EFFECTS OF A BREASTFEEDING PILLOW INTERVENTION ON FEEDING PERFORMANCE IN PRETERM INFANTS

Ida Ayu Kade Sri Widiastuti[1*], Yeni Rustina[2], Defi Efendi[2,3], Made Ermayani[4]

[1] Nursing Study Program, Faculty of Medicine, Mulawarman University, Indonesia
[2]Pediatric Nursing Departement, Faculty of Nursing Universitas Indonesia
[3]Neonatal Intensive Care Unit of Universitas Indonesia Hospital
[4] Nursing Study Program, Sekolah Tinggi Ilmu Kesehatan Dirgahayu Samarinda, Indonesia
**corresponding author: idaayukade@fk.unmul.ac.id*

Received June 16, 2025
Revised June 07, 2026
Accepted July 24, 2026
Available online August 17, 2026

Abstract

Aim: Breastfeeding effectiveness is influenced by various factors, including medical conditions, gestational age, maternal health, and environmental influences, all of which affect a baby's ability to breastfeed effectively. A breastfeeding pillow may improve breastfeeding positioning, attachment, sucking ability, and suckling duration, thereby enhancing feeding performance and reducing maternal discomfort.

Methods: A quasi-experimental pretest-posttest control group study with repeated outcome measurements was conducted involving 70 hospitalized preterm infants recruited using consecutive sampling. Mothers in the intervention group used a customized U-shaped breastfeeding pillow, while the control group received routine breastfeeding care. Breastfeeding performance, including positioning, attachment, sucking ability, and suckling duration, was assessed using an 11-item observational checklist at four predetermined time points over four-day intervention period. Data were analyzed using a general linear model repeated measures analysis.

Results: Significant group-by-time interaction effects were observed for breastfeeding position, attachment, sucking ability, and suckling duration (all $p<0.001$). Compared with the control group, preterm infants in the intervention group demonstrated greater improvements in breastfeeding positioning (mean final score: 1.09 vs.2.11; 95% CI: -1.276 to 19.787), attachment (1.09 vs. 2.57; 95% CI: -1.712 to -1.259), and sucking ability (1.29 vs. 2.51; 95% CI: -1.487 to 3.123). Suckling duration also increased significantly in the intervention group from baseline to the final assessment (21.34 vs. 15.43 min; 95% CI: 1.163-3.577; $p<0.001$).

Conclusion: The use of a breastfeeding pillow significantly improved breastfeeding effectiveness in preterm infants by enhancing positioning, attachment, sucking ability, and suckling duration.

Keywords: breastfeeding, breastfeeding positioning, breastfeeding pillow, feeding performance, Preterm infant, sucking ability

Introduction

Preterm birth, defined as birth before 37 completed weeks of gestation, remains a major global health problem, accounting for approximately 10% of live births worldwide and contributing substantially to neonatal morbidity and mortality (WHO, 2023; Cao et al., 2022; Zhang et al., 2024). Owing to physiological immaturity, preterm infants are particularly vulnerable to feeding difficulties, infections, and

adverse neurodevelopmental outcomes (Jiang et al., 2025; Cerasani et al..2020; Zhang et al., 2024). The World Health Organization (WHO) recommends breastfeeding as the optimal source of nutrition for all infants, including those born preterm, because human milk supports growth, immunity, and brain development (WHO, 2023; Parker et al., 2026; Cerasani et al., 2020; Victora et al, 2016). Human milk is especially beneficial for preterm infants, as it reduces the risk of necrotizing enterocolitis, infections, and long-term developmental impairment (Quigley et al., 2024; Yakar & Korgali, 2025, Peng et al., 2026; American Academy of Pediatrics, 2022). Nevertheless, breastfeeding success in this population is influenced by multiple factors, including gestational age, maternal and neonatal conditions, and neonatal care practices (Dong et al., 2022; Liu et al., 2024; Mills et al., 2024; Heller et al., 2021; Yakar & Korgali, 2025).

Feeding difficulties in preterm infants primarily result from immature oral motor and physiological development. Inadequate coordination of sucking, swallowing, and breathing often leads to ineffective latching, poor milk transfer, rapid fatigue, and limited feeding endurance (Fucile et al., 2021; Pineda et al., 2020; Guo et al., 2025; Peng et al., 2026). Although early breastfeeding initiation is feasible with appropriate clinical support and structured lactation management (Song et al., 2023), breastfeeding performance often remains poor. Although physiological immaturity is widely recognized as a major contributor to breastfeeding difficulties, evidence regarding the influence of gestational age is inconsistent. For example, Coca et al. (2016) reported no significant association between gestational age, latch quality, and suckling ability in infants. These findings indicate that successful breastfeeding in preterm infants requires supportive strategies that address both infant physiological limitations and maternal breastfeeding challenges (Mills et al., 2024; Tran et al., 2023; Heller et al., 2021). Various interventions have been introduced to improve breastfeeding performance in preterm infants, including skin-to-skin contact, lactation counseling, positioning techniques, and assistive devices (Song et al., 2023; Yang et al., 2023).

Among these interventions, breastfeeding pillows provide continuous ergonomic support by improving maternal posture, optimizing infant positioning, and reducing physical strain during the feeding process. Appropriate positioning promotes effective latch and suckling, whereas poor positioning is associated with nipple pain, reduced breastfeeding effectiveness, maternal musculoskeletal discomfort, and shorter feeding duration (Douglas, 2022; Wang et al., 2020; Zakerihamidi et al., 2025; Rani et al., 2019). Studies have also shown that breastfeeding pillows can stabilize infant posture, particularly in side-lying or sim positions, thereby improving infant alignment, maternal comfort, and breastfeeding mechanics (Park et al., 2024; Ren et al., 2025; Chou et al., 2026; Smith & Lee, 2021; Widiastuti et al., 2020). However, findings regarding their effectiveness in improving feeding outcomes in hospitalized preterm infants remain inconsistent (Chou et al., 2026; Park et al., 2024).

Despite the increasing use of breastfeeding pillows in neonatal care, existing studies have largely focused on maternal comfort, safety, or isolated breastfeeding outcomes rather than on comprehensive neonatal feeding performance (Chou et al., 2026). Evidence evaluating the combined effects of breastfeeding pillows on positioning, attachment, sucking ability, and feeding duration among hospitalized preterm infants, particularly in neonatal intensive care settings, is scarce (Park et al., 2024; Ren et al., 2025). Considering that immature oral-motor coordination and feeding instability are characteristics of preterm infants (Guo et al., 2025; Peng et al., 2026; Bowden et al., 2019), identifying effective interventions that enhance breastfeeding performance is clinically important. Therefore, this study aimed to evaluate the

effectiveness of a breastfeeding pillow intervention on multidimensional feeding performance, including positioning, attachment, sucking ability, and feeding duration, in preterm infants.

Methods

Research design

This quasi-experimental pretest-posttest control group study evaluated the effectiveness of a customized U-shaped breastfeeding pillow on breastfeeding performance among hospitalized preterm infants. The sample size was calculated using the formula for comparing two population means (Ranganathan et al., 2024; Sadiq et al., 2024). Eligible infants were recruited using consecutive sampling methods. After enrollment, respondents were allocated to either the intervention or control group using block allocation with a fixed block size of four to maintain balanced group size throughout the study. An independent researcher prepared the allocation schedule before respondent recruitment (Broglio, 2018).

Setting and samples

The study was conducted over two months in the perinatology unit of a hospital in Jakarta. A total of 70 eligible preterm infants were recruited for the study. The inclusion criteria were infants with a gestational age of 32–36 weeks or corrected age of less than 36 weeks, a birth weight of at least 2000 g, born to parous mothers, and the absence of congenital anomalies or major congenital disorders. The exclusion criteria included infants with deteriorating clinical conditions, such as apnea, shock, or ventilator dependence, as well as maternal conditions that could interfere with breastfeeding, including severe illness, maternal death, or breastfeeding complications. The respondents were equally allocated to the intervention and control groups.

Intervention (applies to experimental studies)

The intervention was explained to each respondent's mother, and written informed consent was obtained prior to enrollment. Before the intervention, all mothers received standardized breastfeeding education, including breastfeeding positioning, attachment, and effective suckling techniques training. Mothers in the intervention group participated in structured breastfeeding sessions using a customized U-shaped breastfeeding pillow (65 cm × 50 cm x18 cm) made of soft cotton and high-quality microfiber, whereas mothers in the control group received routine breastfeeding care without a breastfeeding pillow.

Compared with the standard commercial version, the pillow used in this study was customized by increasing the amount of filling material, resulting in a deeper U-shaped contour, greater height, and a firmer support structure. These modifications were intended to improve infant trunk stability, maintain appropriate positioning during breastfeeding, reduce maternal arm and back strain by minimizing the need to manually support the infant's weight, and prevent pillow displacement during feeding. Adjustable waist straps further enhanced pillow stability and helped maintain consistent infant positioning, proper attachment, and effective suck-swallow-breathe coordination throughout breastfeeding (Widiastuti et al., 2020). A customized pillow was developed based on ergonomic breastfeeding principles for preterm infants. Breastfeeding sessions were conducted every three hours over four consecutive days under the supervision of the research team and ward nurses to ensure adherence to the intervention protocol and correct use of the breastfeeding pillow.

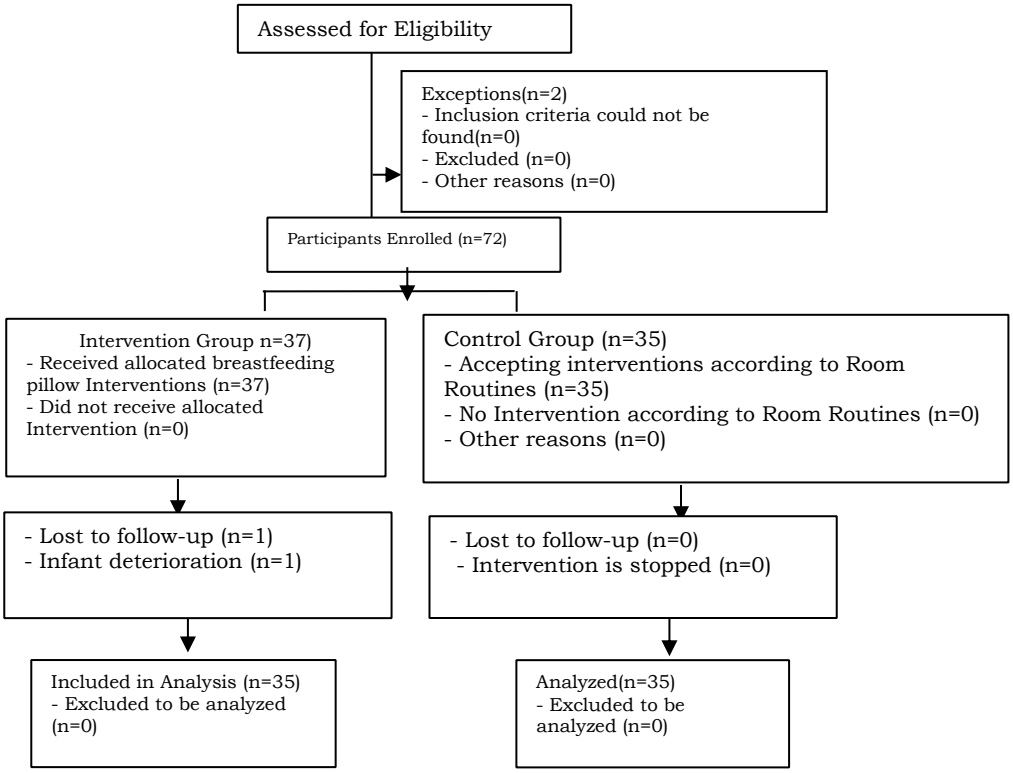

Figure 1. Flow Diagram of Respondent Recruitment and Follow Up

Measurement and data collection

The primary outcome was breastfeeding effectiveness, assessed based on previous studies comparing breastfeeding effectiveness scores between the control (3.9±1.1) and intervention (4.7±1.2) groups (Aksu, 2010). Statistical analysis was performed at a 95% confidence level (α=0.05) with 80% power. The estimated variance for both groups was 1.3, derived from the pooled variance of the standard deviations reported in previous studies, while the expected effect size (π_1-π_2) was 0.8, resulting in a minimum required sample size of 31 respondents per group. After applying a 10% adjustment for potential attrition, the final sample size was 35 respondents per group.

The intervention was implemented over four consecutive days, with breastfeeding sessions scheduled every three hours, resulting in 12 sessions. In contrast, mothers in the control group breastfed according to standard ward practices, without using a breastfeeding pillow. Before the intervention, all respondents received individual breastfeeding education through verbal instructions, printed educational leaflets, and direct demonstrations. The educational content included proper breastfeeding positioning, attachment techniques, effective suckling, and instructions on breastfeeding pillow use. Demonstrations were performed using infant mannequins and breastfeeding pillows, followed by return demonstrations by the mother to ensure adequate understanding and competency before the intervention began. The pillow was secured around the mother's waist using adjustable straps, and breastfeeding was performed in either the sitting or cradle hold positions. Each group was observed separately.

An 11-item observational checklist was used to evaluate breastfeeding effectiveness, consisting of four items assessing positioning, four assessing attachment, and three assessing sucking abilities. The instrument was adapted and modified from the WHO

breastfeeding assessment guidelines and previous validation studies (Safayi et al., 2021; Asmamaw et al., 2022; Gurung & Paudel, 2025). Breastfeeding effectiveness was evaluated in three observational domains: positioning, attachment, and sucking ability. Positioning was assessed based on whether the infant's entire body was supported, the head and body were aligned, the infant faced the mother's breast, and the infant was held close to the mother's body (Safayi et al., 2021; Gurung & Paudel, 2025). Attachment was evaluated by observing chin contact with the breast, wide mouth opening, outward turning of the lower lip, and appropriate areolar grasping (Safayi et al., 2021; Asmamaw et al., 2022). Sucking ability was assessed by observing slow rhythmic sucking, deep sucking movements, and intermittent pauses during feeding (Safayi et al., 2021; Tomita et al., 2024). Each indicator within the positioning, attachment, and sucking ability domains was scored as either present or absent. The scores of the individual items within each domain were summed to generate a summed domain score at each assessment point (Gurung & Paudel, 2025). The summed domain scores were used for all inferential statistical analyses to evaluate changes over time between the intervention and control groups.

For descriptive purposes, the summed domain scores were classified into three categories: good (≥3 indicators present), fair (2 indicators), and poor (≤ 1 indicator). Lower summed domain scores indicate better breastfeeding effectiveness, whereas higher scores reflect poorer breastfeeding performance. Suckling duration was measured separately using a stopwatch and was recorded continuously in minutes. For descriptive presentation only, duration was categorized as <20 min, 20–45 min, or>45 min according to previous studies (Niazi et al., 2019; Parashar et al., 2015). However, the continuous duration values were used for all inferential analyses, consistent with recent breastfeeding intervention studies (Huang et al., 2022; Tomita et al., 2024).

The modification process was conducted to adapt the instrument to the characteristics of preterm infants and the objectives of this study. Content validity was established through expert review by pediatric nursing and lactation specialists who evaluated the relevance, representativeness, and clarity of each item to ensure that the checklist adequately reflected breastfeeding performance in preterm infants. A pilot study was conducted to assess the validity and reliability of the instrument before implementing the main study. Construct validity was assessed using Pearson's product-moment correlation (r>0.444), which met the acceptable threshold for validity (Polit & Beck, 2021). Internal consistency reliability was evaluated using Cronbach's alpha, yielding coefficients of 0.83 for positioning, 0.69 for attachment, and 0.69 for the sucking ability. These values were considered acceptable for the observational instruments used in clinical research. The inter-rater reliability between the two trained observers was assessed using Cohen's Kappa Coefficient, which demonstrated substantial agreement with a value of 0.759 (Vanbelle et al., 2024). Observations were conducted at four time points: baseline, day 1, day 2, and postintervention. Each breastfeeding session lasted between 20 and 45 min, and the effective suckling duration was measured using a stopwatch, with observed durations ranging from approximately 10 to 21 min per session.

Data analysis

Data were analyzed using descriptive and inferential statistical methods. The Chi-square test (2×2 contingency table) was used to analyze categorical variables, including maternal characteristics and baseline group comparisons, to determine whether the distribution of frequencies differed significantly between the intervention and control groups. The Mann-Whitney U test, a non-parametric alternative to the independent samples t-test, was used to compare continuous variables that were not

normally distributed (e.g., gestational age and birth weight) between groups at baseline. For each breastfeeding domain (positioning, attachment, sucking ability, and suckling duration), the scores of the individual items were summed to generate a summed domain score at each assessment time point.

To evaluate the effectiveness of the intervention over time, a General Linear Model Repeated Measures (GLM-RM) analysis was performed to assess changes in breastfeeding position, attachment, sucking ability, and suckling duration across four assessment time points: baseline, day 1, day 2, and post-intervention. The analysis examined three effects: (1) the time effect, representing changes in breastfeeding outcomes within participants across repeated measurements; (2) the group effect, representing differences in breastfeeding outcomes between the intervention and control groups; and (3) the time × group interaction effect, representing whether changes over time differed between the intervention and control groups. Prior to the analysis, the assumptions of the GLM-RM were assessed. Normality was evaluated using the Shapiro-Wilk test, and sphericity was examined using Mauchly's test. Greenhouse-Geisser corrections were applied when the assumption of sphericity was violated in the ANOVA. All statistical tests were two-tailed, and a p-value of less than 0.05 was considered to be statistically significant.

Ethical considerations.
All participating mothers received detailed explanations of the study procedures before enrollment. Written informed consent was obtained from each participant prior to the data collection. Ethical approval for this study was obtained from the Ethics Committee under approval number 15/UN2.F12.D/HKP.02.04/2019.

Results
Repeated-measures analysis was performed using the summed scores for positioning, attachment, and sucking ability. The good, fair, and poor categories were used only for descriptive interpretation and were not included in the inferential analyses

Respondent Characteristics
Baseline characteristics were compared to assess the comparability of the two groups before the intervention. No statistically significant differences were observed between the groups with respect to gestational age, corrected age, infant sex, mode of delivery, maternal education, occupation, or parity status ($p>0.05$), indicating that the intervention and control groups were comparable at baseline (Table 1).

Table 1. Characteristic of Respondents

Variables	Intervention			Control			*p* Value
	Mean	Min-Max/ frequency	SD%	Mean	Min-Max/ frequency	SD%	
Gestational Age	35.89	30-41	2.763	35.14	30-41	2.475	0.235*
Corrected Age	37.77	34-42	2.408	37.54	29-44	3.221	0.715*
Sex							
Male		23	65.7%		16	45.7%	0.149**
Female		12	34.3%		19	54.3%	
Mode type of delivery							
Spontaneous		4	11.4%		9	25.7%	0.219**
C-section		31	88.5%		26	74.3%	
Education							
Primary		23	65.7%		25	71.4%	0.797**
Higher		12	34.3%		10	28.6%	
Occupation							
Unemployed		26	74.3%		29	82.9%	0.560**
Employed		9	25.7%		6	17.1%	
Parity Status							
Primipara		12	34.3%		17	48.6%	0.332**
Multipara		23	65.7%		18	51.4%	

* Uji Mann Whitney, α<0 .05
** Uji Chi Square, α< 0.05

The effects of Breastfeeding Pillow on Attachment, Positioning, Sucking Ability, and Suckling Duration.

Assumption testing was performed prior to conducting the GLM-RM analysis. The Shapiro–Wilk test indicated that several outcome variables were not normally distributed (p<.001). Mauchly's test showed that the assumption of sphericity was met for breastfeeding position (p=0.210). Greenhouse-Geisser corrections were applied to these outcomes because there were violations of sphericity for attachment (p=0.037), sucking ability (p=0.005), and suckling duration (p<.001). The GLM RM analysis demonstrated significant changes in breastfeeding outcomes across repeated measurements and significant differences between the intervention and control groups. Significant time, group, and time × group interaction effects were observed, indicating different patterns of change between the groups over the intervention period.

Table 2 summarizes the effects of the breastfeeding pillow intervention on breastfeeding effectiveness, as assessed using GLM-RM. The outcome measures are presented according to the scoring method described in the Instruments section. GLM-RM analysis demonstrated that, compared with the control group, the intervention group showed significantly greater improvements in breastfeeding positioning, attachment, and sucking ability from Day 1 to the final assessment (p<0.001). Suckling duration also increased significantly in the intervention group throughout the study period (p<0.001).

Table 2. Effects of Breastfeeding Pillow on Breastfeeding Parameters

Variable	Assessment	Intervention	Control	Mean Difference	*p* value	95% Confidence Interval	
		Mean ± SD	Mean ± SD			Lower	Upper
Positioning	Baseline	2.74±0.44	2.86±0.49	-0.12	0.312	-0.338	17.465
	Day I	2.34±0.76	2.89±0.32	-0.55	0.001	-0.823	18.630
	Day II	1.37±0.55	2.40±0.69	-0.03	0.001	-1.327	19.076
	Final	1.09±0.37	2.11±0.63	-1.03	0.001	-1.276	19.787
Attachment	Baseline	2.66±0.68	2.86±0.49	-0.20	0.165	-0.484	0.084
	Day I	2.43±0.78	2.94±0.24	-0.51	0.001	-0.788	-0.260
	Day II	1.69±0.72	2.66±0.64	-0.97	0.001	-1.296	-0.647
	Final	1.09±0.28	2.57±0.61	-1.48	0.001	-1.712	-1.259
Sucking ability	Baseline	2.29±0.46	2.23±0.42	0.06	0.591	-1.154	0.268
	Day I	2.06±0.34	2.94±0.46	-0.08	0.001	-0.421	-0.036
	Day II	1.60±0.50	2.23±0.43	-0.63	0.001	-0.849	-0.408
	Final	1.29±0.46	2.51±0.61	-1.22	0.001	-1.487	-0.971
Suckling Duration	Baseline	2.97±0.17	3.00±0.00	-0.03	0.438	-0.356	0.813
	Day I	2.91±0.28	3.00±0.00	-0.09	0.079	-0.101	1.815
	Day II	2.46±0.51	2.91±0.28	-0.45	0.001	1.163	3.123
	Final	2.09±0.45	2.94±0.24	-0.85	0.00	3.577	-8.251

*Uji General Linier Model Repeated Measure (GLM-RM)
Data for positioning, attachment, and sucking ability are presented as the mean ± SD of the summed domain scores. Suckling duration is presented as the mean ± SD of the observed duration (minutes). The good, fair, and poor categories for breastfeeding performance and the categorical classification of suckling duration were used for descriptive presentation only and were not included in the inferential analyses. Lower summed domain scores indicate better breast-feeding effectiveness.

No statistically significant differences were observed between the intervention and control groups at baseline in terms of breastfeeding position, attachment, sucking ability, or suckling duration (all $p>0.05$) (Table 2). However, significant differences in breastfeeding positioning, attachment, and sucking ability were observed on Day 1, Day 2, and at the final assessment (all $p<0.05$), favoring the intervention group over the control group.

Regarding suckling duration, no significant differences were observed between the groups at baseline or on day 1 (both $p>0.05$). However, statistically significant differences between the groups emerged on day 2 and at the final assessment ($p<0.05$), with infants in the intervention group demonstrating longer suckling durations than those in the control group. Overall, the infants in the intervention group demonstrated progressive improvements in breastfeeding positioning, attachment, sucking ability, and suckling duration across the four assessment time points. These findings indicate that the breastfeeding pillow intervention improved breastfeeding performance in hospitalized preterm infants.

Discussion

The present study demonstrated that the use of a breastfeeding pillow significantly improved breastfeeding positioning, attachment, sucking ability, and suckling duration in hospitalized preterm infants compared with routine breastfeeding care. Compared with the baseline, breastfeeding performance improved progressively throughout the intervention period, suggesting that the benefits of the breastfeeding pillow became increasingly evident with repeated breastfeeding sessions over four consecutive days. These findings suggest that breastfeeding pillows may facilitate more effective breastfeeding by providing ergonomic support for both mothers and

infants. Importantly, the observed improvements appeared to be interrelated rather than independent outcomes. Improved positioning may facilitate better attachment, which, in turn, supports more coordinated sucking and longer feeding duration.

The observed improvement may be explained by the ergonomic support provided by breastfeeding pillows. Preterm infants often exhibit reduced muscle tone, immature postural control, and difficulty in maintaining head and neck alignment during breastfeeding. By elevating and stabilizing the infant at the breast level, the pillow helps mothers maintain proper positioning while reducing physical strain on the arms, shoulders, and back. Adequate support allows the infant to remain close to the breast with appropriate alignment of the head, neck, and trunk, which may improve the latch quality and milk transfer efficiency. These findings are consistent with recent evidence showing that breastfeeding pillows improve maternal comfort, reduce upper body strain, and facilitate stable infant positioning during breastfeeding (Chou et al., 2026; Zhou et al., 2024). Similarly, recent studies have emphasized that optimal breastfeeding positioning promotes effective latch, coordinated suckling, and maternal comfort, thereby improving breastfeeding effectiveness (Blair et al., 2024; Blair et al., 2025; Wang et al., 2020). Beyond positioning, the breastfeeding pillow appears to facilitate improved attachment between the infant and the mother. Effective attachment is characterized by close chin contact with the breast, a wide-open mouth, outward turning of the lower lip, and an adequate areolar grasp (Mislu et al., 2024; Gurung & Paudel, 2025). In preterm infants, maintaining these attachment characteristics can be challenging because of immature neuromuscular development and reduced stability. The additional support provided by the pillow may help mothers maintain a stable feeding position, thereby reducing repeated repositioning and allowing infants to maintain a deeper and more effective latch. Improved attachment is clinically important because it promotes efficient milk transfer, reduces nipple trauma, and supports successful breast feeding. The observed improvement in sucking ability may also be related to the enhanced stability provided during the breastfeeding process. Effective sucking requires coordinated interactions among the sucking, swallowing, and breathing mechanisms.

Although the infants were approximately 36 weeks of corrected gestational age and physiologically ready for oral feeding, preterm infants commonly exhibit less mature oral-motor function and less coordinated sucking, swallowing, and breathing patterns than term infants. Stable positioning and effective attachment may facilitate feeding efficiency by promoting physiological stability and reducing the effort required to maintain optimal feeding posture. Previous evidence suggests that oral feeding performance in preterm infants is influenced by oral motor maturity, feeding readiness, and the coordination of sucking, swallowing, and breathing mechanisms (Dong et al., 2022; Huang et al., 2025; Ren et al., 2025). Furthermore, feeding difficulties in preterm infants are often associated with the delayed development of oral feeding skills and immature neuromuscular function, which may compromise feeding effectiveness (Zhao et al., 2024; Ibrahim et al., 2024; Chen et al., 2025; Huang et al., 2024). In the present study, the breastfeeding pillow may have contributed to improved feeding efficiency by supporting infant comfort and promoting a more stable feeding position during breastfeeding.

Fatigue experienced by preterm infants during breastfeeding may be reduced through the use of a breastfeeding pillow, which provides additional postural support and helps to maintain a stable feeding position. Preterm infants often have immature muscle tone and limited energy reserves so maintaining their body alignment during

feeding may require considerable effort (Pineda et al., 2020; Fucile et al., 2021). By supporting the infant's head, neck, and trunk, the breastfeeding pillow may facilitate physiological stability and feeding efficiency, allowing infants to devote more energy to coordinated sucking, swallowing, and breathing activities during feeding (Dong et al., 2020; Ren et al., 2025). Improved feeding efficiency may help minimize fatigue during breastfeeding.

Consequently, improvements in positioning, attachment, and sucking ability may explain the longer suckling duration observed in the intervention group. These breastfeeding components are closely interconnected, and successful feeding depends on the infant's ability to maintain an effective latch and coordinated sucking throughout the feeding session. Similar improvements in oral feeding performance and feeding endurance have been reported among preterm infants receiving supportive feeding interventions (Fucile et al., 2021; Ren et al., 2025). Ibrahim et al, (2024). Similarly, Sirikijkhajor and Suksamarnwong (2023) reported higher LATCH scores among mothers using a U-shaped breastfeeding pillow, indicating improved breastfeeding effectiveness. Unlike the study by Sirikijkhajor and Suksamarnwong (2023), which primarily evaluated breastfeeding effectiveness using the LATCH assessment tool among healthy postpartum mothers, the present study focused on preterm infants, a population particularly vulnerable to feeding difficulties due to immature oral motor function and limited physiological reserves. The positive effects observed in the current study may have greater clinical relevance in supporting feeding performance in preterm infants. It is important to recognize that suckling duration in preterm infants is influenced by multiple physiological and developmental factors beyond breastfeeding support devices, including gestational age, neurological and oral-motor maturity, coordination of sucking–swallowing–breathing mechanisms, infant fatigue, feeding readiness, and overall clinical stability (Dong et al., 2022; Huang et al., 2024). These factors may affect the duration and effectiveness of breastfeeding sessions. Preterm infants often have less mature oral-motor function and feeding coordination then term infants, which may limit feeding endurance and increase susceptibility to fatique during feeding (Pineda et al., 2020; Fucile et al., 2021). Therefore, the longer sucking duration observed in the intervention group may reflect both the supportive effect of the breastfeeding pillow and the maturation of feeding skills during the observation period.

By promoting maternal comfort and reducing physical strain, a breastfeeding pillow may enable mothers to maintain a more stable breastfeeding position with fewer interruptions or repositioning. Previous evidence has shown that breastfeeding pollows can reduce maternal discomfort, while appropriate positioning and attachment are associated with more effective breastfeeding (Widiastuti et al., 2020; Wang et al., 2020; Mislu et al., 2024; Zakerihamidi et al., 2025). Longer active suckling duration may facilitate more effective milk transfer and could potentially contribute to improved nutritional outcomes; however, milk transfer and nutritional outcomes were not directly measured in the present study. These findings extend previous evidence on the ergonomic benefits of breastfeeding pillows by demonstrating potential benefits for feeding performance among hospitalized preterm infants, a population that remains relatively understudied in breastfeeding support intervention.

From an ergonomic perspective, the use of a breastfeeding pillow may contribute to a longer feeding duration by enhancing maternal comfort and facilitating appropriate infant positioning. The pillow may help maintain alignment between the infant's mouth and the mother's breast, supporting effective attachment and reducing the need for repeated repositioning. By reducing physical strain on the mother's arms,

shoulders, and back breastfeeding pillows may facilitate a more stable and sustained breastfeeding position (Widiastuti et al., 2020; Chou et al., 2026; Wang et al., 2020). Consequently, the mother may focus more effectively on the breastfeeding process, potentially prolonging the duration of each session. Recent evidence indicates that maintaining appropriate positioning and attachment improves breastfeeding effectiveness, facilitates efficient milk transfer, and may prolong the active breastfeeding duration (Mislu et al., 2024; Wang et al., 2020; Zakerihamidi et al., 2025). Taken together, these findings suggest that breastfeeding pillows may represent a simple, low-cost, and feasible intervention for supporting breastfeeding among hospitalized preterm infants. Beyond improving maternal comfort, the intervention was associated with better infant positioning, attachment, sucking ability, and suckling duration, which collectively reflect enhanced feeding performance of the infant. Thus, incorporating breastfeeding pillows into routine neonatal care may represent a practical strategy for supporting breastfeeding in preterm infants, although confirmation through large multicenter studies is warranted.

Implication and limitations

Suckling is a newborn's primary mechanism for fulfilling nutritional needs and adapting to the extrauterine environment. Inadequate breastfeeding may impair the neonatal adaptation process and prolong hospitalization. The findings of this study suggest that breastfeeding pillow interventions may enhance breastfeeding effectiveness by improving infant positioning and attachment, reducing discomfort, improving sucking ability, prolonging suckling duration, and optimizing breast milk intake in preterm infants.

Neonatal nurses and healthcare providers should consider incorporating ergonomic breastfeeding support and breastfeeding pillow education into routine assistance programs for mothers of preterm infants. Additionally, hospitals and policymakers should consider developing standardized breastfeeding support protocols and providing appropriate breastfeeding assistive devices in neonatal care settings to enhance breastfeeding outcomes. Parents should also receive practical education on appropriate breastfeeding positioning and the safe use of breastfeeding pillows to improve feeding comfort and effectiveness at home.

This study had several limitations that should be considered. This study employed a quasi-experimental design, selection bias could not be completely excluded despite the comparable baseline characteristics observed between the intervention and control groups. Furthermore, this study was conducted in a single-center neonatal unit, evaluated only one breastfeeding position and one type of breastfeeding pillow, and included a relatively small sample size, which may limit the generalizability of our findings. Finally, although repeated assessments were performed over four consecutive days, a longer follow-up was not performed. Consequently, the long-term effects of the intervention on infant outcomes remain uncertain. Further multicenter studies involving larger sample sizes, diverse breastfeeding positions, different breastfeeding pillow designs, and extended follow-up periods are warranted to strengthen the evidence regarding the effectiveness of breastfeeding pillows in hospitalized preterm infants.

Conclusion

The use of a breastfeeding pillow significantly improved breastfeeding effectiveness in preterm infants, as evidenced by improvements in positioning, attachment, sucking ability, and suckling duration. As a simple and low-cost intervention, breastfeeding pillows may be incorporated into breastfeeding support programs to

enhance the feeding performance of preterm infants. Further research is needed to examine their effects on infant weight gain, growth, breastfeeding continuation, and other long-term outcomes.

Acknowledgments
The authors thank all the respondents (mothers and babies) who participated in this study.

Author contribution
IAKSW conceptualized and designed the research, collected and analyzed the data, and drafted the manuscript. YR and DE contributed to the study's conceptualization and design and supervised data analysis. ME was responsible for drafting and critically revising the article.

Conflict of interest
The authors declare no conflicts of interest.

References
American Academy of Pediatric (AAP). (2022). Breastfeeding and the use of human milk. *Pediatrics, 150*(1), e2022057988. https://doi.org/10.1542/peds.2022-057988

Aksu, H., Kucuk, M., & Duzgun, G. (2011). The effect of postnatal breastfeeding education/support offered at home 3 days after delivery on breastfeeding duration and knowledge: A randomized trial. *The Journal of Maternal-Fetal and Neonatal Medicine, 24*(2), 354–361. https://doi.org/10.3109/14767058.2010.497569

Asmamaw, D. B., Habitu, Y. A., Negash, W. D., Desta, D., & Mekonnen, E. G. (2022). Effective breastfeeding technique and associated factors among lactating mothers in Gidan District, North-East, Ethiopia: a community-based cross-sectional study. *BMJ Open*, 12. https://doi.org/10.1136/bmjopen-2021-059518

Blair, A., Brimdyr, K., Reyes, M., Svensson, K., Mbalinda, S., Kagawa, M., Bastarache, L., Kamoga, L., Kigozi, E., & Cadwell, K. (2025). Predictors of Effective Breastfeeding in Newborns and 6-Week-Old Infants: Modifiable Pre-Feeding, Positioning and Latching-On Elements. *Acta Paediatrica*, (114), 3317-3317. https://doi.org/10.1111/apa.70261

Broglio, K. (2018). Randomization in clinical trials: Permuted blocks and stratification. *JAMA, 319*(21), 2223–2224. https://doi.org/10.1001/jama.2018.5242

Cao, G., Liu, J., & Liu, M. (2022). Global, regional, and national incidence and mortality of neonatal preterm birth, 1990–2019. *JAMA Pediatrics, 176* (8), 787–796. https://doi.org/10.1001/jamapediatrics.2022.1622

Cerasani, Jacopo; Ceroni, Federica; De Cosmi, Valentina; Mazzocchi, Alessandra; Morniroli, Daniela; Roggero, Paola; Mosca, Fabio; Agostoni, Carlo; GiannÃ¬, Maria Lorella. (2020). *Human Milk Feeding and Preterm Infantsâ: Growth and Body Composition: A Literature Review. Nutrients, 12(4), 1155.* doi:10.3390/nu12041155

Chen, G. (2025). Prefeeding Interventions to Enhance Oral Feeding in Preterm Infants. *World Congress of Advances in Otorhinolaryngology and Head & Neck Care* https://doi.org/10.51219/urforum.2025.gaoyan-chen

Chou, J., Kuo, C.-H., Tam, K.-W., Jen, H.-J., Chang, W.-P., Chou, Y.-Y., & Chen, K.-H. (2026). Effects of Traditional and Innovative Safe Breastfeeding Pillows on Postpartum Maternal Breastfeeding Self-Efficacy, Awareness, and Comfort: A

Randomized Controlled Trial. *Journal of Nursing Management*. http://doi.org/10.1155/jonm/8414086

Coca, K. P., Gamba, M. A., Silva, R. S., Abrão, A. C. F. V., & Martinez, F. E. (2016). Breastfeeding preterm infants: Experience, support and difficulties. *Revista da Escola de Enfermagem da USP, 50*(1), 36–43. https://doi.org/10.1590/S0080-623420160000100005

Dong, D., Ru, X., Huang, X., Sang, T., Li, S., Wang, Y., & Feng, Q. (2022). A prospective cohort study on lactation status and breastfeeding challenges in mother giving birth to preterm infants. *International Breastfeeding Journal*, 17 (1), 6. 17(1), 6. https://doi.org/10.1186/s13006-021-00447-4

Douglas, P. (2022). Re-thinking lactation-related nipple pain and damage. *Women's Health*, 18. https://doi.org/10.1177/17455057221087865

Fucile, S., Wener, E., & Dow, K. (2021). Enhancing breastfeeding establishment in preterm infants: A randomized clinical trial of two non-nutritive sucking approaches. *Early human development*, 156, 105347. http://doi.org/10.1016/j.earlhumdev.2021.105347

Guo, W., Zhang, H., Wang, L., Huang, F., D., Zgambo, M., Chen, S., Wu, Y., Bu, Y., & Shimpuku, Y. (2025). Factors influencing the provision of human milk feeding support for preterm infants in Neonatal Intensive Care Units in China: a qualitative study of neonatal nurses' perspectives. International Breastfeeding Journal, 20. https://doi.org/10.1186/s13006-025-00778-6

Gurung, A., & Paudel, B. (2025). Breastfeeding Technique among Postnatal Mothers at the Teaching Hospital, Bharatpur, Nepal. *International Journal of Medical and Health Research.* http://doi.org/10.61424/ijmhr.v3i2.205

Heller, N., Rüdiger, M., Hoffmeister, V., & Mense, L. (2021). Mother's Own Milk Feeding in Preterm Newborns Admitted to the Neonatal Intensive Care Unit or Special-Care Nursery: Obstacles, Interventions, Risk Calculation. *International Journal of Enviromental Research and Public Health*, 18. https://doi.org/10.3390/ijerph18084140

Huang, C.-C., Chen, Y.-H., Lin, H.-Y., & Hsu, Y.-C. (2024). Oral feeding readiness assessment tools for preterm infants. *Hu Li Za Zhi (The Journal of Nursing), 71*(5), 89-95–18. https://doi.org/10.6224/jn.202410

Ibrahim, C., Chavez, P., Smith, D., Craig, J., & Pineda, R. (2024). Oral motor interventions used to support the development of oral feeding skills in preterm infants: An integrative review. *Early human development*, 198,106125. https://doi.org/10.1016/j.earlhumdev.2024.106125

Jiang, Xin., Ding, L., Wu, Na., Xu, Yiting., Yao, Xiao., Huo, K.Y., & Huang, R. (2025). Long Studies on breastfeeding among preterm infants: a scoping review. BMC Pregnancy and Childbirth, 25 :738. https://doi.org/10.1186/s12884-025-07837-0

Jiang, Xin., Ding, L., Wu, Na., Xu, Yiting., Yao, Xiao., Huo, K.Y., & Huang, R. (2025). Long Studies on breastfeeding among preterm infants: a scoping review. BMC Pregnancy and Childbirth, 25 :738. https://doi.org/10.1186/s12884-025-07837-0Mills, M., Nommsen-Rivers, L., Kaplan, H. C., Liu, C., Ehrlich, S. R., & Ward, L. (2024). Predictors of Direct Breastfeeding in Preterm Infants. *Breastfeeding Medicine*, 19, 779-787. https://doi.org/10.1089/bfm.2024.0041

Mislu, E., Kumsa, Henok., Arage, MW., Shitie, A., & Adimasu, A. (2024). Effective breastfeeding techniques and associated factors among lactating women: a community-based study, north east Ethiopia. *Frontiers Public Health*, (12). https://doi.org/10.3389/fpubh.2024.1337822

Niazi, A., Yousefzadeh, S., Rakhshandeh, H., & Esmaeily, H. (2019). The effect of nipple soreness treatment with purslane cream and lanolin on frequency and

duration of breastfeeding in nursing mothers: A randomized clinical trial. *Journal of Midwifery and Reproductive Health, 7*(1), 1527–1535. https://doi.org/10.22038/jmrh.2018.24788.1267

Parashar, M., Singh, S., Kishore, J., & Patavegar, B. (2015). Breastfeeding attachment and positioning technique, practices, and knowledge of related issues among mothers in a resettlement colony of Delhi. *Infant, Child, & Adolescent Nutrition, 7*(6). https://doi.org/10.1177/1941406415602528

Park, J., Thoyre, S., Smallcomb, J., Mcternan, M., & Kneeland, T. (2024). Biobehavioral Efficacy of the Elevated Side-lying Position for Feeding Preterm Infants: Study Protocol. *Journal of advanced nursing*, 81, 2819-2827. http://doi.org/10.1111/jan.16444

Parker, M. G., Stellwagen, L., Miller, E. R., Noble, L., Corkins, M., & Hudak, M. L. (2026). Promoting Human Milk and Breastfeeding for the Very Low Birth Weight Infant: Clinical Report. *Pediatrics. https://doi.org./10.1542/peds.2025-073625*

Peng, H., Li, X., Guo, X.-M., Li, Y., Huang, X., Zeng, L., Liu, C., Li, Y., & Hu, Y. (2026). NICU nurses' knowledge, attitudes, practices, and influencing factors regarding breastfeeding of newborns: a scoping review. International Breastfeeding Journal, 21. *International Breastfeeding Journal*, 21. https://doi.org/10.1186/s13006-025-00807-4

Pineda, R., Prince, D., Reynolds, J., Grabill, M., & Smith, J. (2020). Preterm infant feeding performance at term equivalent age differs from that of full-term infants. *Journal of Perinatology, 40*(4), 646–654. https://doi.org/10.1038/s41372-020-0616-2

Polit, D. F., & Beck, C. T. (2021). *Nursing research: Generating and assessing evidence for nursing practice* (11th ed.). Wolters Kluwer.

Quigley, M., Embleton, N. D., Meader, N., & McGuire, W. (2024). Donor human milk for preventing necrotising enterocolitis in very preterm or very low-birthweight infants. *The Cochrane database of systematic reviews*, 9, CD002971. https://doi.org/10.1002/14651858.cd002971.pub6

Rani, S., Habiba, U. E., Qazi, W. A., & Tassadaq, N. (2019). Association of breastfeeding positioning with musculoskeletal pain in postpartum mothers of Rawalpindi and Islamabad. *Journal of the Pakistan Medical Association, 69*(4), 564–566.

Ranganathan, P., Deo, V., & Pramesh, C. (2024). Sample size calculation in clinical research. *Perspectives in Clinical Research*, 15, 155 - 159. http://doi.org/10.4103/picr.picr10024

Ren, G., Fan, L., Chen, Y., Lei, H., Wu, W., Y., & Huang, Y. (2025). Effect of sequential swallow training programme on feeding transition and suck-swallow-breath coordination in preterm infants. *Early human development*, 201, 106193. https://doi.org/10.1016/j.earlhumdev.2025.106193

Sadiq, I. Z., Usman, A., Muhammad, A., & Ahmad, K. H. (2024). Sample size calculation in biomedical, clinical and biological sciences research. *Journal of Umm Al-Qura University for Applied Sciences*, 11, 133-141. https://doi.org/10.1007/s43994-024-00153-x

Safayi, B. L., Assimamaw, N. T., & Kassie, D. (2021). Breastfeeding technique and associated factors among lactating mothers visiting Gondar town health facilities, Northwest Ethiopia: observational method. *Italian Journal of Pediatrics*, 4. https://doi.org/10.1186/s13052-021-01158-6

Sirikijkhajor, K., & Suksamarnwong, M. (2023). The effect of using a U-shaped nursing pillow on breastfeeding success among postpartum mothers: A randomized controlled trial. *Belitung Nursing Journal, 9*(1), 23–30.

Smith, A. R., & Lee, K. A. (2021). Effects of breastfeeding support devices on maternal comfort and infant feeding behavior: A randomized controlled trial. *Maternal*

and Child Health Journal, 25(4), 567–574. https://doi.org/10.1007/s10995-020-03043-7

Song, J. T., Kinshella, M. W., Kawaza, K., & Goldfarb, D. (2023). Neonatal intensive care unit interventions to improve breastfeeding rates at discharge among preterm and low birth weight infants: A systematic review and meta-analysis. *Breastfeeding Medicine, 18*(3), 173–184. https://doi.org/10.1089/bfm.2022.0151

Tomita, A., Tahara-Sasagawa, E., Yonezawa, K., Usui, Y., & Haruna, M. (2024). Factors associated with breastfeeding rates at 1 month of age: Focusing on newborn feeding behaviours in a Japanese maternity hospital. *Journal of Paediatrics and Child Health*, 60, 852-858. http://doi.org/10.1111/jph.16691

Tran, H. T., Luu, H., Le, T. D., Pham, N., Sobel, H. L., & Murray, J. (2023). Factors associated with high exclusive breastfeeding rates among preterm infants under 34 weeks of gestation in Da Nang, Vietnam: A retrospective cohort study. *Journal of Global Health*, 13. https://doi.org/10.7189/j0gh.13.04121

Vanbelle, S. (2024). Statistical inference for agreement between multiple raters on a binary scale. *The British Journal of Mathematical and Statistical Psychology* https://doi.org/10.1111/bmsp.12333

Victora, Cesar G., Bahl, R., Barros, A. J. D., França, G. V. A., Horton, S., Krasevec, J., Murch, S., Sankar, M. J., Walker, N., & Rollins, N. C. (2016). Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *The Lancet, 387*(10017), 475–490. https://doi.org/10.1016/S0140-6736(15)01024-7

Wang, Z., Liu, Q., Min, L., & Mao, X. (2020). The effectiveness of the laid-back position on lactation-related nipple problems and comfort: a meta-analysis. MBC Pregnancy and Childbirth, 21. https://doi.org/10.1186/s12884-021-03714-8

Widiastuti, I. A. K. S., Rustina, Y., & Efendi, D. (2020). The use of breastfeeding pillow to reduce discomfort for breastfeeding mothers. *Pediatric Reports, 12*(Suppl. 1), 8702. https://doi.org/10.4081/pr.2020.8702

World Health Organization (WHO). (2023). *Preterm birth*. https://www.who.int/news-room/fact-sheets/detail/preterm-birth

Yakar, F. E., & Korğalı, E. Ü. (2025). Possible Factors Affecting Breast Milk Feeding Status Of Preterm Infants Monitored in the Neonatal Intensive Care Unit. *Turkish archives of Pediatrics*, 60,280-288. https://doi.org/10.5152/turkarchpediatr.2025.24265

Yang, L., Fu, H.-D., & Zhang, L. (2023). A systematic review of improved positions and supporting devices for premature infants in the NICU. Heliyon, 9. https://doi.org/10.1016/j.heliyon.2023.e14388

Zakerihamidi, M., Maamouri, G., Boskabadi, A., Rakhshanizadeh, F., Parvini, Z., Ramazani, A., Bagheri, F., & Boskabadi, H. (2025). Comparison of newborns' characteristics between neonates with proper and improper breastfeeding positions. *Journal of Neonatal-Perinatal Medicine*, 18, 218-225. http://doi.org/10.1177/17455057982513273 82

Zhang, R., Ying, E., Wu, X., Qin, H., Guo, Y., Guo, X., Yu, Z., & Chen, J. (2024). A systematic review and meta-analysis of breastfeeding and neurodevelopmental outcomes in preterm infants. *Frontiers in Public Health, 12*. https://doi.org/10.3389/fpubh.2024.1401250

Zhou, B., Liang, R., Zhang, J., Li, X., Broach, Z., & Yip, J. (2024). Posture Monitoring During Breastfeeding: Smart Underwear Integrated with an Accelerometer and Flexible Sensors. *Sensor (Basel, Switzerland), 24*. https://doi.org/10.3390/s24237641