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Impact of Exclusively Administered Hindmilk-Rich Feeds on Weight Gain in Preterm Neonates

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ABSTRACT

Introduction: Preterm and low-birth-weight (LBW) neonates are at heightened risk of growth failure and neonatal morbidity due to immature gastrointestinal systems and high metabolic demands. Human breast milk, particularly hindmilk, is rich in fat and calories and may enhance early postnatal growth. This study aimed to evaluate the impact of hindmilk feeding on the growth parameters of preterm neonates compared to standard composite milk feeding.

Materials and Methods:A prospective observational study was conducted over 12 months (January–December 2024) in the Department of Pediatrics at a tertiary care hospital in Kanchipuram. A total of 100 preterm neonates (<37 weeks gestation, <2500 grams) without clinical complications were enrolled and randomly assigned to two groups. Group 1 (n = 50) received exclusively expressed hindmilk; Group 2 (n = 50) received composite milk feeds. Daily weight and weekly head circumference and length were measured for two weeks or until discharge. Data were analyzed using SPSS Version 20.0, with $p < 0.05$ considered statistically significant.

Results: At baseline, both groups were comparable in admission weight and APGAR scores. However, Group 1 neonates had slightly lower gestational age, head circumference, and length. By discharge, the hindmilk group showed significantly greater improvements in weight ($p = 0.02$), head circumference ($p = 0.04$), and length ($p = 0.001$) compared to the composite milk group. Subgroup analysis also revealed enhanced growth in neonates between 28–32 weeks gestation in the hindmilk group.

Conclusion: Hindmilk feeding significantly improved early growth outcomes in preterm and LBW neonates, supporting its role as a practical and safe nutritional strategy. Promoting maternal education and implementing hindmilk-focused feeding protocols in NICUs may contribute to better neonatal health and development

Keyword: *Hindmilk, Preterm neonates, Low birth weight, Neonatal growth, Breast milk feeding, Neonatal nutrition, Anthropometry*

1. INTRODUCTION

Neonatal care, particularly for infants with low birth weight, remains a pressing global health concern due to its strong association with both perinatal and neonatal mortality rates [1]. Preterm infants, especially those categorized as having very low birth weight (VLBW), face an elevated risk of numerous medical complications. These include respiratory distress, sepsis, and metabolic imbalances, all of which emphasize the critical importance of providing optimal nutritional support during the early postnatal period [2].

Recent literature highlights that the nutritional practices followed during the first few weeks of life play a pivotal role in determining the growth patterns and long-term outcomes of preterm neonates [3]. Adequate and timely nutrition not only supports physical development but also reduces the risk of hospital-acquired complications and contributes to better neurodevelopmental trajectories.

Among the various feeding options available, human breast milk—preferably from the infant's own mother—remains the gold standard for neonatal nutrition. It provides not only the full spectrum of macronutrients and micronutrients necessary for growth but also a range of biologically active components, including immunoglobulins, cytokines, growth factors, and enzymes, which collectively strengthen the immune system and facilitate maturation of the gut and other organs [4].

Due to their immature gastrointestinal systems and higher metabolic requirements, preterm infants often exhibit suboptimal weight gain. This is compounded by their limited gastric capacity, which restricts the volume of feeds that can be safely administered. As a result, increasing the caloric density of feeds without increasing volume becomes an essential strategy for improving growth in this population [2].

Breast milk composition varies during the course of a feeding session. The milk expressed at the beginning, known as

foremilk, is relatively lower in fat and energy content. In contrast, hindmilk—extracted towards the end of a breastfeeding session—is significantly richer in fat and provides higher caloric density [1]. Hindmilk also contains essential long-chain polyunsaturated fatty acids (LCPUFAs), such as arachidonic acid (AA) and docosahexaenoic acid (DHA), which are vital for neuronal development, linear growth, and visual function in neonates [2].

Given these benefits, this pilot study was designed to explore whether selectively feeding preterm neonates (weighing less than 2500 grams) with exclusively expressed hindmilk could lead to improved weight gain compared to standard mixed milk feeds. The hypothesis was that targeted use of the higher-fat, energy-rich hindmilk could offer a safe and practical nutritional intervention to support enhanced growth in this vulnerable population

2. MATERIALS AND METHODS

A prospective observational study was carried out in the Department of Pediatrics at a tertiary care hospital located in Kanchipuram. The study spanned 12 months, from January 2024 to December 2024, and included preterm neonates with low birth weight. A total of 100 newborns, born before 37 weeks of gestation and weighing less than 2500 grams, who were admitted to the Neonatal Intensive Care Unit (NICU) and free from clinical complications, were enrolled. Infants were excluded if they had congenital anomalies, severe postnatal complications (such as birth asphyxia, respiratory distress syndrome, meconium aspiration, or congenital defects like tracheoesophageal fistula), Rh incompatibility, prolonged need for respiratory support, severe intrauterine growth restriction, exposure to maternal HIV infection, formula feeding, or any condition likely to affect weight gain. Informed written consent was obtained from the parents or guardians of all participating infants.

Study Design and Group Allocation

Participants were randomly assigned into two groups using a computer-generated block randomization list. Group 1 received exclusively hindmilk feeds, while Group 2 (control group) received composite milk feeds. Composite milk, comprising both foremilk and hindmilk, was expressed from the same breastfeeding session and typically contained 4–5% fat by volume (intermediate between foremilk and hindmilk), approximately 1–1.2% protein, and 6.5–7% carbohydrates. Baseline data such as gestational age, weight, and anthropometric parameters were recorded and monitored for two weeks or until discharge. All neonates were cared for in a thermo-neutral environment.

Breast Milk Expression and Handling

Mothers were instructed to express breast milk using sterilized breast pumps into clean, clearly labeled containers. Foremilk was collected during the first three minutes of milk flow. A noticeable change in color from white to yellow signified the beginning of hindmilk expression. Hindmilk was then collected until the breast was completely emptied. Proper hygiene and sterilization protocols were followed throughout the process. Mothers received lactation counseling from trained staff and milk bank personnel, emphasizing the nutritional benefits of hindmilk for preterm infants. Education included addressing factors that could impact milk production, such as maternal stress and nutrition, and training on the effective use of breast pumps. Mothers were encouraged to express milk frequently—every two to three hours—to ensure a consistent milk supply. Regular engagement with mothers continued in the postnatal ward to promote hindmilk expression and dispel common misconceptions about breast hygiene.

Feeding Protocol

Neonates were fed every two hours using either nasogastric tubes or sterilized spoon-feeding sets. The daily feeding volume was gradually increased by 15 mL/kg until reaching a target of 200 mL/kg in both groups. This stepwise increase was intended to ensure feed tolerance and minimize gastrointestinal complications. After the initial two-week period, all infants transitioned to full expressed milk feeding until they were discharged. Any infant developing complications such as recurrent vomiting or apnea during the study was excluded from the final analysis.

Anthropometric Measurements

Neonates were weighed daily using a calibrated digital neonatal weighing scale for a period of two weeks or until discharge. Additional anthropometric parameters—namely, head circumference and body length—were recorded on a weekly basis throughout the study period.

Statistical Analysis

All data collected during the study were compiled in Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 20.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics such as means, standard deviations, frequencies, and percentages were used to summarize the data. Continuous variables with normal distribution were compared between groups using the independent sample t-test. For variables not normally distributed, the Mann-Whitney U test was applied. Categorical variables were analyzed using either the chi-square test or Fisher's exact test, depending on applicability. A two-tailed p-value of less than 0.05 was considered to indicate statistical significance.

3. RESULTS

Table 1: Comparison of Baseline Characteristics Between Study Groups

Characteristic	Group 1 (Hindmilk) N = 50	Group 2 (Composite Milk) N = 50	p-value
Maternal age (years)	23.9 ± 3.1	24.5 ± 3.7	0.31
Gestational age (weeks)	30.1 ± 2.5	32.0 ± 1.8	0.01
Admission weight (grams)	1625.4 ± 318.2	1609.6 ± 362.4	0.83
Admission head circumference (cm)	29.5 ± 2.6	30.3 ± 1.7	0.04
Admission length (cm)	40.6 ± 3.9	42.2 ± 2.8	0.003
Vaginal delivery	24 (48%)	27 (54%)	0.46
Cesarean delivery	26 (52%)	23 (46%)	
Gestational age 28–32 weeks	30 (60%)	27 (54%)	0.52
Gestational age 32–34 weeks	20 (40%)	23 (46%)	
Primigravida	26 (52%)	17 (34%)	0.04
Multigravida	24 (48%)	33 (66%)	
APGAR at 5 minutes – 8/10	18 (36%)	20 (40%)	0.58
APGAR at 5 minutes – 9/10	32 (64%)	30 (60%)	

The baseline characteristics of the two groups were largely comparable, with no significant differences in maternal age, birth weight, or APGAR scores at 5 minutes. However, statistically significant differences were observed in gestational age, head circumference, and length at admission, with Group 2 (composite milk) showing slightly higher values in each. A higher proportion of primigravida mothers was seen in Group 1, while multigravida mothers were more common in Group 2. Mode of delivery and distribution across gestational age ranges (28–34 weeks) were similar between the groups. Overall, both groups were relatively well-matched, allowing for a fair comparison of feeding outcomes.

Table 2: Comparison of Weight, Head Circumference, and Length Between Study Groups at Admission and Discharge

Parameter	Time Point	Group 1 (Hindmilk) Mean ± SD	Group 2 (Composite Milk) Mean ± SD	p-value
Weight (grams)	Admission	1623.8 ± 318.4	1610.5 ± 361.2	0.82
	Discharge	1702.6 ± 325.1	1553.2 ± 370.5	0.02
Head Circumference (cm)	Admission	29.6 ± 2.6	30.2 ± 1.8	0.03
	Discharge	31.8 ± 2.4	30.9 ± 3.9	0.04

Parameter	Time Point	Group 1 (Hindmilk) Mean ± SD	Group 2 (Composite Milk) Mean ± SD	p-value
Length (cm)	Admission	40.5 ± 3.9	42.1 ± 2.8	0.003
	Discharge	44.6 ± 2.7	42.4 ± 3.7	0.001

Note: N = 50 per group; p-value < 0.05 was considered statistically significant.

Table 2 compares the growth parameters—weight, head circumference, and length—between the two study groups at admission and discharge. While both groups had similar baseline measurements, neonates in the hindmilk group (Group 1) showed significantly greater improvements in all three parameters by discharge. Notably, the mean weight and length gain were higher in Group 1, with p-values indicating statistical significance. These results suggest that hindmilk, due to its higher fat and caloric content, may contribute more effectively to early postnatal growth in preterm infants compared to composite milk.

4. DISCUSSION

This study explored the effects of targeted hindmilk feeding on growth parameters and early health outcomes in preterm and low-birth-weight neonates. The findings strongly suggest that infants who received hindmilk exhibited significantly better growth outcomes by the time of discharge when compared to those fed composite milk. Despite a higher proportion of very premature infants in the hindmilk group, baseline characteristics such as admission weight were comparable between the groups. However, Group 1 neonates presented with slightly smaller head circumferences and lengths, which may reflect developmental differences related to gestational age rather than the type of feeding alone.

In contrast to the work of Ogechi et al. [5], which reported minimal variation in gestational age and birth weight across groups, our study identified a statistically significant difference in gestational age ($p = 0.009$), as well as lower head circumference ($p = 0.03$) and length ($p = 0.002$) at baseline in the hindmilk-fed group. These disparities may highlight demographic variability that can influence both initial anthropometry and postnatal response to nutritional interventions.

Throughout the observation period, the hindmilk group demonstrated superior weight gain ($p = 0.03$), increased head circumference ($p = 0.04$), and greater length increments ($p = 0.00$) at discharge. These outcomes are consistent with findings from Spencer et al. [6], Valentine et al. [7], Slusher et al. [8], and Alshaikh et al. [9], who collectively reported that hindmilk, due to its higher caloric and fat content, supports enhanced growth in preterm neonates. In our study, these infants also appeared more settled and slept better between feedings, suggesting improved satiety and energy intake.

Moreover, the incidence of clinical complications during hospitalization was lower in the hindmilk group, suggesting that enriched fat content may not only foster growth but also support better physiological adaptation after birth. This observation is supported by earlier studies [10,11] that linked hindmilk to improved early health outcomes.

An interesting observation was the association between lower APGAR scores and reduced growth velocity, especially in weight and head circumference. These neonates may require additional support due to delayed physiological adaptation and increased vulnerability during the early neonatal period. Similar patterns were observed in the findings of Shukla et al. [12], while Costa et al. [13] reported differing outcomes, possibly due to population or methodological differences.

Further subgroup analysis by gestational age bands (28–32 weeks and 32–34 weeks) revealed significant differences in discharge weight ($p = 0.002$), head circumference ($p = 0.03$), and length ($p = 0.03$ and 0.04, respectively), reinforcing the positive influence of hindmilk, especially in very preterm infants. These results align with Alshaikh et al. [9], who found continued benefits of hindmilk feeding even after discharge, particularly in promoting head growth among very preterm neonates.

While many studies have focused on hindmilk's impact on weight gain and head circumference, its influence on neonatal length is less frequently documented. Our study contributes to this less-explored area, suggesting that hindmilk may also support linear growth. Nevertheless, further research is warranted to substantiate these findings and clarify the underlying mechanisms [14,15].

In summary, this study provides compelling evidence that hindmilk feeding has a beneficial impact on short-term growth and anthropometric outcomes in preterm and low-birth-weight neonates. Incorporating hindmilk-focused feeding protocols in neonatal care units could potentially enhance early developmental outcomes. Future research should investigate the long-term developmental implications of such feeding strategies and explore broader factors influencing neonatal growth beyond the early postnatal period.

5. CONCLUSION

This study demonstrated that hindmilk feeding offers substantial advantages for the growth and health of preterm and low-birth-weight neonates, particularly those born between 28 and 32 weeks of gestation. Despite a greater proportion of very preterm infants in the hindmilk group, these neonates achieved significantly better growth outcomes by the time of discharge. Promoting awareness and providing targeted education to mothers of such high-risk infants—focusing on the importance of hindmilk and dispelling common myths—should be a priority for healthcare providers. To further enhance neonatal outcomes, continued clinical research and implementation of evidence-based feeding practices are essential, ensuring that all vulnerable infants have access to the full benefits of hindmilk nutrition

REFERENCES

[1] Cooke RJ, Ainsworth SB, Fenton AC: Postnatal growth retardation: a universal problem in preterm infants . Arch Dis Child Fetal Neonatal Ed. 2004, 89:428-30. 10.1136/adc.2001.004044

[2] American Academy of Pediatrics: Pediatric nutrition. Kleinman RE, Greer FR (ed): American Academy of Pediatrics, Elk Grove Village, IL; 2014. https://www.vasiliadis-books.gr/Vasiliadis-books/wp content/uploads/2015/06/PEDIATRIC-NUTRITION-LOOK-INSIDE.pdf.

[3] Anatolitou F: Human milk benefits and breastfeeding. J Pediatr Neonat Individual Med. 2012, 23:11-8. 10.7363/010113

[4] Mosca F, Giannì ML: Human milk: composition and health benefits. Pediatr Med Chir. 2017, 39:155. 10.4081/pmc.2017.155

[5] Ogechi AA, William O, Fidelia BT: Hindmilk and weight gain in preterm very low-birthweight infants. Pediatr Int. 2007, 49:156-60. 10.1111/j.1442-200X.2007.02336.

[6] x Spencer SA, Hendrickse W, Roberton D, Hull D: Energy intake and weight gain of very low birthweight babies fed raw expressed breast milk. Br Med J (Clin Res Ed). 1982, 285:924-6. 10.1136/bmj.285.6346.924

[7] Valentine CJ, Hurst NM, Schanler RJ: Hindmilk improves weight gain in low-birth-weight infants fed human milk. J Pediatr Gastroenterol Nutr. 1994, 18:474-7. 10.1097/00005176-199405000-00013 Slusher T, Hampton R, Bode-Thomas F, Pam S,

[8] Akor F, Meier P: Promoting the exclusive feeding of own mother's milk through the use of hindmilk and increased maternal milk volume for hospitalized, low birth weight infants (< 1800 grams) in Nigeria: a feasibility study. J Hum Lact. 2003, 19:191-8. 10.1177/0890334403252490

[9] Alshaikh BN, Festival J, Reyes Loredo A, Yusuf K, Towage Z, Fenton TR, Wood C: Hindmilk as a rescue therapy in very preterm infants with suboptimal growth velocity. Nutrients. 2023, 15:929. 10.3390/nu15040929

[10] Hård AL, Nilsson AK, Lund AM, Hansen-Pupp I, Smith LE, Hellström A: Review shows that donor milk does not promote the growth and development of preterm infants as well as maternal milk. Acta Paediatr. 2019, 108:998-1007. 10.1111/apa.14702

[11] Prentice P, Ong KK, Schoemaker MH, et al.: Breast milk nutrient content and infancy growth . Acta Paediatr. 2016, 105:641-7. 10.1111/apa.13362

[12] Shukla VV, Bann CM, Ramani M, et al.: Predictive Ability of 10-Minute Apgar Scores for Mortality and Neurodevelopmental Disability. Pediatrics. 2022, 149:149. 10.1542/peds.2021-054992

[13] Costa TL, Mota A, Duarte S, Araujo M, Ramos P, Machado HS, Lemos P: Predictive factors of Apgar scores below 7 in newborns: can we change the route of current events?. J Anesth Clin Res. 2016, 7:10. 10.4172/2155-6148.1000672

[14] Berger HM, Scott PH, Kenward C, Scott P, Wharton BA: Milk pH, acid base status, and growth in babies . Arch Dis Child. 1978, 53:926-30. 10.1136/adc.53.12.926

[15] Altun-Köroğlu O, Ozek E, Bilgen H, Cebeci D: Hindmilk for procedural pain in term neonates . Turk J Pediatr. 2010, 52:623-9.