The Effect of Bergamot Essential Oil Aromatherapy on Improving Depressive Mood and Sleep Quality in Postpartum Women: A Randomized Controlled Trial

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ABSTRACT

Background: The postpartum period is a physiologically and psychologically crucial transition phase for every woman who gives birth. Aromatherapy may improve mood and alleviate sleep challenges. However, few randomized controlled clinical trials have focused on the effect of aromatherapy in postpartum women.

Purpose: This study was designed to explore the effect of a bergamot essential oil aromatherapy intervention on depressive mood and sleep quality in postpartum women.

Methods: This randomized controlled trial used consecutive sampling. The participants were all women in a postpartum care center in eastern Taiwan and were randomly assigned to either the experimental (n = 29) or control (n = 31) group. Bergamot essential oil aroma was used in the experimental group, and pure water aroma was used in the control group. The experimental and control interventions were both performed while the participants were residents at the postpartum care center in the afternoon for 15 minutes each day. Before the aroma intervention, pretests were conducted using the Edinburgh Postnatal Depression Scale and the Postpartum Sleep Quality Scale. The first and second posttests were conducted using the same two scales at 2 and 4 weeks after the intervention, respectively.

Results: At both the first and second posttests, depressive mood was significantly lower (p < .001) in the experimental group than in the control group, supporting the positive effect of the bergamot essential oil aroma intervention on depressive mood in postpartum women. No significant intergroup difference in sleep quality (p > .05) was observed at either the first or second posttest, indicating an uncertain effect of the bergamot essential oil aroma intervention on sleep quality.

Conclusions/Implications for Practice: The results of this study support the effectiveness of bergamot essential oil aromatherapy in alleviating depressive mood in postpartum women. In addition, the results provide a practical reference for clinical postpartum nursing care.

Key Words: postpartum women, bergamot essential oil, depressive mood, sleep quality, aromatherapy.
mood and sleep challenges are diagnosed at a relatively early stage and managed appropriately, the overall quality of life of postpartum women may be improved.

Under the complementary health classification system used by the National Center for Complementary and Alternative Medicine (2018) in the United States, aromatherapy is defined as a natural product practice. Essential oils are extracted from different parts of various plants and are used in various settings based on their healing characteristics. In clinical settings, aromatherapy is often used in combination with massage therapy, during which aromas from essential oils are inhaled to improve physical and psychological symptoms (Tiran, 2000).

Bergamot, *Citrus bergamia*, is a citrus species from the family Rutaceae, cultivated in Italy and Morocco. Bergamot essential oil, extracted primarily from bergamot fruit skin, may have calming and relaxing effects and alleviate moodiness and insomnia in humans (Price, 1999). The major chemical components of bergamot essential oil are bergapten (5-methoxypsoralen), linalool, and linalyl acetate (Statti et al., 2004). According to a review of its biological properties, bergamot essential oil increases melatonin concentrations in plasma because the oil contains 5-methoxypsoralen. Melatonin regulates circadian rhythm and associated physiological functions and thus may be effective in alleviating depressive mood and improving sleep quality (Forlot & Pever, 2012). In addition, animal experiments have shown that melatonin induces sleep and regulates sleep rhythms (Gandhi et al., 2015). The biological properties of linalool, a monoterpenic alcohol, have antibacterial, analgesic, antianxiety, and antidepressive properties (Pereira et al., 2018). In animal experiments, linalool showed antidepressive properties (dos Santos et al., 2018). Linalyl acetate activates nitric oxide, facilitating vascular smooth muscle relaxation (Koto et al., 2006).

The aforementioned studies have elucidated the negative effects of postpartum depressive mood and poor sleep quality on women's lives, whereas the animal experiments have shown that the constituent components of bergamot essential oil offer the potential to alleviate depressive mood, regulate sleep, and facilitate relaxation. However, most studies on the effects of bergamot essential oil have been based on animal experiments, whereas few have investigated the effects of bergamot essential oil on postpartum women using clinical experiments, random assignment, and a control group. This study was designed to investigate the effects of bergamot essential oil on depressive mood and sleep quality in postpartum women. The results may provide a reference for improving postpartum care.

**Methods**

**Design and Participants**

A randomized controlled trial with consecutive sampling was adopted in the experimental design. Consecutive sampling is a nonprobabilistic sampling technique that is rigorous in recruiting people who meet the inclusion criteria from an accessible population (Polis & Beck, 2012). Therefore, every postpartum woman staying in a postpartum care center and satisfying the inclusion criteria had an equal chance of being recruited as a participant in this study. The participants were recruited from a postpartum care center in eastern Taiwan between September 23, 2015, and June 21, 2017. The researchers assigned the participants into two groups randomly by flipping a coin, with heads assigned to the experimental group and tails assigned to the control group.

The inclusion criteria for the participants were (a) married postpartum women aged > 20 years, (b) singleton birth free of postpartum complications, (c) being able to communicate effectively in Mandarin or Hokkien (Taiwanese), and (d) having a full-term and healthy infant and planning to reside in the postpartum care center for 4 weeks. The exclusion criteria were (a) being diagnosed with depression during the current pregnancy and undergoing related treatment, (b) regular use of hypnotics, (c) having a history of allergies to essential oil or a skin allergy, and (d) inability to read and write Chinese.

The sample size was estimated using G*Power (Version 3.1.9.4; UCLA, Los Angeles, CA, USA) and applied using the statistical test of between-subjects, repeated-measures analysis of variance. In the pilot study, the mean and standard deviation of the Edinburgh Postnatal Depression Scale (EPDS) scores in the experimental group (11 participants) and control group (nine participants) were 5.04 ± 3.0 and 8.61 ± 5.29, respectively. A two-tailed test was used. The effect size was .4, the alpha was set at .05, the correlation coefficient was .5, the power was set at .9 to limit the risk of a Type II error to 10%, and the total number of samples required for calculation was at least 46. Allowing for a 20% attrition rate, the minimum required number of participants in this study was 55. Sixty-five people met the inclusion criteria, with three declining to participate because of disinterest in the research topic. After random assignment, the experimental and control groups included 29 and 33 participants, respectively. Over the course of the study, two participants were discharged after living in the postpartum care center for 1 week and withdrew from the study. Thus, data from 60 participants (29 and 31 in the experimental and control groups, respectively) were collected and analyzed (Figure 1).

**Interventions**

The bergamot essential oil used in this study was made in Italy. Four drops of 100% bergamot essential oil were diluted in 15 ml of pure water, and the solution was used in an ultrasonic atomizer for aromatherapy in the experimental group (S. H. Liu et al., 2013). Aromatherapy for the control group was conducted using 15 ml of pure water. The aromatherapy was performed for 15 minutes by a designated researcher in the single, 26.4 × 33.3 m² room in which each postpartum woman regularly resided. The ultrasonic atomizer used in the intervention switched off automatically after
15 minutes. Two identical atomizers were separately used for the two groups to avoid cross-contamination. The intervention lasted 4 weeks for both groups, which is in line with the 1-month period recommended by Chinese tradition for postpartum recovery. The researcher who performed the intervention is an internationally certified aromatherapist who has taken courses and received training in aromatherapy. A different researcher conducted the outcome assessments.

**Data Collection**

Sociodemographic and obstetric information collected included participant’s age, educational level, employment status, and parity; whether the pregnancy was planned; delivery method; feeding type; and gender of the newborn. A questionnaire including the EPDS and Postpartum Sleep Quality Scale (PSQS) was answered by the participants at pretest (before the intervention) and at 2 and 4 weeks into the intervention by one of the authors, who was blinded to participant grouping assignment.

The EPDS was used to assess depressive mood status in the postpartum women. The EPDS is a 10-item self-administered questionnaire that typically takes around 5 minutes to complete. Each item is scored from 0 to 3 points, with the total possible score for the scale ranging between 0 and 30 points. The authors of the EPDS recommend using a cutoff score of > 9 to limit failed detection to < 10% and conducting a reassessment after 2 weeks (Cox et al., 1987). Assessments were performed using the Taiwanese version of the EPDS, which has an internal consistency of .87, a split-half reliability of .89, and a concurrent validity (using the Beck Depression Inventory) of .79, indicating an appropriate level of reliability and validity. A cutoff score of > 9 has been used to screen for postpartum depressive mood in Taiwanese women (Heh, 2001). In this study, the Cronbach’s alpha for the Taiwanese version of EPDS was .89.

Sleep quality was assessed in this study using the PSQS, which is a 14-item self-administered questionnaire that typically takes 5–10 minutes to complete. Each item is scored between 0 and 4 points, with a total possible score range for the scale of 0–56 points and higher scores indicating poorer sleep quality. The scale’s internal consistency is .81, and its test–retest reliability is .81. Furthermore, the scale has shown excellent construct validity and convergent validity (Yang et al.,
In this study, the Cronbach’s alpha for the PSQS was .76.

**Ethical Considerations**

Data collection was initiated after the research plan was approved by the institutional review board (No. 14-10-018). The research purpose was explained by the researchers to the postpartum women who satisfied the inclusion criteria. The women were invited to volunteer to participate. They were guaranteed that their quality of care at the postpartum care center would not be affected by their decision to participate or not and that they had the right to withdraw from the study at any time. Those who volunteered as participants signed an informed consent form and then received a preintervention skin test. This skin test consisted of a drop of bergamot essential oil being applied to the inner part of the forearm. Those whose skin did not exhibit redness, itch, or tingle were enrolled as participants.

**Data Analysis**

The data were processed and analyzed using IBM SPSS Statistics Version 22.0 (IBM Inc., Armonk, NY, USA). Sociodemographic and obstetric information in the two groups were summarized using descriptive statistics. In addition, an independent sample t test was used to examine the homogeneity of the data between the two groups. Scores for depressive mood and sleep quality were represented using the mean and standard deviation, and a generalized estimating equation was used to analyze depressive mood and sleep quality in the two groups. A first-order autoregressive correlation matrix was selected to control for the effect of time, and robust standard errors were used to calculate statistical significance (Liang & Zeger, 1986), which was indicated by a p < .05.

**Results**

Sixty postpartum women participated in this study, with 29 and 31 participants in the experimental and control groups, respectively. Mean age was 33 years, and most held a bachelor or junior college degree. In addition, most were employed, had planned pregnancies, and had given birth vaginally. Because no significant differences were identified in the sociodemographic and obstetric characteristics of the two groups, the two groups were considered homogenous (Table 1). The average number of days of the intervention was 23 and 25 in the experimental and control groups, respectively.

The mean scores for depressive mood and sleep quality at pretest, first posttest, and second posttest are presented in Table 2. As shown in Table 3, the regression coefficients of the two groups were nonsignificant (p > .05), which indicates no significant differences in depressive mood between the two groups at pretest. The interaction effect for the Experimental Group × T2 was significant (p < .001), indicating that the scores for depressive mood changed significantly in both groups between pretest and the first posttest. B was negative, with the experimental group scoring an average of 3.32 points less on the EPDS than the control group, showing that the intervention effect was stronger in the experimental group than in the control group. The results support the positive effect of 2 weeks of bergamot essential oil aromatherapy on depressive mood in postpartum women. The regression coefficient for the interaction effect in the Experimental Group × T3 was significant (p < .001), showing that depressive mood in both groups changed significantly between pretest and the second posttest. In addition, B was negative, with the experimental group scoring an average of 4.09 points less than the control group on the EPDS at the second posttest. Therefore, the effect of bergamot essential oil aromatherapy was found to be positive and significant in this study.

The regression analysis results, shown in Table 3, indicate that sleep quality was not significantly different between the two groups (p > .05). In other words, the sleep quality in the two groups did not vary significantly either before or after the intervention. The regression coefficients of the two interaction effects, namely, Experimental Group × T2 and Experimental Group × T3, were nonsignificant (p > .05). This result suggests that bergamot essential oil aroma has no effect on sleep quality in postpartum women.

**Discussion**

In this study, a 15-minute aromatherapy intervention with bergamot essential oil performed daily in the afternoon was shown to ameliorate depressive mood in postpartum women. The sleep quality scores were insignificantly lower in both posttest scores compared with the pretest scores. Regarding the effect of aromatherapy on depressive mood, Xiong et al. (2018) observed that essential oil massage and essential oil aroma may alleviate depressive mood in older adults in the community. Although their findings are consistent with the results of this study, the research populations used were significantly different. In addition, their study used a compound essential oil containing highland lavender and sweet orange, which makes it challenging to analyze the unique characteristics of a specific essential oil. Kianpour et al. (2016) proposed that three drops of highland lavender essential oil placed in the palm thrice a day for 4 weeks may reduce depressive mood levels in postpartum women. Similarly, Kianpour et al. (2018) recommended a 6-week routine of placing seven drops of highland lavender essential oil on a piece of cloth, inhaling it 10 times before sleeping, and placing the cloth near one's pillow. Thus, the aforementioned procedures may also be effective in improving postpartum depressive mood. Kianpour et al. (2016, 2018) used highland lavender essential oil, the main ingredient of which is linalool, which is similar to bergamot essential oil. Thus, highland lavender essential oil has also been shown to have antidepressive properties (Pereira et al., 2018). Although the three aforementioned studies used different essential oil types, doses, and methods of application, they still
present practical applications and expand the scope of potential aromatherapy applications. The results of these previous studies and this study raise the question as to which essential oil has superior effects in postpartum depressive mood management. This question may be investigated in future research.

The effect of bergamot essential oil on postpartum depressive mood has not been investigated in the literature. In studies on bergamot essential oil by K. M. Chang and Shen (2011) and S. H. Liu et al. (2013), bergamot essential oil was found to alleviate anxiety and work pressure in elementary school teachers. However, the two studies were based on target populations, variables, and essential oil quantities that differed significantly from this study. In addition, only single interventions were performed in these studies, and no control groups were used for comparison. Nevertheless, the results may provide a reference on the psychological and mood regulation effects of bergamot essential oil aromatherapy.

To test the effect of aromatherapy on sleep quality, Afshar et al. (2015) placed four drops of highland lavender essential

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### Table 1
Comparison of Participant Characteristics (N = 60)

| Characteristic                  | Experimental Group (n = 29) | Control Group (n = 31) | t/χ² | p    |
|--------------------------------|-----------------------------|------------------------|------|------|
| **n (%)**                      |                             |                        |      |      |
| Age (years; M and SD)          | 33.45 (4.36)                | 33.42 (4.21)           | 0.03 | .98  |
| Educational level              |                             |                        |      |      |
| High school                    | 2 (6.9)                     | 4 (12.9)               |      |      |
| College or university          | 23 (79.3)                   | 21 (67.7)              |      |      |
| Graduate and above             | 4 (13.8)                    | 6 (19.4)               |      |      |
| Employment status              |                             |                        |      |      |
| Employed                       | 24 (82.8)                   | 21 (67.7)              |      |      |
| Not employed                   | 5 (17.2)                    | 10 (32.3)              |      |      |
| Parity                         |                             |                        |      |      |
| Primiparous                    | 16 (55.2)                   | 14 (45.2)              | 0.60 | .44  |
| Multiparous                    | 13 (44.8)                   | 17 (54.8)              |      |      |
| Pregnancy expected             |                             |                        |      |      |
| Yes                            | 21 (72.4)                   | 24 (77.4)              | 0.20 | .66  |
| No                             | 8 (27.6)                    | 7 (22.6)               |      |      |
| Delivery type                  |                             |                        |      |      |
| Vaginal delivery               | 23 (79.3)                   | 29 (93.5)              |      |      |
| Cesarean section               | 6 (20.7)                    | 2 (6.5)                |      |      |
| Infant gender                  |                             |                        |      |      |
| Male                           | 19 (65.5)                   | 14 (45.2)              | 2.51 | .11  |
| Female                         | 10 (34.5)                   | 17 (54.8)              |      |      |
| Infant feeding                 |                             |                        |      |      |
| Breastfeeding                  | 10 (34.5)                   | 13 (41.9)              | 0.35 | .55  |
| Mix                            | 19 (65.5)                   | 18 (58.1)              |      |      |
| Night breastfeeding            |                             |                        |      |      |
| Yes                            | 9 (31.0)                    | 7 (22.6)               | 0.55 | .46  |
| No                             | 20 (69.0)                   | 24 (77.4)              |      |      |
| Postpartum exercise            |                             |                        |      |      |
| Yes                            | 14 (48.3)                   | 15 (48.4)              | 0.00 | .99  |
| No                             | 15 (51.7)                   | 16 (51.6)              |      |      |

*a* Fisher’s exact test.

### Table 2
Mean Scores for Depressive Mood and Sleep Quality in the Experimental and Control Groups

| Variable                  | Pretest | Posttest 1 | Posttest 2 |
|---------------------------|---------|------------|------------|
|                           | M       | SD         | M          | SD       | M          | SD       |
| Depressive mood           |         |            |            |          |            |          |
| Experimental group        | 8.97    | 4.70       | 5.52       | 3.28     | 4.03       | 2.31     |
| Control group             | 8.06    | 4.64       | 7.94       | 4.54     | 7.23       | 4.14     |
| Sleep quality             |         |            |            |          |            |          |
| Experimental group        | 21.69   | 8.34       | 15.59      | 7.73     | 12.59      | 6.28     |
| Control group             | 24.23   | 8.09       | 17.74      | 6.90     | 17.65      | 6.75     |
oil on a cotton ball and then asked participants to inhale the aroma deeply from the cotton ball 10 times before sleeping and to place the cotton ball near their pillow. The procedures were performed 4 times for 8 weeks, with an improvement observed subsequently in the sleep quality of postpartum women. Dyer et al. (2016) observed that using aromasticks for 3 weeks improved the sleep quality of patients with cancer. However, Dyer et al. used compound essential oil containing bergamot, sandalwood, and lavender essential oils. Consequently, the effects of single essential oils on sleep quality could not be determined. The effect of bergamot essential oil only on postpartum sleep quality was investigated in this study. Although Forlot and Pevet (2012) proposed that bergamot essential oil increases melatonin concentrations in plasma, potentially improving sleep quality, a significant effect of bergamot essential oil on postpartum sleep quality was not observed in this study. This may be because the aromatherapy intervention in this study was administered in the afternoon. Future studies may apply the aromatherapy before participants sleep at night, which may show an enhanced positive effect on sleep quality.

Limitations
This study was affected by several limitations. First, Taiwanese women adhere to the custom of postpartum confinement for 1 month after childbirth to promote bodily repair and recovery. Therefore, collecting blood samples to examine physiological parameters was challenging. Second, the aromatic molecules of the essential oils are odorous. Thus, participants may have been able to discern their group assignment, which would negatively impact on study blindness. Third, postpartum women experience physical, hormonal, psychological, and other multifaceted changes after childbirth, which may limit the generalizability of the findings to other populations. Four, depressive mood was assessed using scores on a short questionnaire, which may vary easily and do not reflect a clinical diagnosis. Furthermore, regardless of the presence or absence of aromatherapy, during the natural course of postpartum recovery, depressive mood may improve because of other factors such as hormonal changes, wound pain relief, socioeconomic status, and self-adjustment. Aromatherapy has been little examined in the literature, and stringent experimental designs are required to unravel the effects of essential oil on the human body and to provide empirical evidence for these effects.

Conclusions
The findings of this study suggest that bergamot essential oil aromatherapy alleviates depressive mood in postpartum women. Aromatherapy is an adjuvant therapy that is based on the concept of preventative medicine. Bergamot essential oil aroma may enhance psychological health in postpartum women. Careful assessment of the care needs of women is required in postpartum care institutions and clinical practice, and awareness and acceptance of aromatherapy among women should be investigated further. In addition, high-quality, pure essential oils should be used under the instruction of therapists with relevant aromatherapy training to ensure accurate evaluation and safe use of essential oils to improve psychological well-being and facilitate depressive mood management in postpartum women.

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Study conception and design: MLC, HFL
Data collection: HFL
Data analysis and interpretation: MLC
Drafting of the article: YEC, MLC
Critical revision of the article: YEC, MLC

Table 3
Generalized Estimating Equation Analysis of Group Differences in Depressive Mood and Sleep Quality

| Parameter                      | Depressive Mood | Sleep Quality |
|-------------------------------|-----------------|---------------|
|                               | B   | SE  | p    | B   | SE  | p    |
| Intercept                     | 8.06 | 0.82 | < .001 | 24.23 | 1.43 | < .001 |
| Experimental group (T1) vs. Control group (T1) | 0.90 | 1.19 | .448 | −2.54 | 2.09 | .224 |
| T2                            | −0.13 | 0.58 | .824 | −6.48 | 1.24 | < .001 |
| T3                            | −0.84 | 0.56 | .133 | −6.58 | 1.43 | .001 |
| Experimental group × T2       | −3.32 | 0.74 | < .001 | 0.38 | 2.07 | .854 |
| Experimental group × T3       | −4.09 | 0.82 | < .001 | −2.52 | 2.22 | .255 |

Note. T1 = pretest; T2 = posttest 1; T3 = posttest 2.
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