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Original Research Article

Evaluating the nutritional status of preterm very low birth weight infants at discharge: a prospective cohort study

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ABSTRACT

Background: Low birth weight (LBW), defined by the WHO as a birth weight under 2500 grams, is a critical risk factor associated with morbidity and mortality. This study aims to assess the nutritional status of preterm very low birth weight infants at the time of discharge.
Methods: This prospective-cohort study was conducted at Maulana Azad Medical College and Lok Nayak Hospital, New Delhi, from April 2009 to March 2010.
Results: 80 patients enrolled, comprising 48 males and 32 females. Among the 33 infants (≤32 weeks gestation), 24 completed the study up-to 52 weeks post-conception. Infants born at<32 weeks gestation show significant growth in weight, length and head-circumference by 52 weeks post-conception, yet many fall short of growth standards. Mean weight increased from 1210.4 to 3907 (grams), length from 37.7 to 52 (cm) and head-circumference from 26.7 to 39.5 (cm). A significant proportion remained in the <-3 S.D. category for weight (majority) and length (91.7%), with head-circumference deficits reducing from 21.2% to 12.5%.
Conclusions: Exclusive breastfeeding may not reduce the prevalence of extrauterine-growth-restriction in very low birth weight preterm infants, extended follow-up period could show improvements, highlighting a study limitation.

Keywords: Growth restriction, Nutrition, Preterm infants, Very low birth weight

INTRODUCTION

Low birth weight (LBW) is a risk factor associated with increased infant mortality and morbidity and is often studied to assess survival conditions and overall quality of life.[1] Over the past two decades, advancements in Neonatal Intensive Care Unit (NICU) services have significantly improved the survival rate of newborns with low birth weight (LBW). The World Health Organization defines LBW as a birth weight of less than 2500 grams.

Globally, it is estimated that 15% to 20% of all births fall into this category, accounting for over 20 million births annually.[2] The incidence of low birth weight (LBW) is notably higher in developing countries compared to developed nations. In India, approximately 33% of infants are born with LBW, in contrast to just 4.5% in industrially developed countries.[3] According to UNICEF and WHO, nearly 8 million babies are born in India each year, with almost one-third of these newborns classified as low birth weight (LBW). This reflects an incidence rate of 30%, the highest globally, accounting for nearly 40% of the world's LBW burden-more than any other country.[4]

Based on analysis by the Indian Statistical Institute using NFHS-3 data, the North zone of India has the highest percentage of low birth weight (LBW) babies at 26.60%, while the North-East zone has the lowest at 13.67%. Very low birth weight (VLBW) infants make up approximately 4-7% of all live births in India, with mortality rates in this group accounting for up to 30% of early neonatal deaths.[5]

Among survivors, the reported rates of extrauterine growth restriction (EUGR) vary widely, ranging from 28% to 86%, yet remain unacceptably high. This high incidence of EUGR may have implications for reduced adult stature. The growth potential of very low birth weight (VLBW) Indian preterm infants is further affected by the fact that nearly one-third of these infants have experienced intrauterine growth retardation. During the postnatal growth period for preterm infants, as opposed to intrauterine growth during the same gestational period, energy expenditure shifts away from growth-promoting activities to focus on survival.

This shift ultimately results in extrauterine growth retardation (EUGR).[6] These factors have led to the implementation of aggressive nutritional interventions aimed at promoting postnatal growth to match intrauterine growth rates.

However, a key question remains are intrauterine growth reference standards truly suitable for assessing the postnatal growth of preterm infants and are growth charts designed for term-born neonates appropriate for preterm infants once they reach a post-conception age of 40 weeks gestation? To address this issue, the present study was conducted to evaluate the nutritional status of preterm very low birth weight (VLBW) infants at the time of discharge.

METHODS

Study design

This study was designed as a prospective cohort study.

Study place

This study was conducted in the Newborn Unit of the Department of Pediatrics at Maulana Azad Medical College and its associated Lok Nayak Hospital in New Delhi.

Study duration

The study period spanned from April 2009 to March 2010, with initial screening and enrollment conducted between April and October 2009.

Sample size

A total of 130 preterm neonates weighing less than 1500 grams were screened for eligibility. Eighty subjects were ultimately enrolled in the study.

Inclusion criteria

The inclusion criteria for this study included neonates with intramural live births weighing less than 1500 grams, parents who were residents of Delhi during the study period and neonates who were discharged from the hospital within three months.

Exclusion criteria

The exclusion criteria included newborns with major congenital malformations and parents who declined participation in the study.

Informed written consent was obtained from the parents of all enrolled subjects and the study received approval from the institution's ethical committee. The nutritional status at 3 months postnatal age, corrected for gestational age, was assessed by measuring standard deviations in weight, length and head circumference, using the reference growth standards of Niklasson for comparison.[7]

The Niklasson Swedish growth charts for preterm children provide continuous reference data from the 24th week of gestation up to 24 months of age, covering weight, length and head circumference for both genders. These charts were developed using data from the Swedish Medical Birth Registry (1990–1999) and a longitudinal study of 3,650 children from birth to final height. They offer a seamless transition from intrauterine to postnatal growth patterns, facilitating the monitoring of growth in preterm infants.[8]

The sample size was calculated based on the incidence of EUGR. To detect 30% incidence of EUGR (Extra-uterine growth restriction) with a precision of 5% and at a confidence level of 99 % it was estimated that about 25 subjects would be required. Allowing for dropouts during follow up it was decided to enroll at least 50 neonates.

Infants were followed up weekly (±2 days) till 3 months of corrected post-natal age and at each visit they were assessed for their anthropometric status, feeding details (e.g., frequency of feeds, type of feed, mode of feeding, etc) and details of any morbidity they have experienced (sepsis, acute respiratory illness, diarrhoea and need for hospitalization).

Statistical analysis

Univariate continuous data were compared using either ‘t’ test or Mann Whitney U test. Proportions were compared using “chi square” or “Fisher exact test”. Repeated measures over time were evaluated using ANOVA for repeated measures. A probability of 5% was considered significant. Data were entered into Epi 2000 software and analysed using both Epi 2000 and SPSS analytical software.

RESULTS

The study enrolled 80 patients, comprising 48 males (60%) and 32 females (40%). Table 1 presents the baseline maternal characteristics for both the cohort that completed the study and those lost to follow-up. There were no significant differences in any of the maternal characteristics between these groups. Among the 80 infants enrolled in the study, there was no evidence of chorioamnionitis or chronic illness in the mothers and none of the mothers were smokers. The baseline neonatal characteristics of the study population showed an average birth weight of approximately 1280 grams and a gestational age around 33 weeks. There were no significant differences in these baseline characteristics between the subjects who completed the study and those lost to follow-up, as outlined in Table 2.

Table 3 presents the frequency distribution of morbidities among the enrolled subjects. The most common morbidity experienced by the neonates was sepsis, followed by neonatal hyperbilirubinemia and apnea of prematurity. None of the enrolled subjects experienced hypothermia or hypoglycemia.

Table 1: Baseline maternal characteristics.

Variables	Cohort completing the study (n=51)	Cohort loss to follow up (n=29)
Age (in years) (mean, S.D)	26.6 (3.9)	24.9 (3.5)
Gravida (median, range)	2 (1-6)	2 (1-6)
Parity (median, range)	1 (0-4)	1 (0-4)
Twins (%)	10 (19)	2 (6.9)
Antenatal care (3 visits) (%)	31 (60.8)	16 (55.2)
Hypertension (%)	12 (23.5)	9 (31)
Antepartum hemorrhage (%)	9 (17.6)	3 (10.3)
Preterm rupture of membranes (%)	15 (29.4)	8 (27.6)
Diabetes mellitus (%)	1 (2)	0
Socioeconomic status (%)		
Upper	0	0
Upper middle	3 (3.9)	0
Lower middle	11 (20.5)	6 (20.7)
Upper lower	37 (75.6)	23 (79.3)
Lower	0	0
Maternal weight (kg) (mean, SD)	52.3 (7.5)	53.3 (6.5)
Maternal height (cm) (mean, SD)	150.1 (5.9)	153.5 (4.2)
Maternal haemoglobin (gm%) (mean, SD)	10.03 (1.2)	10.3 (0.9)

Table 2: Baseline neonatal characteristics.

Variables	Cohort completing the study (n=51)	Cohort loss to follow up (n=29)
Birth weight (grams) (mean, SD)	1280.1 (164.1)	1289.8 (145.6)
Gestational age (weeks) (mean, SD)	32.7 (2.2)	33.5 (1.9)
Sex, N (%)		
Females	17 (33.3)	15 (51.7)
Males	34 (66.7)	14 (48.3)
Mode of delivery, N (%)		
Vaginal	40 (78.4)	23 (79.3)
Caesarean	11 (21.6)	6 (20.7)
Apgar (mean, SD)		
1 minute	8.6 (1.1)	8.5 (1.5)
5 minutes	8.8 (0.4)	8.8 (0.5)
Number of neonates requiring resuscitation at birth, N (%)	7 (13.7)	3 (10.3)

The mean birth weight of this cohort was 1210 grams and the mean gestation was 30.8 weeks. Of the 33 infants in this gestational age group, 24 (72.7%) completed study up to post-conception age of 52 weeks. a total of 33 infants who were less than or equal to 32 weeks at enrollment. The mean birth weight of this cohort was 1210 grams and the mean gestation was 30.8 weeks. The percentage of children with weight for age less than 3 SD was 57.6% at birth which increased to 83.3% at 52 weeks postnatal age. Length for age showed a similar trend with the percentage of children with length for age less than 3 SD increasing from 75.8% at birth to 91.7% at 52 weeks postnatal age. Head circumference showed a favourable outcome with percentage of children with head circumference below 3 SD decreasing from 21.25 at birth to 12.5 at 52 weeks postnatal age.

Table 3: Neonatal morbidities during hospital stay.

Variables	Cohort completing the study (n=51)	Cohort loss to follow up (n=29)
Anemia, N (%)	1 (2)	0
Apnea of prematurity, N (%)	4 (7.8)	3 (10.3)
Hyperbilirubinemia, N (%)	7 (13.7)	3 (10.3)
Intraventricular hemorrhage, N (%)	3 (5.9)	0
Respiratory distress syndrome, N (%)	2 (4)	2 (6.9)
Sepsis, N (%)	10 (20)	7 (24.1)
Others, N (%)	3 (6)	1 (3.4)

Table 4: Growth in infants born at<32 weeks.

Variables	Birth (n=33)	40 weeks (n=27)	44 weeks (n=80)	48 weeks(n=11)	52 weeks (n=24)
Weight (grams) (mean, SD)	1210.4 (158.6)	2055.1 (387.2)	3013.7 (590.4)	3305 (729.6)	3907 (743.5)
Weight standard deviation (%)					
<-3 SD	19 (57.6)	25 (92.6)	6 (75)	10 (90.9)	20 (83.3)
-2 to-3 SD	12 (36.4)	2 (7.4)	2 (25)	1 (9.1)	4 (16.7)
-1 to-2 SD	2 (6.1)	0	0	0	0
>-1 SD	0	0	0	0	0
Length (cm) (mean, SD)	37.7 (1.8)	44.1 (1.8)	48.8 (2.2)	51.2 (2.9)	52 (3.7)
Length standard deviation (%)					
<-3 SD	25 (75.8)	26 (96.3)	7 (87.5)	10 (90.9)	22 (91.7)
-2 to-3 SD	5 (15.2)	1 (3.7)	1 (12.5)	0	1 (4.2)
-1 to -2 SD	3 (9.1)	0	0	1 (9.1)	1 (4.2)
>=1 SD	0	0	0	0	1 (4.2)
Head circumference (mean, SD)	26.7 (1.4)	32.3 (1.5)	35.2 (1.2)	37.6 (3.5)	39.5 (2.5)
Head circumference standard deviation (%)					
<-3 SD	7 (21.2)	13 (48.1)	1 (12.5)	4 (36.4)	3 (12.5)
-2 to -3 SD	11 (33.3)	10 (37)	5 (62.5)	1 (9.1)	8 (33.3)
-1 to -2 SD	13 (39.4)	3 (11.1)	2 (25)	4 (36.4)	2 (8.3)
>-1 SD	2 (6.1)	1 (3.7)	0	2 (18.2)	11 (45.8)
Triceps skin fold thickness (mm) (mean, SD)	1.25 (0.15)	1.89 (0.39)			2.67 (0.5)

DISCUSSION

It was observed that among the group of infants with a gestational age of 32 weeks or less, 83% had a weight below -3 SD at three months of corrected post-natal age, in contrast to 57.6% of infants whose birth weight was below -3 SD. Similarly, when extra-uterine growth restriction was assessed in terms of length, it was found that approximately 92% of infants had a length below -3 SD at three months corrected post-natal age, compared to 76% of infants with a birth length below -3 SD. In contrast, analysis of head circumference data showed that only 12% of infants had a head circumference below -3 SD at three months corrected post-natal age, compared to 21% who had a head circumference below -3 SD at birth.

The data clearly indicates that there was a substantial burden of extra-uterine growth restriction in this population concerning weight and length, though there was a marked reduction in head growth restriction by three months corrected post-natal age. Notably, just over half of the infants with a gestational age of 32 weeks or less exhibited growth retardation at birth, but this proportion increased by nearly 50% by three months corrected post-natal age. In terms of length, the extent of growth restriction had risen by approximately 15% over the same period.

A noteworthy study for comparison is that of Campos et al, who evaluated the growth at discharge of very low birth weight infants and observed that only 18% of small for gestational age babies achieved catch up growth in comparison to 92% catch up growth in very low birth weight born appropriate for gestational age babies.[9] The results of the present study are somewhat similar to that of Campos et al, indicating that most small for gestational age babies continue to remain growth retarded even at 3 months corrected post-natal age and a larger number of appropriate for gestational age babies showed catch up growth.[9] Clark et al, evaluated the incidence of extra uterine growth restriction among very preterm babies (23 – 24 weeks at birth) and observed that the proportion of babies whose weight, length and head circumference were less than 10 percentiles at 32 weeks post-natal age was 23%, 20% and 13% respectively.[10] Extrauterine growth restriction (EUGR) remains a significant concern among preterm infants, particularly those born at or before 32 weeks gestational age. Our study revealed that 83% of these infants exhibited weights below -3 standard deviations (SD) at 3 months corrected postnatal age, indicating substantial challenges in achieving catch-up growth. This finding aligns with a study conducted in Ethiopia, which reported an EUGR incidence of 86.2% among preterm infants at hospital discharge. The study identified factors such as being small for gestational age (SGA), very low birth weight (VLBW) and prolonged hospital stays as significant contributors to EUGR.[11]

Our study also observed that 92% of infants had lengths below -3 SD at 3 months corrected postnatal age, suggesting that linear growth is particularly affected. This is consistent with findings from a review that associated EUGR with poor growth and neurodevelopmental outcomes, as well as cardiometabolic alterations in childhood.[12] Notably, only 12% of infants in our study had head circumferences below -3 SD at 3 months corrected postnatal age, indicating relatively better head growth compared to weight and length. This pattern has been observed in other studies, suggesting that while somatic growth may be compromised, head growth can be preserved to some extent.[13]

The high prevalence of EUGR in our cohort underscores the need for targeted nutritional interventions and monitoring strategies to support optimal growth trajectories in preterm infants. Comparative studies reinforce the importance of addressing factors such as birth weight, gestational age and associated morbidities to mitigate the risk of EUGR and its long-term consequences.

Aggressive nutritional support has been associated with improved growth outcomes without a significant increase in the risk of adverse effects.[14] Optimal nutrition can prevent postnatal growth failure and support extrauterine weight gain comparable to that of fetuses at the same gestational age.[15] The current standard of care in developed countries includes a combination of parenteral nutrition, early initiation and advancement of enteral feeding and fortification of human milk.[16,17] Such interventions are often inaccessible in low-income countries. Under-nutrition in infancy is linked to cognitive deficits, poorer academic performance and a higher likelihood of behavioral problems in later life.[18]

The burden of growth failure observed in the present study is comparable to other.[7,19] The reason for the higher burden of extra uterine growth restriction at 3 months corrected gestational age in the present study possibly is related to several factors: More than half the infants in the present study were growth restricted at birth for weight, length and head circumference, which in itself could be a major contributor for persistence of extra uterine growth restriction, unlike the other studies published from developed countries, where they received formula milk at discharge, almost all the infants in the present study were largely on breast milk. It is possible that breast milk may not be adequate to achieve adequate catch-up growth in extra uterine growth restricted babies especially if they have experienced intrauterine growth restriction, weight and length catch up takes longer than 3 months corrected post-natal age unlike head growth. Therefore, it is possible that if this cohort had been followed up for a longer period than 3 months corrected post-natal age, the catch with respect to weight and length would have been better and the burden of extra uterine growth restriction with respect to these anthropometric measurements would have been less.

CONCLUSION

The study reveals a high prevalence of extrauterine growth restriction (EUGR) in preterm infants, particularly those born before 33 weeks gestation, with significant deficits in weight and length by 3 months corrected age. Exclusive breastfeeding, while beneficial, does not appear to reduce EUGR in this group, suggesting the need for targeted nutritional interventions and longer follow-up. Notably, head growth shows relatively better outcomes, possibly reflecting prioritized nutritional needs for neurodevelopment. Long-term follow-up could clarify if extended interventions might improve growth and developmental outcomes for these infants.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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