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Retrospective analysis of volumes of manually expressed colostrum among healthy postnatal mothers at a tertiary care referral unit in South India. Not enough milk or not enough patience?

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ABSTRACT

Introduction The volumes of colostrum have been quantified as 5 mL and 25 mL per feed on days 1 and 3, respectively, as per the data described about 20 years ago. However, the use of commercial formula is on the rise and 'not enough milk' is a common complaint by postnatal mothers.

Objectives To determine the average volume of colostrum in one sitting per day on first three postnatal days among healthy late preterm and term gestational mothers and to compare the same among late preterm, term gestation and modes of delivery.

Design Retrospective study.

Setting A tertiary care perinatal setting in South India.

Patients Healthy late preterm and term gestational mothers whose babies were roomed in.

Interventions A lactation consultant helped the mothers manually express breast milk.

Main outcome measures Volumes of manually expressed colostrum on first three postnatal days.

Results Of the 391 mothers analysed in the study, on first three postnatal days, the average volume of colostrum in one sitting each was 4.68 mL, 8.87 mL and 22.53 mL, respectively. There was no statistically significant difference in volumes of colostrum secreted among term and late preterm mothers and also among mothers with different modes of delivery. As anticipated, multiparous mothers expressed significantly higher volumes as compared with primiparous mothers, on all three postnatal days.

Conclusions The volumes of colostrum on first three postnatal days among healthy mothers were comparable with traditional volumes described about two decades ago. Gestational age and mode of delivery did not affect the volumes of colostrum in the present cohort.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The volumes of colostrum on postnatal day 1 and day 3 were described as 5 mL and 25 mL traditionally.

WHAT THIS STUDY ADDS

⇒ After two decades, the average colostrum volumes remain comparable at 4.7 mL, 8.9 mL and 22.5 mL on first three postnatal days, respectively.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The usage of formula feeds is on the rise despite the volume of colostrum being consistent with traditional norms. The perception of 'not enough milk' is probably false and the resourceful services of lactation consultant can help achieve successful exclusive breast feeding.

INTRODUCTION

Optimal breast feeding is so critical that it could save the lives of over 820 000 children under the age of 5 years each year. Breast feeding is the best preventive healthcare approach that developing countries can employ to reduce under-5 mortality.[1] The benefits of breast feeding are beyond neonatal nutrition. Breast feeding is known to reduce the rates of respiratory infections and diarrhoeal episodes among children and reduce the risk of breast and ovarian cancer among mothers. The benefits have led to extensive research activities in breast milk and breastfeeding practices. The volumes of colostrum have been quantified as 5 mL on first postnatal day and up to 25 mL on third postnatal day. The volumes may seem modest, but they are typically adequate, to meet the needs of their newborns.[2 3] However, 'not enough milk' is a common complaint in postnatal wards. It is a daunting task for the paediatrician and neonatologist to counsel the mothers that the volume of colostrum is sufficient for the newborn. The rate of maternal perception of 'not enough milk' can be as high as 50%, according to a large database of postnatal mothers.[4]

The escalating use of commercial infant formula can be attributed to maternal concerns regarding perceived inadequate

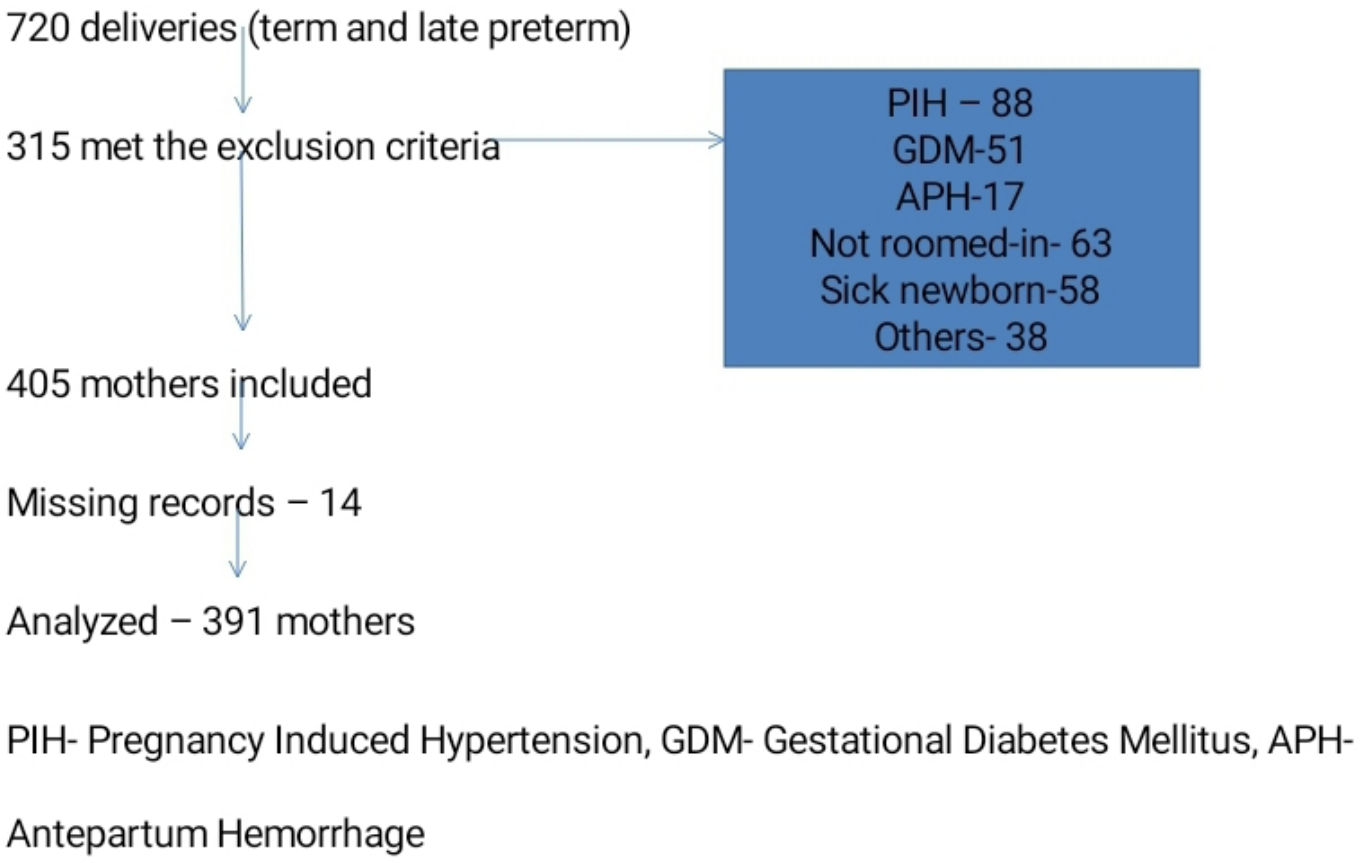

Figure 1 The flow chart depicting inclusion and exclusion of participants in the study.

milk production. In large perinatal settings, early discharges (at the completion of 72 hours) are often carried out due to logistic reasons like availability of beds and financial aspects. Since the enrolled population in the present study consists of term and late preterm infants, their mothers typically breastfeed directly, and the volume of colostrum secreted is not usually quantified. Practices such as prelacteal feeding and discarding colostrum further exacerbate the problem. The issue of 'not enough milk' is predominantly reported by mothers in our setting. This raises questions about the potential for actual low milk transfer from mother to baby over the last two decades, despite our desire to believe otherwise. With early discharge becoming commonplace in high-volume settings within low-income and middle-income countries (LMICs), this study endeavours to estimate the average volume of colostrum produced through manual expression in a single session. The study also aids in determining a mother's readiness for discharge by assessing her ability to secrete a certain volume of milk by the third postnatal day. The study aims to find the approximate volume of colostrum secreted by healthy mothers in the first three postnatal days.

METHODOLOGY

A retrospective study spanning 8 months, from June 2023 to January 2024, was conducted at a tertiary care centre in South India. The primary objective of this study was to analyse the volumes of colostrum in one sitting per day during the first three postnatal days among mothers of both late preterm ($34+^{0}$ to $36+^{6}$ weeks of gestation) and term gestation. The secondary objective was to compare colostrum volumes among different gestational periods and modes of delivery. The study included postnatal mothers within the first 3 days of delivery, excluding those who were admitted to the Intensive Care Unit post-delivery. Additionally, mothers with gestational diabetes, pregnancy-induced hypertension, antepartum haemorrhage or those receiving medication beyond routine nutritional supplements prescribed to antenatal mothers in India were excluded from the study as these variables could act as potential confounders for quantity of breast milk secreted by the mother. Mothers whose babies were admitted to Neonatal Intensive Care Unit were excluded from the analysis. All neonates included in the cohort were roomed in with their mothers and were fed on demand. Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Mothers in the cohort were provided with two important aspects of care to ensure exclusive breast feeding in line with hospital policy. Breastfeeding initiation occurred in the labour room or operation theatre within the first few minutes of birth, shortly after initial stabilisation of the

newborn. The practice was also part of a parallel study at the institute to ensure the first latch at breast soon after birth. Additionally, a lactation counsellor visited the mothers and made them express milk manually once a day during the first three postnatal days. The lactation counsellor is a qualified professional who has been certified by BPNI (Breastfeeding Promotion Network of India) as BPNI's Infant and Young Child Feeding (IYCF) Counselling Specialist. The process of milk expression was done as per the standard operating procedure outlined in the IYCF manual which is uniformly practised throughout India. Local issues of breast such as flat nipple and retracted nipple were addressed before the expression of milk. The milk was expressed from both the breasts and the volume was recorded using marked containers. The volume of milk when secreted in small quantities was measured using a marked sterile syringe, with aseptic precautions. The expression was carried out in the morning hours as the mothers were most receptive to milk expression during this hour and the lactation counsellor kept records of the same. The duration of milk expression depended on the mother's comfort and hence was not uniform. The breast pumps were not used due to risk of infection. Another important reason for not using the breast pumps in the present study was to make sure that the study results are applicable to general population who generally rely on manual expression of breast milk. Maternal baseline characteristics such as name, address, age, parity, gestational age and mode of delivery were documented. The volumes of milk expressed in one sitting during each postnatal day until day 3 were recorded. The volume of colostrum expressed in each sitting was recorded in the study proforma. Mothers with any of the three missing values for volume of colostrum were excluded from the analysis. All neonates in the cohort were discharged home without any morbidities. The data were extracted from human milk bank database, which is password protected with limited access to milk bank staff.

Sample size calculation was done prior to the study with the help of a statistician.

Huang *et al*[4] stated that 50% of the mothers had perceived insufficient milk supply at different points after delivery. Borrowing from the above study, with an effect size of 50%, α error 5%, the number needed to find statistical significance for colostrum volumes was 384 mothers.

Statistical methods

Descriptive statistics (frequencies, percentages, means and SDs) were calculated to characterise the sample. Missing records were excluded from the analysis. A two-tailed significance with an alpha level of 0.05 of significance was used. Student's t-test was employed to compare the means and SDs among the subgroups. Pearson correlation was used to assess the relationship between volumes of colostrum with each passing postnatal day. SPSS V.29 was used for data analysis.

Table 1 Baseline characteristics of mothers in the study

Characteristics N=391	Frequency Mean±SD or n (%)
Maternal age (years)	27±4.5
Primigravida	209 (53.4)
Caesarean section	204 (52.2)
Male	209 (53.4)
Gestational age (weeks)	38±1.5
Birth weight (grams)	2714±178

RESULTS

During the study period, medical records of 720 deliveries at the institute were assessed for eligibility. Among this group, 405 mothers, free of any morbidities, were confirmed as eligible participants. However, 14 mothers were excluded from the analysis due to missing records. Thus, a total of 391 mothers were included and analysed in the study. This has been depicted in figure 1.

Of the 391 mothers included in the study, 338 had pregnancies lasting to term, while 53 had late preterm gestation. The average age of the mothers in the cohort was 27 years. Among them, 209 were primigravida, 139 were second gravida, 35 were third gravida and 8 belonged to the fourth gravida category. Caesarean sections were performed on 204 mothers, while 187 mothers underwent vaginal deliveries. There were 182 female babies and 209 male babies born to the mothers in the study. Table 1 shows the distribution of relevant demographic and clinical variables of the cohort.

Under the supervision and guidance of a lactation consultant, the average volume (mL) of colostrum secreted in one sitting on first three postnatal days through manual expression of milk was recorded as follows: 4.68 mL, 8.87 mL and 22.53 mL, respectively. Additionally, the daily volumes were compared between term and preterm gestational groups, as well as among different modes of delivery, as these factors are believed to have a significant impact on the volume of colostrum secretion. Table 2 shows the comparison of colostrum volumes (mL) in the present study with that of traditionally defined volumes. The standard textbooks of paediatrics and on breast feeding,[3 5] for days 1–3 describe the volumes of milk per feed as 5–20 mL. A study among healthy multiparous mothers also mentions the volumes

Table 2 Comparison of average volumes of colostrum in the present study with traditionally defined volumes of colostrum

Average colostrum volumes (mL) all values as median	Present study (volume in mL)	Traditional volumes defined (mL)
Day 1	5	5
Day 2	10	10[3 5 6]
Day 3	25	25[3 5 6]

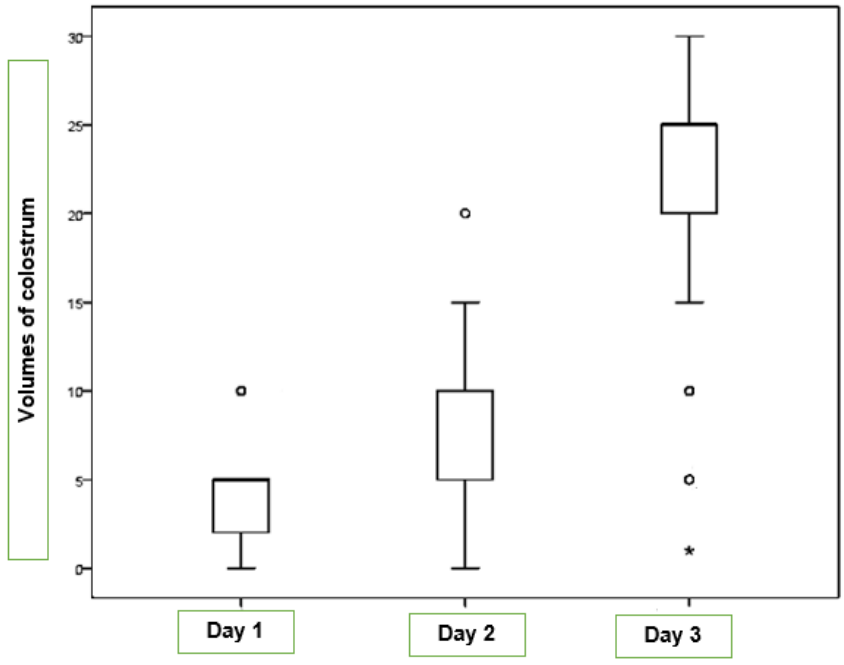

Figure 2 Box plot analysis of colostrum volumes (ml) on y-axis in the cohort plotted against each postnatal day on x-axis.

of milk per day from postnatal days 1–3.[6] Deriving volumes per feed from the above references, the average volumes of traditionally defined colostrum volumes (mL) have been quoted in table 2. However, the SD is missing for textbook-referenced values. Hence, a direct head-to-head comparison with p value could not be done. Figure 2 presents a box plot analysis of colostrum volumes (mL) on the y-axis in the cohort plotted against each postnatal day on the x-axis.

Table 3 shows the average volumes of colostrum (mL) per sitting on each postnatal day among the subgroups of the study with respect to each day's milk volume. The comparison was done using 't' test. There was no significant difference in the volumes of colostrum among term and late preterm cohorts and among vaginal v/s caesarean deliveries. Multiparous mothers expressed significantly higher volumes of colostrum as compared with primiparous mothers, as expected.

There was a statistically significant positive correlation between volumes of colostrum (mL) with each passing postnatal day, as anticipated, which was shown by Pearson correlation. Table 4 shows the p value and r-value of Pearson correlation for colostrum volumes (mL) with each passing postnatal day, considering the

Table 3 Subgroup analysis and comparison of average volumes of colostrum with each postnatal day

		Colostrum average volume (mL)		
Sl. No.	**Characteristic (n)**	**Day 1**	**Day 2**	**Day 3**
1	Term (338)	4.70±2.86	8.93±3.89	22.61±4.06
2	Late preterm (53)	4.58±2.97	8.49±4.12	22±5.32
	p value	**0.790†**	**0.443**	**0.326**
3	Vaginal delivery (187)	4.80±2.91	9.12±3.81	22.78±3.92
4	Caesarean delivery (204)	4.57±2.83	8.65±4.01	22.31±4.53
	p value	**0.432**	**0.231**	**0.273**
5	Primipara	4.16±2.74	8.1±3.99	21.86±4.53
6	Multipara	5.27±2.9	9.75±3.64	23.3±3.77
	p value	**0.001***	**0.0001***	**0.001***

* p<0.05 considered significant
† p > 0.05 considered non-significant

Table 4 Pearson correlation comparing average volume of colostrum (mL) per feed with each postnatal day

	r value	P value
Day 1	Baseline	
Day 2	0.90	<0.0005
Day 3	0.60	<0.0005

average colostrum volume on postnatal day one as the baseline.

DISCUSSION

The present study aimed to analyse if the colostrum volumes indeed decreased during the first three postnatal days as reported by mothers recently. The study showed that the mean and the median volumes of colostrum matched the traditionally defined volumes of colostrum. The mothers were given professional assistance by a certified lactation counsellor for timely and practical help during breast feeding. There was no significant difference in volumes of colostrum with respect to mode of delivery. However, a significant difference was observed among multiparous mothers who had a higher quantity of colostrum as compared with primiparous mothers, which was an anticipated finding.

Colostrum secreted in the first 2–3 days after delivery is initially produced in small amounts. The secretion of colostrum is typically around 40–50 mL on the first day, equivalent to approximately 5 mL per feed. Subsequently, milk production increases, with larger amounts being produced between 2 and 4 days postdelivery, leading to a sensation of fullness in the breasts, commonly referred to as 'milk coming in'. By the third day, an infant typically consumes about 300 mL per 24 hours, which equates to approximately 25 mL per feed. It is important to note that these data are derived from studies conducted approximately 20 years ago.[2 3 5 6]

The present study showed that the mothers secreted comparable volumes of colostrum on postnatal days 1–3. Hence, the rising use of formula milk and the perception of 'not enough milk' may be a consequence of a lack of practical help and assistance from trained healthcare workers. Various studies have explored the average volume of colostrum and transitional milk in postnatal mothers on different days for different objectives. Nevertheless, a primary reason for lactation failure and the adoption of formula feeding is the maternal perception of 'not enough milk'.[4 7 8]

Further, the mode of delivery has been identified as another significant perceived barrier to successful exclusive breast feeding. A systematic review and meta-analysis revealed a negative correlation between prelabour caesarean delivery and early breastfeeding initiation.[9] It is hypothesised that early initiation of breast feeding in the labour room or operation theatre within the present cohort could have facilitated comparable colostrum secretion among mothers, irrespective of the mode of delivery. The comparison of colostrum volumes among preterm gestational mothers has been a subject of considerable debate. Data from our own centre have revealed that preterm donor mothers secreted significantly lesser quantities of breast milk compared with term mothers (122 mL vs 142 mL, p=0.0068).[10] However, it is important to note that the gestational age in the cohort was considerably lower, and breast milk expression was facilitated using a breast pump, as part of voluntary donation to the milk bank. In the present study, multiparous women secreted higher amounts of colostrum as compared with primiparous women. A study by Bystrova *et al* showed that multiparous women are more likely to experience breast engorgement and give a higher number of feeds as compared with primiparous mothers, though there was no significant difference in milk volumes among the two groups.[11]According to previous studies, the average feeding volumes for late preterm babies were suggested as 5–10 mL every 2–3 hours on the first day, 10–20 mL on day 2 and 20–30 mL on day 3.[12–14]

A study conducted in China found that mothers producing less than 140 mL/day on day 4 were found to be 9.5 times more likely to have low or inadequate milk production by 6 weeks of postnatal period.[4] The present study enrolled mothers of late preterm gestation and interestingly, the volumes of colostrum among this cohort of mothers were found to be similar to that of term mothers though the study is not powered to find this difference. In the present high-volume perinatal setting, early discharges are common practice, with mothers of late preterm and term gestation typically being discharged on the fourth day of life. Therefore, this study provides valuable insights into two key aspects. First, it highlights the practical assistance provided by a lactation consultant, resulting in comparable volumes of breast milk for both late preterm and term mothers. Second, the study helped us to arrive at a volume of milk on postnatal day 3, which could be used as a discharge guide for reassuring the mother that her breast milk secretion is adequate. Overall, this study promotes exclusive breastfeeding practices by reassuring mothers who doubt their milk production and helps the healthcare workers take the baby-friendly practices forward. The present study's strengths lie in the inclusion of a substantial number of healthy mothers, providing robust data for analysis. The study results can be generalised to most of the settings in LMICs as the method of milk expression is manual in nature. Limitations of the study, such as the retrospective nature and the measurement of colostrum volume from one sitting rather than the total daily volume, are important to consider. The retrospective design of the study does limit the study's reliability due to interplay of multiple confounders. Important variables such as maternal support system, antenatal counselling, maternal education, socioeconomic status, hydration status of the mother, maternal health, body mass index (BMI) have not been taken into account in the present study. The

lack of adjustment (by regression analysis) of maternal and neonatal factors that could affect colostrum volumes is lacking in the present study. The other limitation of the study is the lack of follow-up and exclusion of 14 mothers who had missing values in the medical records.

Thus, the present study emphasised that the maternal perception of 'not enough milk' is likely false and that, with professional assistance, mothers can achieve higher rates of successful exclusive breast feeding. The study aligns with the objective of promoting exclusive breastfeeding practices and thereby avoiding formula feeding in LMIC settings. The present study has paved the way for future directions of research such as the inclusion of mothers with morbidities to quantify colostrum volumes, the inclusion of serial weight gain of newborns to make the data more objective and also to consider other relevant maternal factors like maternal BMI and hydration status.

CONCLUSIONS

The volumes of colostrum during the first 3 days of the postnatal phase were 4.7, 8.9 and 22.5 mL, respectively, aligning closely with traditionally defined volumes of colostrum from decades ago. Remarkably, these volumes remained consistent among the study cohort, raising questions about the increasing use of formula feeding in perinatal settings. The study findings support the promotion of the Baby Friendly Hospital Initiative but require further affirmation through prospectively designed, risk-adjusted analyses.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

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