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Effect of PIONER (Oxytocin Massage with Electromagnetic Stimulation) on Breast Milk Production: A Repeated-Measures Intervention Study Among Postpartum Mothers

Rosida Hi. Saraha[1]*, Rabiah Umanailo[2], Darwis Durahim[3], Fahrul Islam[4]
[1]Departement of Midwifery, Poltekkes Kemenkes Ternate, Maluku Utara, Indonesia
[2]Departement of Midwifery, Poltekkes Kemenkes Ternate, Maluku Utara, Indonesia
[3]Departement of Physioteraphy, Poltekkes Kemenkes Makassar, Sulawesi Selatan, Indonesia
[4]Departement of Physioteraphy, Poltekkes Kemenkes Makassar, Sulawesi Selatan, Indonesia

*Corresponding Author: E-mail: sidahisaraha@yahoo.co.id

ARTICLE INFO	ABSTRACT
	Introduction: Breast milk production is regulated by prolactin and oxytocin, and oxytocin massage is known to facilitate milk ejection. To address limitations of manual stimulation, an electromagnetic-assisted oxytocin massage device (PIONER) was developed to support postpartum mothers in improving breast milk flow. This study aimed to evaluate the effectiveness of the PIONER device in improving breast milk production indicators among postpartum breastfeeding mothers.
	Methods: A quasi-experimental repeated-measures design was conducted involving 10 postpartum breastfeeding mothers selected using purposive sampling from three community health centers in Ternate City. PIONER-assisted oxytocin massage was administered on days 1, 3, 5, 7, and 9, twice daily for 10 minutes. Breast milk adequacy indicators urination frequency, defecation frequency, breastfeeding frequency, infant sleep duration, and infant weight were measured on days 2, 4, 6, 8, and 10. Data were analyzed using repeated-measures ANOVA (Greenhouse–Geisser correction) with a significance level of $\alpha = 0.05$.
	Results: Significant time-based differences were observed for urination frequency ($F = 13.500$, $p = 0.005$), defecation frequency ($F = 25.839$, $p < 0.001$), and infant weight ($F = 45.375$, $p < 0.001$). No significant changes occurred in breastfeeding frequency or sleep duration. Confidence intervals could not be calculated because raw standard errors were not available.
	Conclusion: PIONER effectively improved indicators of breast milk production, particularly urinary and fecal output and infant weight gain, with no adverse effects observed during the study. Larger controlled studies are recommended to strengthen generalizability.

INTRODUCTION

Research demonstrates the numerous health, human capital, and future economic advantages breastfeeding offers to young children, their mothers, and nations (1). In addition to meeting a kid's fundamental needs as a child's right, breastfeeding especially exclusive breastfeeding also greatly enhances human resources and promotes a love bond between mother and child (2)(3). The baby's survivability is greatly impacted by it. However, the practice is not accompanied by ease in achieving and maintaining this behavior in various situations (4) Inability to produce breast milk in the first day after delivery is also a factor in the failure of exclusive breastfeeding (5). A deficiency in oxytocin stimulation may lead to disruptions in the seamless flow of breast milk, highlighting its essential function in this process. Consequently, the endeavor to express breast milk becomes essential for certain postpartum mothers (6). Two elements govern the production of breast milk: the synthesis and the secretion. The production of breast milk is governed by the hormone prolactin, whereas its release is regulated by the hormone oxytocin. One approach to remedying insufficient breast milk production is through the application of oxytocin massage (7). Oxytocin massage entails the application of massage techniques along the spine, specifically targeting the area between the 5th and 6th scapular nerves. This practice can enhance the function of the parasympathetic nervous system, which communicates with the posterior region of the brain, leading to the release of oxytocin (8). The release of oxytocin occurs through nipple stimulation, either by the baby's sucking or through massage on the mother's spine. This massage can promote a sense of calm and relaxation in the mother, enhance her pain threshold, and foster a bond with her baby, facilitating the quick release of breast milk. The study results, analyzed using the chi-square statistical test ($x2$), yielded a p-value of 0.037 (p-value $\leq$ 0.05). This indicates a significant relationship between oxytocin massage and breast milk production in postpartum mothers (9). However, existing interventions still rely solely on manual techniques, which are limited in consistency and intensity. Although oxytocin massage has demonstrated physiological benefits, no studies have explored technologically assisted approaches capable of enhancing oxytocinergic pathways.

Recent advances in neuroendocrine and bioelectromagnetic research further strengthen the theoretical basis for electromagnetic-assisted oxytocin massage devices such as PIONER. Non-invasive neuromodulation methods particularly transcutaneous vagus nerve stimulation (tVNS) have been shown to enhance oxytocin release in humans. For example, a randomized controlled trial found that auricular tVNS increased peripheral oxytocin levels, likely via activation of vagal afferents (10). Meanwhile, mechanistic neuroendocrine studies have clarified how stimulation of the vagus may engage hypothalamic–pituitary circuits to facilitate oxytocinergic signaling (11). At the same time, new work on extremely-low-frequency electromagnetic fields (ELF-EMF) indicates systemic neuromodulatory effects. A system-level study showed that low-dose ELF-EMFs can influence immune and neuroregulatory function, suggesting they may support vagal or parasympathetic tone in vivo (12) . Although direct studies on ELF-EMF and oxytocin release in humans remain limited, related work in large animals (e.g. dairy cows) reports that electromagnetic stimulation can increase oxytocin secretion and milk yield (13). Importantly, advances in neuroscience continue to refine our understanding of how oxytocin neurons operate during lactation. For example, researchers have now recorded real-time, pulsatile activity of oxytocin neurons in freely-lactating mice, revealing precise burst patterns that are tightly linked to mother–infant interactions (14). Moreover, new reviews highlight how context (such as behavioral state or stress level) strongly shapes oxytocin release, and how neuromodulation strategies (like EMF or VNS) might leverage these dynamics to support lactation more effectively (15). Taken together, these recent findings provide stronger empirical and mechanistic support for an electromagnetic-assisted oxytocin massage device: such a device could plausibly tap into autonomic (vagal) circuits, modulate neural activity via ELF-EMF, and facilitate the endogenous pulsatile release of oxytocin all in service of enhancing milk ejection and lactation.

Electromagnetic stimulation can enhance parasympathetic (vagal) activity, which plays a key role in facilitating oxytocin release from the hypothalamic–pituitary axis. Evidence from tVNS and ELF-EMF studies supports the plausibility that electromagnetic-assisted massage may amplify oxytocinergic signaling needed for milk ejection. These insights provide a concise theoretical foundation for developing devices such as PIONER. This study involved the development of an electromagnetic massage device intended to supplant manual massage techniques targeting the spinal region, specifically from the vertebrae to the fifth and sixth rib bones, with the aim of enhancing breast milk production to optimize exclusive breastfeeding efforts (16).

METHOD

This research utilized a one-group pretest–posttest experimental design. The initial stage of this research began with the design of the PIONER device (electromagnetic oxytocin massager) through the design of the PIONER device's shape, materials, and the power required to activate it. This design was carried out in collaboration with a research team with a background in physiotherapy who were also members of the collaborative partner team. Given the exploratory and prototype-testing nature of the study, this preliminary phase was essential to ensure device feasibility, safety, and functional stability before application in human subjects. The methodological choice to begin with device development aligns with the study's objective to evaluate performance under controlled, real-world postpartum conditions. The model or object used in this study is the PIONER massage tool used by normal breastfeeding mothers, who do not consume breast milk stimulant drugs, whose babies are born normally, have no defects, have good sucking reflexes, and are given exclusive breastfeeding. These inclusion criteria were selected to minimize confounding variables and enhance internal validity, while mothers or infants with complications, congenital abnormalities, or concurrent lactation interventions were excluded to ensure reliable interpretation of breast milk adequacy indicators.

PIONER (Oxytocin Massage with Electromagnetism) is a device designed in the form of a textile vest connected to a massage motor to perform oxytocin massage on the spine, neck, back, or along the vertebrae to the fifth to sixth ribs. The massage on the neck and spine is done in a circular motion.

The front of the vest has a zipper to secure the right and left sides of the vest. The specifications are as follows:

7-12 volt DC voltage.

12V/2A AC to DC adapter.

1800 mAh battery capacity.

Auto-stop feature: 10 minutes until it stops automatically, then can be resumed by pressing the "start" button.

Three parallel high-torque DC motors are equipped with a reduction gear to increase rotational power. Furthermore, prior to deployment, the device underwent internal bench testing to verify motor performance, voltage stability, thermal output, and auto-stop functionality, accompanied by calibration of vibration amplitude and rotational speed to ensure consistency across sessions.

PIONER uses an electronic low-voltage controller.

Three massage control buttons with kneading, rotating, and rubbing techniques.

Rechargeable: The device can be recharged.

The PIONER measures 125 cm long and 100 cm wide.

The PIONER's operating instructions are available in the copyrighted PIONER SOP.

The tool's creation began with a wiring diagram in collaboration with HAF Research, which has a background in electrical engineering. The process began with initial modeling of the massager, purchasing tools and materials, creating 2D and 3D designs, and then continuing with gear box design, inter-component wiring, wiring testing, voltage measurements, and functional testing of each component.

Figure 1. Design of Gear Box

Figure 2. Wiring test

After the device was ready for use, a trial of the PIONER massager was conducted before use on a research sample of breastfeeding postpartum mothers to determine its suitability. The results of the trial massage time did not match the programming, so an evaluation and reprogramming were conducted.

Figure 3. Device trial on breastfeeding mothers

Once the massage equipment is prepared for usage, the subsequent stage involves monitoring or assessing an enhancement in breast milk production by noting the rise in the infant's weight, frequency of urination, defecation, breastfeeding sessions, and the duration of the baby's sleep. This study has received ethical approval, reference number UM.02.03/6/501/2025, and a research authorization from the National Unity and Politics Agency of Ternate City, reference number 000.9.2/581/BKBP/2025. The sampling method employed was purposive sampling, targeting 10 breastfeeding postpartum moms from the working areas of Puskesmas Siko, Puskesmas Bahari Berkesan, and Puskesmas Kalumata. In addition to ethical approval, the study adhered to established research ethics procedures, including a comprehensive informed consent process in which all participants received detailed information about the study's objectives, procedures, potential risks, benefits, and their right to withdraw at any time without penalty. Participant protections were ensured through strict confidentiality measures and secure handling of personal data. Furthermore, device risk monitoring protocols were implemented, including safety checks of the PIONER device before each use, observation for any discomfort or adverse effects, and immediate mitigation procedures aligned with best practices in research ethics.

Massage was performed on days 1, 3, 5, 7, and 9 using a PIONER massager twice daily (morning and evening) for 10 minutes. To help the mother relax, a chair or pillow was used for support. The immediate effect after the massage was reduced back fatigue. Postpartum mothers typically sleep less and sleep less during the first few days. This is due to changes in demographic and clinical characteristics, particularly the new role of motherhood after childbirth. Mothers must meet the nutritional needs of newborns, who wake up every 2–3 hours to breastfeed, both during the day and at night (17).

Figure. Observations were conducted on days 2, 4, 6, 8 and 10 using questionnaires and observation sheets. Observations were performed in the afternoon, focusing on the infant's weight, urine and defecation frequency, breastfeeding frequency, and sleep duration.

of breastfeeding and duration of baby's sleep

RESULTS

The characteristics of respondents in this study can be seen in the following table.

Table 1. The characteristics of respondents

Characteristics	Description	Total
Age	< 20 years	1
	20 - 35 years	6
	> 35 years	3
Parity	≤2 children	2
	>2 children	8
Postpartum period	0-24 hours	0
	1-7 days	2
	8-40 days	8
Education level	Less than High School	0
	High School	3
	Diploma	2
	Bachelor	5
	Master	0

Table 1 shows that the respondents with the highest age were 20 - 35 years, as many as 6 people (60%), the highest number of parities was >2 children as many as 8 people (80%), the postpartum period which lasted >8-40 days as many as 8 people (80%), and the highest level of education was Bachelor's degree as many as 5 people (50%).

The results of statistical analysis using the repeated ANOVA test aim to test the comparison of paired data from more than two measurements (in this case the comparison of days 2, 4, 6, 8, and 10) to determine whether there are differences between times based on the variables of frequency of urination, defecation, sleep time, frequency of breastfeeding, and body weight. The statistical test, the following results were obtained.

Table 2. Variable frequency of urination

| Times	Average	Standard deviation	Notation
Day 2	1.30	0.483	**a**
Day 4	1.30	0.483	**a**
Day 6	1.90	0.316	**b**
Day 8	1.90	0.316	**b**
Day 10	1.90	0.316	**b**
F (p-value)			
Greenhouse-Geisser	= 13.500 (0.005)*		
***: significant (p< 0.05).**			

Estimated marginal means of urination
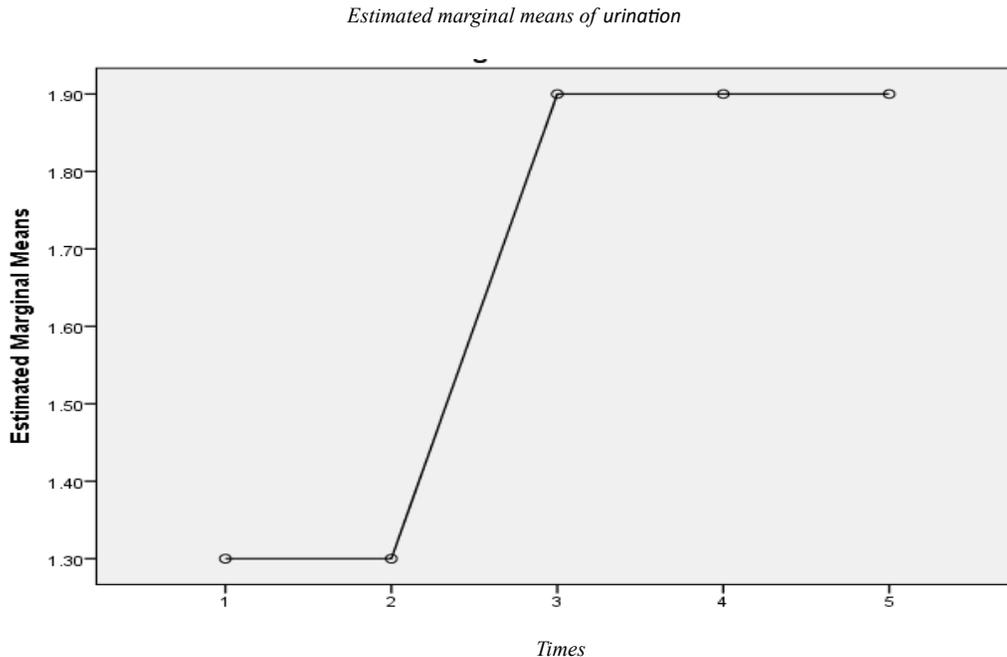
Graph 1. Average Urination between times

The average of the urination category on the 2nd and 4th days was the same at 1.30±0.483, and the average of the urination category on the 6th, 8th, and 10th days was the same at 1.90±0.316. The results of the repeated ANOVA analysis showed that there was a significant difference in the average based on time from days 2, 4, 6, 8, and 10 to the measured urination variable, which can be seen from the Greenhouse-Geisser p-value which is smaller than α (0.005 <0.050). There was a significant increase in the average urination category between times. From the comparison between times, there was no difference in the average between days 2 and 4 and between days 6, 8, and 10 because they were the same, but days 2, 4 and days 6, 8, and 10 were significantly different.

Table 3. Variable frequency of defecation

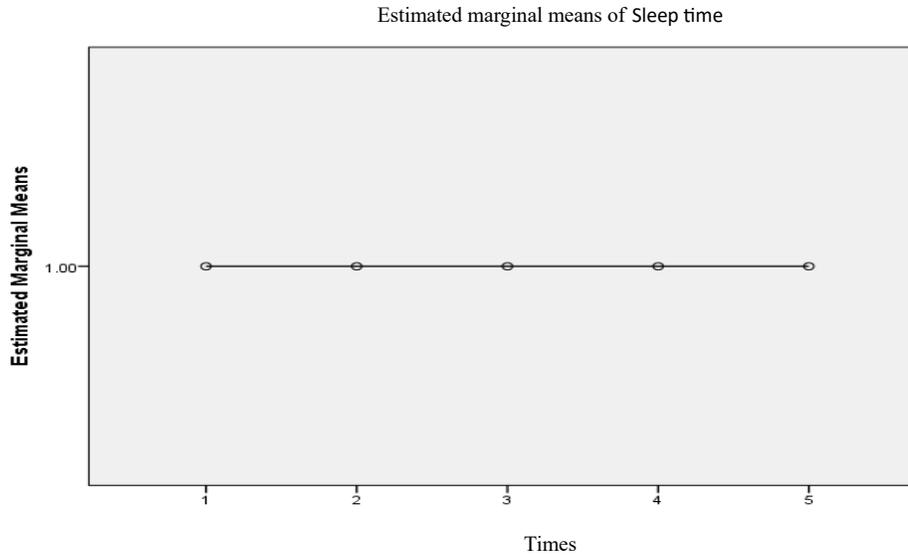| Times	Average	Standard Deviation	Notation
Day 2	0.20	0.422	**a**
Day 4	0.20	0.422	**a**
Day 6	0.90	0.316	**b**
Day 8	1.00	0.000	**b**
Day 10	1.00	0.000	**b**
F (p-value)			
Greenhouse-Geisser	= 25.839 (0.000)*		
***: significant (p< 0.05).**			

Estimated marginal means of defecation
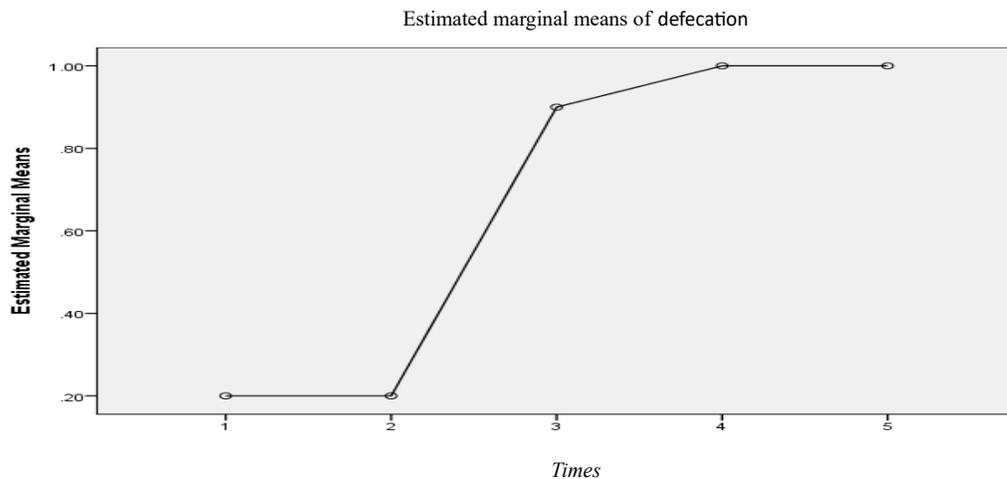
Graph 2. Average Defecation between times

The average category of defecation on the 2nd and 4th days was the same at 0.20±0.422, the average category of bowel movements on the 6th day was 0.90±0.316, and the average category of defecation on the 8th and 10th days was the same at 1.00±0.000. The results of the repeated ANOVA analysis showed that there was a significant difference in the average based on time from days 2, 4, 6, 8, and 10 on the measured defecation variables, which can be seen from the Greenhouse-Geisser p-value which was smaller than α (0.000 <0.050). There was a significant increase in the average category of defecation between times. From the comparison between times, there was no difference in the average between days 2 and 4 and between days 8 and 10 because they were the same, but days 2, 4 and days 6, 8, and 10 were significantly different.

Table 4. Variable baby's sleep time

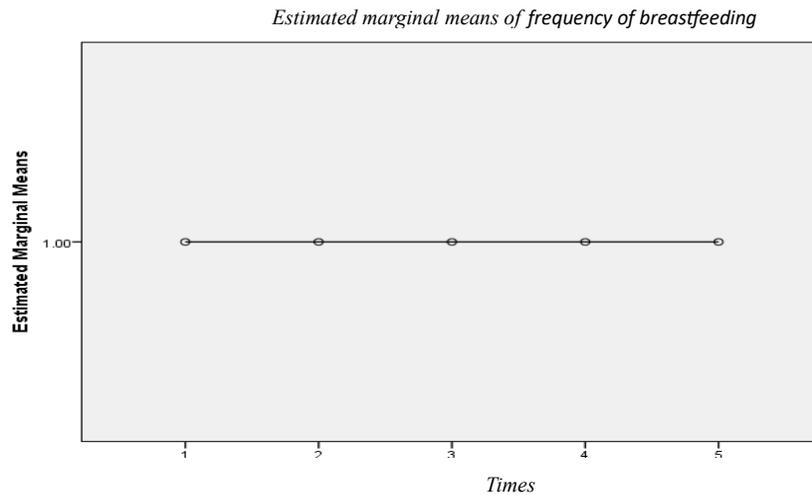| Times	Average	Standard Deviation	Notation
Day 2	1.00	0.000	**a**
Day 4	1.00	0.000	**a**
Day 6	1.00	0.000	**a**
Day 8	1.00	0.000	**a**
Day 10	1.00	0.000	**a**
F (p-value)			
Greenhouse-Geisser	= - (-)		
***: significant (p< 0.05).**			

Estimated marginal means of Sleep time

Graph 3. Average Sleep Time baby between times

The average of sleep time categories for days 2, 4, 6, 8, and 10 were equal at 1.00±0.000. Repeated-measures ANOVA analysis yielded no results because there was no change between the time periods, or the sleep time categories remained constant.

Table 5. Variable frequency of breastfeeding

Times	Average	Standard deviation	Notation
Day 2	1.00	0.000	**a**
Day 4	1.00	0.000	**a**
Day 6	1.00	0.000	**a**
Day 8	1.00	0.000	**a**
Day 10	1.00	0.000	**a**
F (p-value)			
Greenhouse-Geisser	= - (-)		
*: significant (p< 0.05).			

*Estimated marginal means of frequency of breastfeeding*

Graph 4. Average Frequency of Breastfeeding between times

The analysis results indicated that the average breastfeeding frequency for the 2nd, 4th, 6th, 8th, and 10th days remained consistent at 1.00±0.000. The repeated ANOVA analysis did not produce a number because there was no change between times or the category of breastfeeding frequency between times remained the same.

Table 6. Variable of Baby Weight

Times	Average	Standard deviation	Notation
Day 2	0.00	0.000	a
Day 4	0.10	0.316	a
Day 6	0.80	0.422	b
Day 8	1.00	0.000	b
Day10	1.00	0.000	b
F (p-value)			
Greenhouse-Geisser	= 45.375 (0.000)*		
***: significant (p< 0.05).**			

Estimated marginal means of Baby Weight
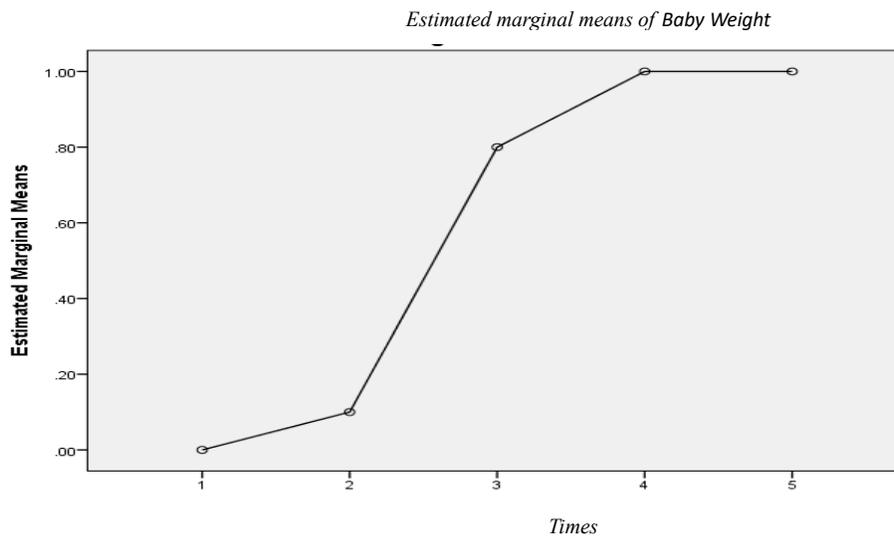
Graph 5. Average Baby Weight between times

The average of baby weight category on day 2 was 0.00±0.000, the average baby weight category on day 4 was 0.20±0.316, the average weight category on day 6 was 0.80±0.422, and the average weight category on day 8 and 10 were the same at 1.00±0.000. The results of the repeated ANOVA analysis showed that there were significant differences in the average based on time from day 2, 4, 6, 8, and 10 on the measured weight variable, which can be seen from the Greenhouse-Geisser p-value which was smaller than α (0.000 <0.050). There was a significant increase in the average weight category between times. From the comparison between times, there was no significant average difference between the 2nd and 4th days and there was no significant average difference between the 6th, 8th, and 10th days, but the 2nd, 4th and 6th, 8th, 10th days were significantly different. Although repeated-measures ANOVA was applied in this study, this approach is not optimal for ordinal outcome variables. More appropriate analytical strategies such as advanced nonparametric procedures or generalized mixed-effects models should be considered to account for the categorical structure and repeated nature of the data.

Breast milk production rises in postpartum moms who receive oxytocin massage with PIONER, resulting in a longer breastfeeding duration and an average weight gain of 300–400 grams on days 2, 4, 6, 8, and 10. Potential confounders, including infant hydration status, feeding intervals, caregiver reporting bias, and environmental factors.

DISCUSSION

The findings of this study align with the research conducted by Kurniati D.P and Yudita Y.H. Further analysis utilizing the Wilcoxon test revealed no significant difference in the average frequency of infant urination post-treatment between the intervention group and the control group (p = 0.000). The intervention group exhibited a notable increase in the average frequency of infant urination following the administration of oxytocin massage, surpassing the outcomes observed in the control group. The mean variation in the frequency of infant urination within the intervention group was observed to be 1.2 times per day. The mean variation in the frequency of infant urination observed in the control group was 0.7 times per day (18). Although the current findings suggest that the use of the PIONER device may be associated with improvements in milk-related outcomes, these results should not be interpreted as evidence of a causal effect. The proposed mechanistic explanation namely that electromagnetic stimulation may enhance oxytocinergic signaling remains theoretical in the absence of direct biomarker measurements such as circulating oxytocin, prolactin, or autonomic neurophysiological indicators. As such, the observed improvements should be viewed as preliminary associations that warrant further validation through controlled studies incorporating hormonal assays and mechanistic endpoints. The engineering innovation of the PIONER device represents a noteworthy contribution within the expanding field of digital and assistive lactation technologies. Recent advancements—such as sensor-integrated smart breast pumps, mobile lactation-support applications, and wearable biosensors for physiological monitoring—demonstrate a global shift toward technologically assisted breastfeeding support (19).

Urine and fecal output are important indicators of whether a baby is getting enough milk and are easily recognized by parents if they have sufficient information and knowledge about it. Several studies have shown that for mothers to evaluate their own breastfeeding, they must be able to assess the wetness and soiling of their baby's diapers. The most effective sign of poor breastfeeding is three or fewer soiled diapers by the fourth day. By the third day, a baby should produce at least three wet diapers in 24 hours, and by the fifth day, six or more wet diapers. The results of research conducted by Ratih S and Dwi A. F showed that the frequency of urination in babies was ≥ 6 times a day, namely 29 babies (96.7%) and the frequency of urination in babies was 4-6 times a day, namely 1 baby (3.3%). The ChiSquare test yielded a p-value of (0.002), which is less than α (0.05). This indicates a relationship between the frequency of urination in babies and the smooth flow of breast milk in normal postpartum mothers (20).

The findings of this study align with the research conducted by Putri I.G et al., indicating that the administration of effervescent tablets derived from Moringa leaves can enhance breast milk production, as evidenced by the frequency of infant bowel movements. Breast milk serves as a vital and natural source of nutrition, providing essential nutrients that are crucial for infants during the initial six months of life. Infants who do not receive breast milk face a risk of stunting that is between 2.2 and 5 times greater (21). According to the findings of prior research, among the 170 toddlers who received exclusive breastfeeding, 28 toddlers (16.5%) met the criteria for very short stunting, while 142 toddlers (83.5%) fell under the short stunting criteria (22).

Breast milk contains lactagogues that can boost milk production, thereby assisting women in addressing breastfeeding challenges. Exhibits the capacity to enhance breast milk production, as indicated by augmented infant weight, heightened bowel movement frequency, raised urination frequency, and elevated nursing frequency (23). The evaluation of breast milk production can be determined by various parameters, including indicators of adequate milk supply in infants. The adequacy of breast milk can be assessed using markers such as the infant's weight, urination frequency, and defecation, which also reflect the sufficiency of breast milk production. Hastuti Usman's research indicates that the Woolwich Massage Method, combined with Massage Rolling (back), positively influences Breast Milk Production, as evidenced by adequate Baby's Weight (p = 0.048), sufficient Urination Frequency (p = 0.006), and adequate Defecation Frequency (p = 0.489). Patel (2013) shows that the effect of back massage on the lactation process during the postpartum period is found to increase breast milk production using parameters of baby's weight, number of urinations and baby's rest time (5). The infant's age is the primary determinant of bowel movement frequency. Healthy infants excrete feces approximately four times daily throughout the initial one to two weeks of

life. At one month of age, newborns exhibited an average of 2.2 defecations each day, with some occurring three times daily, and in one research, as many as six times daily. After the first few weeks, there was a drastic decrease in defecation frequency until two months of age, when defecation were reported to be once per day. By three months of age, the average frequency decreased to once per day. Breastfeeding has been reported to increase bowel movement frequency (24).

This study found no effect of massage using PIONER on sleep duration. The mean sleep duration in this study exceeded 12 hours, aligning with findings from prior research. Breastfed infants typically slept for an average of 11 hours at night. A significant majority of these infants (96.8%) were reported to wake during the night, with 93.5% being breastfed at least once during these awakenings. Adjusted analyses indicated that infants aged 9-12 months exhibited longer sleep durations compared to those aged 6-8 months. Infants co-sleeping with parents exhibited a 1.28-fold increased likelihood of nocturnal awakenings compared to those sleeping in a separate room (25).

The findings of this research indicate that massage utilizing PIONER does not influence the frequency of breastfeeding. The findings of this study align with the research conducted by Kurniati D.P and Yudita Y.H, indicating that the frequency of breastfeeding prior to the administration of oxytocin massage treatment in the intervention group was 14.86 times per day. The mean for the control group was 13.70 occurrences per day. The outcomes of additional analysis employing the Wilcoxon test indicated no notable disparity in the average frequency of breastfeeding prior to treatment administration between the intervention group and the control group (p = 0.157). The mean frequency of breastfeeding following the intervention in the experimental group was recorded at 15.63 times per day (18). Breastfeeding is globally acknowledged as a fundamental component of child health and survival. A multitude of elements plays a role in the decreasing rates of breastfeeding, encompassing maternal psychological aspects, employment circumstances, insufficient knowledge, and socio-cultural influences (26). Furthermore, insufficient breast care may disrupt the stimulation of crucial hormones, including prolactin and oxytocin, which play a vital role in the process of milk production (27).

This study demonstrated a weight increase in infants following massage with PIONER on breastfeeding moms, with an average gain of 300 to 400 grams throughout a 5-day intervention period. This study aligns with prior findings indicating an increase in neonatal weight following maternal oxytocin massage (28). The World Health Organization advocates for exclusive breastfeeding throughout the initial six months of life. Throughout this phase, breast milk must serve as the exclusive source of nutrients for a child's growth and development (29). Exclusive breastfeeding confers health advantages for the kid and diminishes the likelihood of childhood illness and mortality (30). Accurate quantification of breast milk intake is essential to assess the sufficiency of breast milk volume and nutrient consumption, as well as to correlate nursing practices with infant growth and development (31). Breast milk consumption was traditionally assessed using a test weigh method, wherein the child's weight was recorded before and after each feeding, and the difference between these two measurements indicated the quantity of breast milk ingested by the kid (23).

Oxytocin massage with PIONER is performed on the back of the neck to the back or along the spine (vertebra) to the fifth or sixth costae bone(32). Back massage has an effect on the muscular system by providing a balance between relaxation and contraction. Back massage movements make muscles and soft tissues stretch and relax, reducing tension and cramps(33). During the back massage process, relaxation and contraction movements generate signals that are transmitted to the hypothalamus. Subsequently, the hypothalamus relays signals to the pituitary gland, which then stimulates the parasympathetic nervous system to release hormones such as serotonin, oxytocin, and endorphins. These hormones serve to promote relaxation and stimulate breast milk production (34). At the same time, the pituitary gland reduces the hormones cortisol, norepinephrine, and epinephrine. This condition will increase a person's feelings of comfort, create a sense of happiness, psychomotor balance, decrease heart rate frequency, decrease blood pressure, increase blood and lymph circulation so that the body's homeostasis returns to balance and the desire to breastfeed the baby increases (35).

CONCLUSION

Based on the research results and discussion, it can be concluded that the PIONER device demonstrated no observable adverse effects and was associated with improvements in several indicators of breast milk adequacy,

particularly urination frequency, bowel movement frequency, and infant weight gain, while breastfeeding frequency and infant sleep duration remained unchanged. However, because of the study's pilot design and limited sample size, which restrict causal inference, these results should be regarded cautiously. Therefore, future research using larger randomized or controlled designs, supported by biomarker measurements such as oxytocin, prolactin, and autonomic indicators, is recommended to validate the device's effectiveness and further clarify the underlying physiological mechanisms.

AUTHOR'S CONTRIBUTION STATEMENT

All authors contributed significantly to this study. Rosida Hi. Saraha plays a role in study design, data collection, and initial analysis. Rabiah Umanailo played a study design and literature review, as well as the final editing, tensure the feasibility of publication. Rusdiyah supports data analysis using the ANOVA method and interpretation of results. Darwis Durahim and Fahrul Islam designed and created the PIONER. All authors have read and approved the final version of this manuscript.

CONFLICTS OF INTEREST

This research has no conflict of interest from anywhere.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

No generative AI or AI-assisted technologies were used in the writing, editing, or data analysis processes of this manuscript.

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