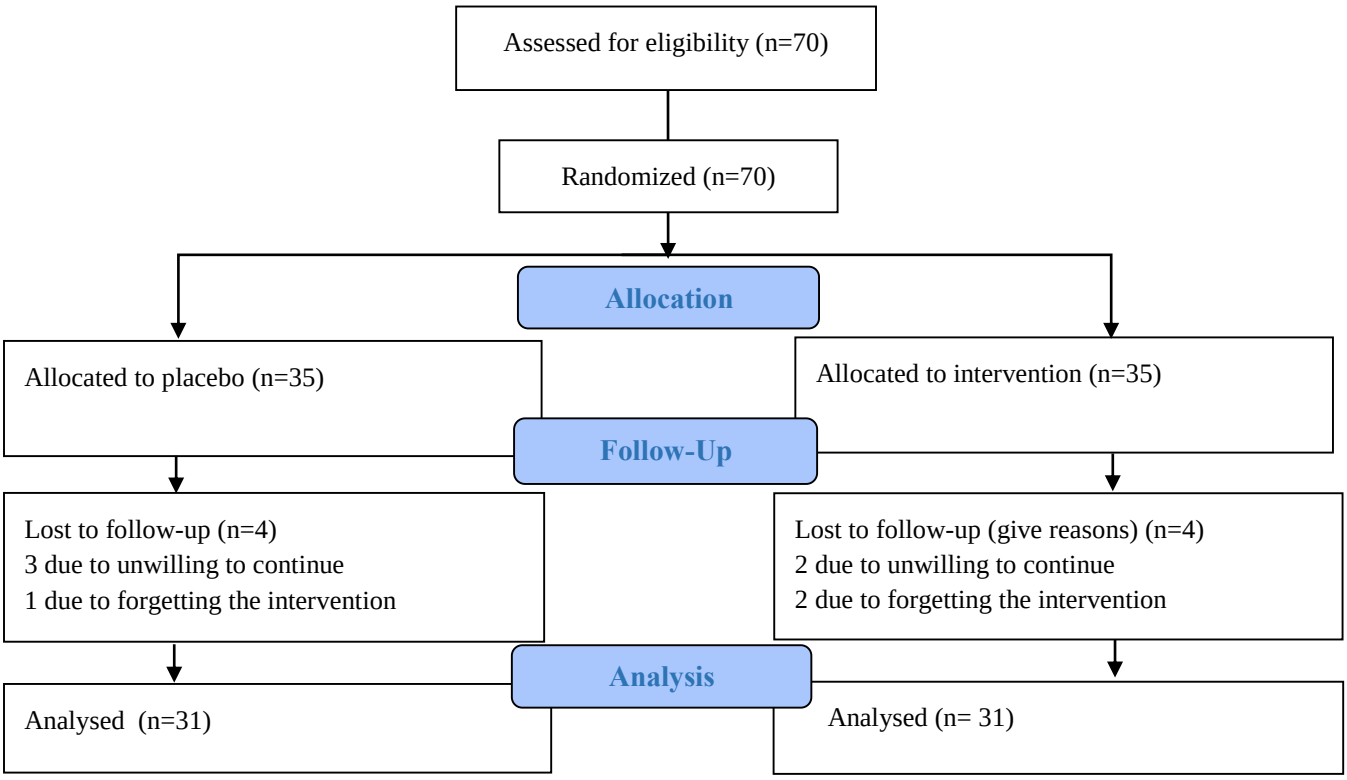

Figure 1. Flow Diagram of Study Selection and Data Collection Process

Table 1. Comparison of Demographic and Menstrual Characteristics Between the Intervention and Control Groups

Variable	Intervention Group (n = 31)		Control Group (n = 31)		
	M	SD	M	SD	*p**
Age (years)	22.16	1.88	22.45	1.91	0.549
BMI (kg/m²)	22.86	3.08	23.21	2.37	0.617
Menarche age (years)	13.00	1.48	13.06	0.92	0.838
Dysmenorrhea onset age (years)	14.00	1.48	14.06	1.20	0.852
Dysmenorrhea duration (days)	1.83	0.63	1.96	0.75	0.469
Menstruation duration (days)	6.00	1.03	5.64	0.98	0.171
Menstrual cycle length (days)	28.87	2.61	29.45	2.01	0.332

*Independent-samples t-tests.

Table 2. Comparison of Pain Severity Between the Intervention and Control Groups Before and After the Intervention

Cycle	Intervention Group (n = 31)		Control Group (n = 31)		t(60)	*P**
	M	SD	M	SD		
First cycle (before)	6.58	0.95	6.29	1.18	1.06	0.294
Second cycle (before)	6.19	0.98	6.16	1.03	0.13	0.900
Third cycle (after)	2.83	0.68	3.64	1.14	3.37	0.001
Fourth cycle (after)	2.32	0.79	3.35	1.17	4.07	< 0.001

*Independent-samples t-tests.

Although both Citrus aurantium (Neroli) oil and sweet almond oil aromatherapy reduced pain severity during the first and second cycles after intervention, independent t-test analysis revealed a statistically significant greater reduction in the intervention group compared to the control group ($p = 0.001$ for the first cycle; $p < 0.001$ for the second cycle). Repeated measures ANOVA showed a significant difference in mean pain intensity before and after intervention ($p < 0.001$), with pain decreasing after intervention compared to before intervention in both groups (Table 3).

These findings indicate that while both groups experienced some reduction in dysmenorrhea severity, inhalation aromatherapy with Citrus aurantium was more effective than the placebo (Table 2).

Table 3. Comparison of Pain Severity of Intervention and Control Groups Before and After the Intervention

Cycle	Intervention Group (n = 31)		Control Group (n = 31)	
	M	SD	M	SD
First cycle (before)	6.58	0.95	6.29	1.18
Second cycle (before)	6.19	0.98	6.16	1.03
Third cycle (after)	2.83	0.68	3.64	1.14
Fourth cycle (after)	2.32	0.79	3.35	1.17
Repeated measure ANOVA	*P*< 0.001		*P*< 0.001	
	Effect of time; *p*< 0.001			

Discussion

The present study was evaluated to determine the effect of inhalation aromatherapy with Neroli oil on the pain intensity of primary dysmenorrhea. Two groups were the same in demographic variables and pain intensity before the intervention. The results of the present study demonstrated that intensity of dysmenorrhea decreased in both groups, but the reduction was significantly greater in the Neroli oil group.

In other words, the results of our study showed that the Neroli oil had an analgesic effect on the pain of dysmenorrhea. These findings are consistent with previous research on the effectiveness of aromatherapy in alleviating dysmenorrhea. For instance, Nurak et al. reported that jasmine and lavender aromatherapy were effective in reducing menstrual pain [14]. Similarly, Hamranani et al. (2020) found that lavender aromatherapy with 3–5 drops inhaled for five minutes significantly reduced dysmenorrhea pain [24]. The findings of these studies showed that inhalation aromatherapy with essential oils can be effective in reducing the pain of dysmenorrhea due to its compounds. Linalyl acetate and linalool are the main ingredients in lavender and have pain-relieving activity. Inhalation aromatherapy can stimulate the hypothalamus to release endorphins and serotonin, thereby reducing the perception of pain [14, 25].

Evidence also supports the analgesic role of Citrus aurantium oil. Bargi et al. reported that aromatherapy with Citrus aurantium significantly reduced postoperative orthopedic pain [26]. Furthermore, Sharifpour et al. showed the positive effect of inhalation aromatherapy with citrus aurantium and salvia officinalis aroma in the reduction of post-cesarean section pain [27].

These effects may be related to the chemical constituents of Citrus aurantium essential oil. Linalool, one of the major components, has been shown to suppress TNF-α and IL-6 production, modulate GABA receptors in the central nervous system, and exert both sedative and analgesic effects [28, 29].

Aromatherapy by olfactory stimulation with the aroma of essential oils can help to improve physical and psychological health [30]. For example, Heydari et al. showed a significant effect of Neroli oil on improving the physiological symptoms of premenstrual syndrome [17].

But they haven’t evaluated its effect on the pain of dysmenorrhea. As a fact, only a few studies have been conducted on the effect of Neroli oil on the pain intensity of dysmenorrhea. For example, Aboualsoltani et al. found that oral administration of Citrus aurantium extract capsules reduced the severity of primary dysmenorrhea compared with placebo [31].

Neroli oil, due to its analgesic and anti-inflammatory activities, by inhibiting the PG synthesis, has a positive effect on the reduction of abdominal constriction [21]. limonene, another key compound in Neroli oil, can inhibit PG synthesis by regulating cyclooxygenase I and II activity, thereby alleviating uterine pain [19].

Many studies have been conducted on the effect of lavender oil on primary dysmenorrhea; however, few studies have been done on the effect of Neroli oil. Taken together, the results of the present study and previous findings indicate that Neroli oil aromatherapy can be considered an effective and safe complementary method for the management of primary dysmenorrhea. Additionally, a small reduction in pain in the control group may have been influenced by the natural course of dysmenorrhea over time. A key strength of this study was the evaluation of Neroli oil as a complementary method for reducing dysmenorrhea pain. The findings suggest that the chemical constituents of essential oils, such as linalool and limonene, may contribute to pain reduction. Several limitations should be considered. The first one was not blinding, and participants could identify which group they were in. The second one is that, because of the small sample size, it needs to be supported by a large sample size and a high-quality study. Third, participants were selected using convenience sampling rather than fully random sampling, which may limit generalizability. Fourth, self-administered inhalation could introduce treatment bias, as adherence to the intervention relied on participants following instructions. Future studies should consider using larger sample sizes, strict randomization procedures, and controlled intervention settings, such as supervised inhalation in a designated room, to further validate these findings.

Conclusion

Based on this study's findings, inhalation aromatherapy with Neroli oil effectively reduces pain intensity in primary dysmenorrhea. This non-invasive, low-cost, and safe intervention can be

considered a viable complementary method for managing dysmenorrhea.

Ethical Consideration

This study was a master's of midwifery whose protocol was approved by the Ethics Committee of the School of Rehabilitation and Nursing, Midwifery of Tehran University of Medical Sciences, with license number (IR.TUMS.FNM.REC.1399.201) and RCT code (IRCT20120414009463N62).

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Conflicting of Interest

No conflict of interest.

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Authors' Contribution

Haghani Sh: Formal analysis. Behboodi Z: Conceptualization, Methodology, Project administration, Writing – review & editing. Bayat Z: Conceptualization, Data curation, Investigation, Methodology, Project administration, Writing – original draft. All authors read and approved the final manuscript.

Artificial Intelligence Utilization for Article Writing

The authors did not use artificial intelligence in the writing of this manuscript.

Data Availability Statement

The data are available from the corresponding author.

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