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Comparing the Effectiveness of Jacobson's Progressive Muscle Relaxation and Foot Reflexology on Adequacy of Breastfeeding and Milk Volume of Mothers with Preterm Infants

Tahereh Sadeghi [1], Elham Khanmohamdi [2], Ali Khorsand Vakilzadeh [3], Raheleh Faramarzi Garmroudi [4], Faezeh Zakerinasab [5], Zhila Sheikhi [6], * Parisa Shojaei [7]

[1] Nursing and Midwifery Care Research Center, Mashhad University of Medical Sciences, Mashhad¸ Iran.
[2] School of Nursing and Midwifery, Mashhad University of Medical Sciences, Mashhad, Iran.
[3] Department of Complementary and Chinese Medicine, School of Persian and Complementary Medicine, Imam Reza Hospital, Mashhad University of Medical Sciences, Mashhad¸ Iran.
[4] Department of Pediatrics, School of Medicine, Ghaem Hospital, Mashhad University of Medical Sciences¸ Mashhad¸ Iran.
[5] Social Determinants of Health Research Center, Mashhad University of Medical Sciences, Mashhad, Iran.
[6] Department of Urology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran.
[7] Faculty of Medicine, TMS.C., Islamic Azad University, Tehran, Iran.

Abstract

Background: Mother's milk is the ideal nutrition for preterm infants. However, due to the underdevelopment of swallowing reflexes and sucking in preterm infants, milk intake often decreases.

Methods: In this clinical trial, 70 mothers of preterm infants (30–34 weeks of gestation) at Ghaem Hospital, Mashhad, were randomly assigned to either Jacobson's progressive muscle relaxation (n=35) or foot reflexology intervention (n=35). Milk volume was quantitatively measured on days 1, 3, and 9, at one and two hours after each intervention session, using an electric breast pump and a graduated cup. Breastfeeding adequacy was assessed using a validated 14-item Persian questionnaire administered before the intervention and 21 days afterward during infant follow-up visits. The questionnaire's content validity was confirmed by experts, and its reliability was demonstrated through test-retest (r=0.81) and Cronbach's alpha (0.89). Group differences over time were evaluated using independent samples t-tests along with repeated measures analysis of variance (ANOVA).

Results: The mean maternal age was 26.5 ± 0.99 years in the Jacobson's relaxation group and 27.1 ± 0.94 years in the reflexology group ($P = 0.488$). No significant differences were observed between the groups regarding the type of delivery or neonatal gender ($P > 0.05$). Breastfeeding adequacy improved significantly within both groups after the intervention ($P < 0.001$), although the difference between groups was not statistically significant ($P = 0.306$). Milk volume increased significantly after the intervention on the first, third, and ninth days ($P < 0.001$).

Conclusion: Both Jacobson's progressive muscle relaxation and foot reflexology were equally effective in increasing milk volume. These relaxation and foot reflexology as non-pharmacologic methods enhanced breastfeeding adequacy and milk production in mothers of preterm infants.

Key Words: Breastfeeding adequacy, Foot reflexology, Jacobson's progressive muscle relaxation, Milk volume, Preterm infants.

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****Corresponding Author:***

Parisa shojaei; Faculty of Medicine, TMS.C., Islamic Azad University, Tehran, Iran. Email : p.shojaei123@iau.ac.ir; shojaee7@gmail.com

1- INTRODUCTION

Pain perception development in Breastfeeding is a multifaceted process that involves not only breast physiology and the endocrine system but also genetic, psychological, emotional, and environmental factors (1). Exclusive breastfeeding during the first six months of life adequately meets the nutritional needs of infants, contributes to immune system maturation, reduces the incidence and severity of infections, and supports cognitive and social development (2). Breast milk is a critical factor influencing the survival of premature infants. Breastfeeding offers numerous short-term and long-term health benefits for both infants and mothers (3). A substantial body of evidence has demonstrated the benefits of human milk, which is widely recognized as the optimal source of nutrition for both term and preterm infants. Preterm infants, in particular, derive greater benefits from breast milk, as it enhances host defense mechanisms and positively influences their growth and developmental outcomes (4). Research has shown that preterm birth can cause symptoms of post-traumatic stress disorder that persist for years (5). Evidence indicates that even five to six years after the birth of a preterm infant, many mothers continue to hold negative perceptions of their pregnancy and postpartum experiences. Mothers of premature infants often face numerous challenges and abrupt changes while adapting to their new role. The transition to motherhood typically begins during pregnancy and continues to evolve after delivery; however, when birth occurs prematurely, this process may be disrupted, affecting the development of emotional bonding with the infant. Prolonged hospitalization of the newborn has also been reported to negatively affect maternal bonding. In addition, the neonatal intensive care environment—with its monitoring devices, tubes, and wires attached to the infant, along with constant noise and medical procedures—can be a significant source of stress for mothers. Separation from the newborn represents another major stressor. Mothers whose infants are admitted to the neonatal unit due to prematurity or other medical conditions often face multiple psychological, emotional, and physiological barriers that may hinder the initiation and continuation of breastfeeding. Consequently, mothers of preterm infants hospitalized in a neonatal unit tend to experience lower rates of successful breastfeeding (6, 7). When mothers feel unable to adequately meet their infants basic needs, they may experience feelings of inadequacy and incompetence, leading to frustration and self-doubt. Furthermore, the birth of a vulnerable infant and the subsequent need for admission to a neonatal intensive care unit represent highly stressful experiences for mothers (8, 9). Vulnerable newborns are frequently hospitalized in neonatal intensive care units for periods ranging from several weeks to a few months due to complications associated with prematurity. Such prolonged hospitalization may lead to adverse psychological outcomes for mothers, including increased levels of stress, anxiety, and depression (10). One noninvasive approach to reducing maternal stress is the use of body comfort techniques. Progressive muscle relaxation is a method designed to induce a state of deep muscular relaxation. In this technique, muscle groups are systematically contracted for approximately 5 to 7 seconds and then gradually released and relaxed for about 10 to 12 seconds (11). Reflexology is considered a simple, accessible, and noninvasive technique that does not require specialized equipment and has gained considerable acceptance among mothers in maternal care settings. Despite the rapid development and diversity of healthcare technologies, the use of

available nonpharmacological approaches for managing symptoms such as stress and anxiety in nursing care remains limited, highlighting the growing need for complementary therapies. Both reflexology and relaxation techniques are recognized as scientific, cost-effective, and nonpharmacological interventions. However, no previous studies have specifically examined mothers' preferences for these two methods among breastfeeding mothers of preterm infants. Therefore, the present study was designed to compare the effects of these two interventions. The primary objective of this research was to conduct a comparative analysis of Jacobson's progressive muscle relaxation and foot reflexology interventions regarding their effectiveness on breastfeeding adequacy and the volume of breast milk produced by mothers of premature infants.

2- MATERIALS AND METHODS

The present study, conducted in 2021, is a clinical trial (IRCTID: IRCT20191207045635N1). The participants were mothers of preterm infants born between 30 and 34 weeks of gestational age. These mothers were recruited from Ghaem Hospital, an educational, research, and treatment facility located in Mashhad, Iran. The sample size was determined using G*Power software with parameters set for comparing means. A confidence level of 95% and a statistical power of 80% were applied, with an anticipated attrition rate of up to 20% factored into the calculation. The sample consisted of 80 mothers who met the inclusion criteria and expressed willingness to participate. Each group initially comprised 38 mothers; however, statistical analysis was ultimately performed on 70 mothers, with 35 in each group. Following the methodology outlined in the CONSORT 2010 Flow Diagram (Figure 1), participants were randomly recruited during two separate two-month sampling periods. The sequence of group enrollment was determined by a coin toss, resulting in the foot reflexology group being recruited first, followed by the Jacobson's progressive muscle relaxation group.

2-1. Inclusion and Exclusion Criteria

Mothers eligible for this study were required to meet the following inclusion criteria:

- Age ranging from 20 to 39 years.
- Literacy, including the ability to comprehend both written and verbal instructions.
- Expressed verbal anxiety.
- A stated intention to breastfeed.
- No history of significant or chronic medical conditions, including cardiovascular diseases or mental health disorders (such as postpartum depression or schizophrenia), as self-reported by the mother.
- No addiction to smoking or illicit drugs, particularly cocaine and its derivatives.
- Avoidance of medications contraindicated during breastfeeding, such as doxepin, tricyclic antidepressants, iodine compounds, gold salts, salicylates, and anticonvulsants throughout the intervention period.
- No prior history of breast surgery, no injuries or wounds at potential reflexology sites, and no existing breast conditions (e.g., fissures, engorgement, mastitis, or abscesses).
- Non-consumption of lactation-enhancing medications, such as metoclopramide.

Inclusion Criteria (Neonate): Eligible infants were those born between 30 and 34 weeks of gestation, were singleton births, and had no congenital anomalies such as

cleft lip or cleft palate. Infants with cardiac abnormalities, cerebral palsy, or any condition that could interfere with breastfeeding were excluded. Only infants admitted to the neonatal intensive care unit (NICU) who did not require ventilator support were included.

Exclusion Criteria: Infants were withdrawn from the study if the mother no longer wished to participate, developed a medical condition during the study period, or began taking medications known to increase milk production, such as metoclopramide. Additional exclusion criteria included the need for neonatal intubation, abnormal vital signs, bleeding, grade IV intraventricular hemorrhage, or prolonged NPO status during the study period.

2-2. Procedure

Thirty-eight mothers were considered for each group, totaling 76. One of the groups was randomly selected, and sampling began. After the sampling of the first group, a week of rest preceded the sampling of the second group. Sampling was conducted across two groups over nine days. Breast milk volume was measured on specific days: the first, third, and ninth days of the intervention. Measurements were taken once daily, one hour post-breastfeeding and two hours post-intervention, utilizing a Philips electric milking machine equipped with a graduated scale. These measurements were performed by the researcher for both groups. For the measurement, the mother sat comfortably, and the brown breast halo was completely placed in the electric milking chamber. The milking machine was turned on at low speed. It should be noted that in the first stage, milk does not come out, but after repeating several times, milk starts to come out drop by drop. After 5 minutes, the milk supply increased. Milking was not painful.

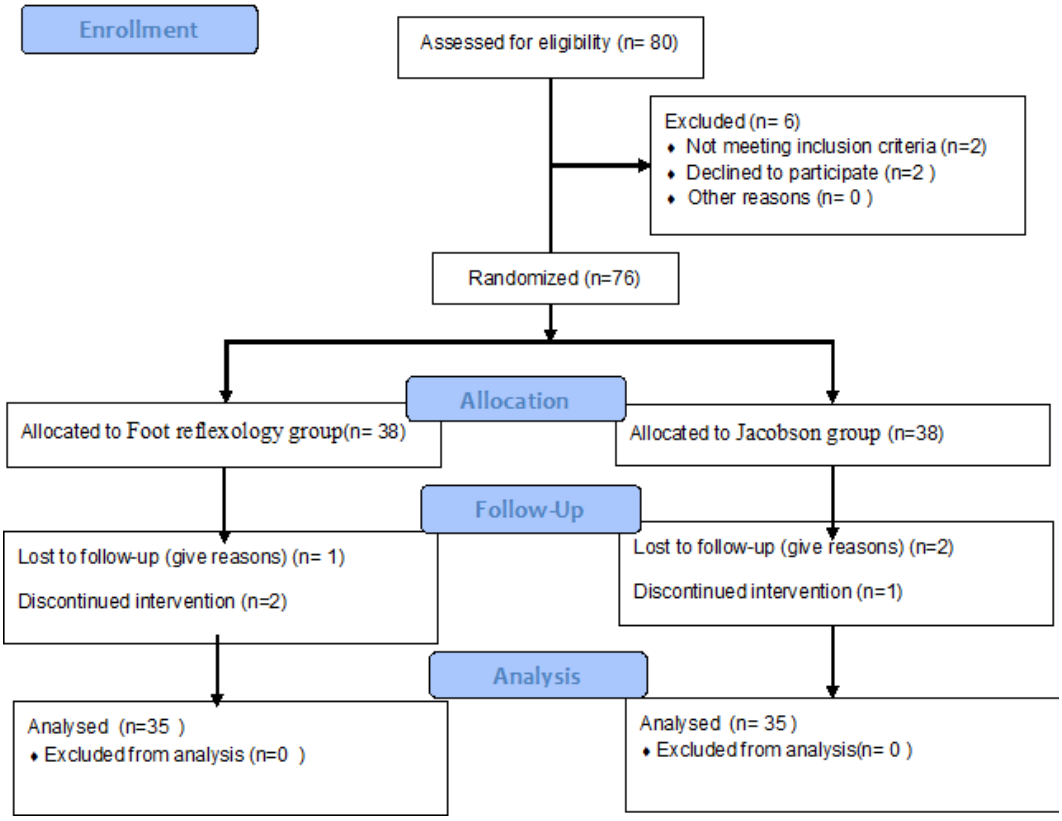

Figure-1: Consort flow chart of the study.

Pressure on the breast was avoided to simulate conditions similar to breastfeeding for the mother. The first breast was milked for 5-7 minutes and then until the milk flow slowed down. Then the other breast was milked for the same amount of time. The first breast was milked for 3-5 minutes, and then the second breast for the same amount of time. The first breast and the second breast were milked again for 2-3 minutes until the milk flow was slow. Breastfeeding adequacy was assessed in both groups of mothers using a questionnaire. This assessment was conducted on the first day of the study and again twenty-one days later, coinciding with the mothers' scheduled visits for infant examinations. The adequacy of lactation and milk volume in the two groups was compared by an independent t-test and analysis of variance with repeated measures.

2-3. Data Collection Tools

The research instruments utilized included the Breastfeeding Adequacy Standard Questionnaire, a demographic information form, and a chart for recording milk volume. The Breastfeeding Adequacy Questionnaire includes 14 questions. Thus, mothers of both groups took the questionnaire once before the intervention and once twenty-one days later when visiting the office for examination. This study utilized a Persian translation of the Breastfeeding Adequacy Questionnaire, which has a documented history of use in previous research. The validity of each tool was established using the content validity method. Reliability was assessed via the test-retest method, involving a pilot study where 12 mothers completed the questionnaire on two separate occasions, 14 days apart. The correlation coefficient between these test-retest results confirmed the reliability of the questionnaires (r = 0.81). Also, Cronbach's alpha coefficient method was used, which was estimated to be 0.89. The volume of breast milk on the third and ninth days was measured by electric milking two hours before and one hour after the intervention using a graduated scale. In this study, the validity of the instrument was confirmed using the opinion of pediatricians and faculty members of Mashhad University of Medical Sciences, which included a group of 7 mothers.

2-4. Intervention

Foot Reflexology Group (n=35): Foot reflexology was administered by a certified reflexologist over nine days, with each session lasting 35 to 45 minutes. These sessions took place in the mothers' rest area within the neonatal ward of Ghaem Hospital. Additionally, mothers were instructed on self-massage techniques. The reflexology intervention for the study group encompassed preparatory and warm-up phases, followed by specific stimulation and massage techniques. In this way, first, to warm the foot and prepare the whole sole and back of the foot, it was massaged for one minute. Then the reflex areas of the breast and the solar plexus were each pressed and rubbed for one minute (5 minutes for each foot and a total of ten minutes) (the pressure was so severe that it felt numb in the position). Mothers were taught how to do reflexology by a researcher.

Jacobson's Progressive Muscle Relaxation Group: The technique was first taught to the mother by the researcher using a practical demonstration, and the mother was asked to sit or lie down in a quiet room with soft light as much as possible to perform this procedure. Subsequently, the researcher demonstrated the 16-step body expansion and contraction technique according to Jacobson's method to the mothers. This practical training lasted for 35 to 45 minutes per session. The program involved systematically inducing muscle contraction for 5 seconds, followed by a 10-second period of muscle relaxation. The sequence commenced with the

muscles of the head, face, and neck, progressing systematically to encompass the torso and lower limbs, including contractions of the back, shoulder (serine), thigh, leg, and toe muscles.

2-5. Data Analysis Method

Statistical analysis was performed using SPSS version 25. Baseline homogeneity between the two groups regarding demographic and contextual characteristics was assessed using the Chi-square test for categorical variables. For continuous variables, the independent samples t-test was applied when the data followed a normal distribution, whereas the Mann–Whitney U test was used for variables that were not normally distributed. Intergroup comparisons were conducted using the independent t test or, when the assumption of normality was not satisfied, the Mann–Whitney U test. Because breast milk volume was measured repeatedly over time, repeated measures analysis of variance (ANOVA) was employed to evaluate changes across measurements. All statistical tests were performed using a 95% confidence level.

3-RESULT

The mean age of the mothers in the Jacobs relaxation group, it was 26.5 ± 0.993 and in reflexology group was 27.1±0.943 years. An independent t-test did not show a significant difference (P = 0.488), and the two groups were homogeneous in this respect. In Jacobson's relaxation group, 54% of the mothers underwent cesarean section, and in the reflexology group, 51% did. The Chi-square test did not show a significant difference in the frequency of type of delivery between the two groups (P = 0.811), and the two groups were homogeneous in terms of type of delivery.

Table-1. Distribution of demographic characteristics of children in two groups.

		Jacobson's relaxation group	Reflexology group	Statistical test result
Mother's age (years)		28.63±6.93	27.07±7.13	P= 0.39*
Age of spouse (years)		31.41±7.56	32.16±7.34	P= 0.65*
Intrauterine age at delivery(week)		32.32± 2.11	32.55±2.89	P=0.86*
Child Gender	**Male**	19 (54.0%)	22 (63.0%)	P=0.465**
	Female	16 (46.0%)	13(37.0%)	
Type of delivery	**cesarean**	20 (57.14%)	22 (62.850%)	P=0.498**
	natural	15 (42.85%)	13 (37.15%)	
Mother occupation	**Employee**	30 (85.7%)	29 (82.85%)	P=0.67**
	Housewife	5 (14.3%)	6 (11.15%)	
Mother education	**Elementary**	10 (29.0%)	11 (31.0%)	P=0.91**
	Diploma	18 (51.0%)	18 (51.0%)	
	Undergraduate	7 (20.0%)	6 (18.0%)	
Father education	**Illiterate**	3 (40.0%)	8 (23.0%)	P=0.23**
	High school	12(54.28%)	11 (71.0%)	
	Diploma	15 (2.85%)	10 (6.0%)	
	Undergraduate	5(40.0%)	6 (23.0%)	
Residency	**Village**	9 (25.72%)	12 (34.28%)	P=0.15**
	City	26 (74.28%)	23 (65.72%)	
Family income status	**Much less than needed**	12 (34.28%)	13 (37.14%)	P=0.58**
	Somewhat less than needed	12 (34.28%)	10 (28.57%)	
	As much as necessary	9 (25.72%)	10(28.57%)	
	Much more than needed	2(5.72%)	2(5.72%)	

* Independent t-test ; ** Chi-square test

In Jacobson's relaxation group 54% and in reflexology group 63% of the neonates were girls. Chi-square test did not show the frequency of gender in the two groups (P = 0.811) and the two groups were homogeneous in terms of type of delivery.

According to Table 1, the reflexology group had a slight increase, but an independent t-test did not show a significant difference (P = 0.306). In the intragroup comparison, both groups had significant differences before and after the intervention (P=0.00).

According to Table 2, milk volume was significantly different one hour before the intervention and two hours after the intervention on the first, third, and ninth days (P=0.00).

Finally, the means of the first, third, and ninth days were compared using a repeated measures test, which showed that the milk volume during three measurements did not differ significantly (Table 3). Jacobson's relaxation and reflexology techniques had the same effect on milk volume (Figure 2).

Table-2. Comparison of the results of breastfeeding adequacy and volume of infants before and after intervention.

	Group		**P-value**
	Jacobson's relaxation group	**Reflexology group**	
	Mean± Standard deviation	**Mean± Standard deviation**	
Adequacy of breastfeeding before intervention	54.88±721	53.15±6.36	0.272*
Adequacy of breastfeeding after intervention	59.45±6.66	58.87±9.37	0.306*
Difference between breastfeeding adequacy before and after the intervention	4.57±5.53	5.72±7.9	0.47*
P-value	P= 0.00**	P= 0.00**	

* Independent t-test; ** paired t-test

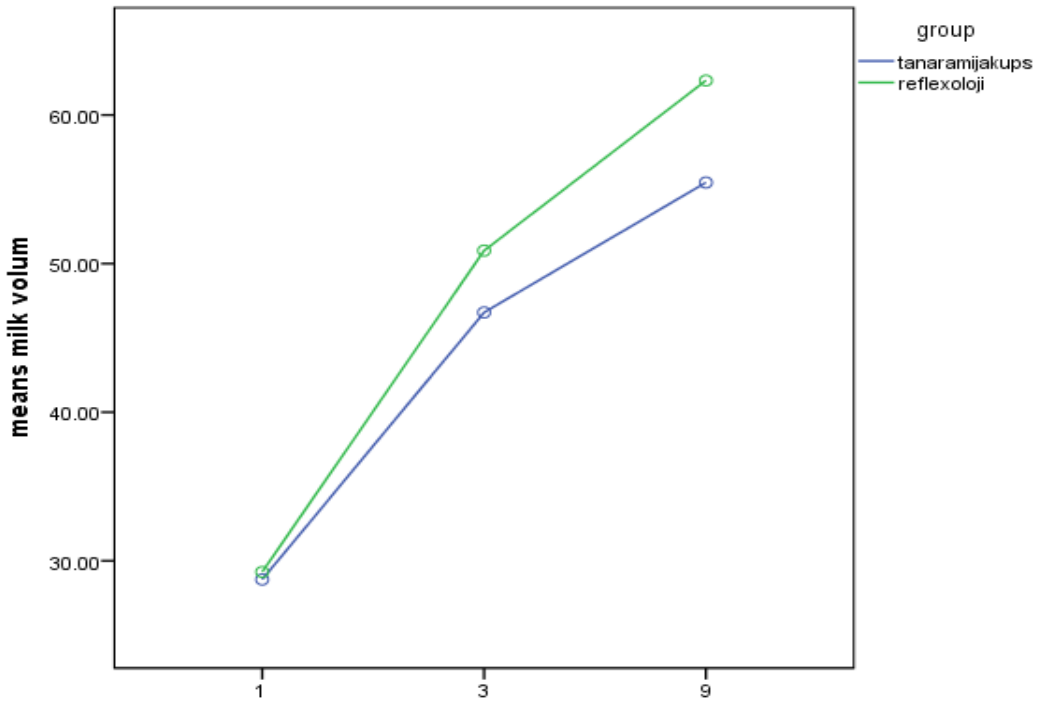

Figure-2: Evaluate milk volume during the first, third and ninth days.

Table-3. A comparison of milk volume was conducted on the first, third, and ninth days, both before and after the intervention.

	Group		P-value
	Jacobson's relaxation group	Reflexology group	
	Mean± Standard deviation	Mean± Standard deviation	
On the first day, milk volume was measured one hour prior to the intervention	28.74±12.10	29.25±10.59	0.382*
On the first day, milk volume was measured two hours following the intervention	30.02±12.33	30.47±10.57	0.866*
The difference in milk volume on the first day	1.28±1.74	1.22±2.46	0.904*
P-value	P= 0.00**	P= 0.00**	
On the third day, milk volume was measured one hour prior to the intervention	39.00±23.78	42.82±28.05	0.525*
On the third day, milk volume was measured two hours following the intervention	46.71±23.82	50.87±26.93	0.484*
Third day milk volume difference	7.71±6.1	8.05±5.26	0.799*
P-value	P= 0.00**	P= 0.00**	
On the ninth day, milk volume was measured one hour prior to the intervention	44.94±18.76	47.77±19.05	0.52*
On the ninth day, milk volume was measured two hours following the intervention	55.45±24.35	62.32±25.28	0.23*
Ninth day milk volume difference	10.51±10.68	14.55±10.47	0.10*
P-value	P= 0.00**	P= 0.00**	
f=187.89, time P ≤ 0.001 f=0.783, group P=0.379***			

* Independent t-test; ** Paired t-test; *** Repeated Measures ANOVA

4- DISCUSSION

This study aimed to compare the effectiveness of Jacobson's progressive muscle relaxation and foot reflexology on breastfeeding adequacy and milk volume among mothers of preterm infants. The results revealed a significant improvement in breastfeeding adequacy in both intervention groups following the procedures. Furthermore, a significant increase in milk volume was observed on the first, third, and ninth days post-intervention. Importantly, no statistically significant difference was found between the two groups, suggesting that both Jacobson's relaxation technique and foot reflexology exert similar positive effects on breastfeeding adequacy and milk volume in this population. In general, based on the tests performed, the two techniques of Jacobson's relaxation and reflexology had an increasing and equal effect on milk volume. Among the techniques for reducing maternal stress that lead to adequate breastfeeding and increasing the volume of breast milk, we can mention the two techniques of Jacobson's relaxation and reflexology. Jacobson's relaxation technique involves active muscle contraction and then relaxation of the same part. In this method, the goal is the interaction between physical relaxation and emotion; thus, muscle relaxation helps to alleviate the symptoms associated with physiological stress (12). Reflexology is a form of complementary therapy and a traditional, noninvasive technique that involves applying pressure and massage to specific reflex points on the hands and feet (13). These two techniques can help breastfeeding adequacy and increase milk volume by reducing stress in the mother. The study

concludes that these two techniques have increased the volume of breast milk in premature infants. Eshgizadeh et al. (2017), showed that during which reflexology massage was studied on the milk production of 30 mothers with premature infants, it was concluded that reflexology massage is not effective on breast milk production of premature infants (14). The findings of this study differ from those of the present research, as our results demonstrated that the use of reflexology was associated with an increase in breast milk production among participants in the reflexology group. In the study by Mohammadpour et al. (2018), which examined the effect of reflexology on breast milk volume of preterm infants on 50 mothers with premature infants in two groups with an equal number (25 people), it was concluded that the increase in breast milk from 1 to 5 days, after the intervention compared to before the intervention, in the reflexology group compared to the control group 1 day, 2 days, 3 days, 4 days and 5 days after the intervention, was significantly higher (15). The result of this study is consistent with our study because, in our study, an increase in breastfeeding after reflexology intervention was observed after the first, third, and ninth days. These findings align with those of Mirzaie et al. (2018), who investigated the impact of foot reflexology massage on breast milk volume in mothers of premature infants. Their study concluded that foot reflexology positively influences the increase of breast milk in premature infants, a result consistent with our current findings (16). Çankaya et al. (2020) investigated the effect of reflexology on lactation and delivery comfort. During this study, it was concluded that reflexology in cesarean section mothers induces breastfeeding, continuous breastfeeding, and increases maternal comfort after cesarean section (17). Allam (2019) investigated the effect of foot reflexology on lactation volume and weight gain in preterm infants in nulliparous women. During this study, the intervention in the reflexology group had a significant effect on breastfeeding mothers with premature infants (18), which is consistent with the results of our study. The current study had some limitations, including: 1. Different genetics of mothers in breastfeeding, 2. Individual differences of infants (sex, age), and 3. Over-the-counter use of painkillers and narcotics for mothers whose precise control of variables was beyond the power of the researcher.

4-1. Limitations

Several limitations should be considered when interpreting the results of this study. First, the relatively limited sample size and the fact that the research was conducted at a single center may restrict the generalizability of the findings to other populations. Additionally, breastfeeding adequacy was partially evaluated through a self-reported questionnaire, which may have been affected by the mothers' subjective perceptions. Because of the nature of the interventions, full blinding of the participants was not feasible. Moreover, the duration of follow-up was relatively short, which prevented a comprehensive assessment of the long-term impact of the interventions on breastfeeding outcomes.

5- CONCLUSION

Jacobson's progressive muscle relaxation and foot reflexology, as two complementary medicine interventions, can improve milk volume in mothers of preterm infants. Since foot reflexology showed a greater increase in milk production, it may be considered a more effective intervention. Both methods also improved breastfeeding adequacy in preterm infants. These findings suggest that implementing either Jacobson's relaxation or foot reflexology in neonatal care programs can support mothers of preterm infants to enhance milk production

and breastfeeding success. Health professionals, including lactation consultants and nurses, can incorporate these non-invasive, low-cost interventions into routine care to promote better infant nutrition and maternal well-being.

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