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Original Article

Paediatrics Section

# Physical Growth of Low Birth Weight Infants in First Six Months of Life: A Prospective Cohort Study

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## ABSTRACT

**Introduction:** Low Birth Weight (LBW) is a commonly encountered problem in developing countries. Growth is the single most important predictor of morbidity and mortality in a LBW infant. LBW babies show a pattern of growth, different from normal weighing babies.

**Aim:** To assess the growth pattern of LBW infants in first six months of life.

**Materials and Methods:** This prospective cohort study was done in Department of Paediatrics, of Kilpauk Medical College and Hospital, a tertiary care hospital in Southern India, from September 2019 to August 2020. Total 310 LBW infants, of which 200 were term and rest preterm were included and followed-up at the ages of three and six months. Clinical details including gender, gestational age, order of birth, length of stay in nursery, maternal and neonatal morbidities, type of feeding and intercurrent illness were noted. The weight, length and head circumference of the infants were measured by standard methods and interpreted using appropriate charts. The anthropometric measures were converted into z-score and compared. The outcome variables were statistically analysed using Chi-square test.

**Results:** Out of 310 babies, 172 (55.5%) were girls and 200 (64.5%) were term babies. Six month follow-up rate was 92%. A total of 228 (79%) infants were on exclusive breastfeeding while the remaining 21% were partially breastfed. The prevalence (95% confidence interval) of undernutrition, short stature and microcephaly at six months were 54.9% (48.93-60.76), 62.2% (56.34-67.88) and 30.7% (25.47-36.47), respectively. Fall in standard deviation score of length, weight and head circumference was observed which was more pronounced in preterm than in term infants ($p<0.05$).

**Conclusion:** Growth faltering is commonly encountered in more than half of LBW infants on six months follow-up, with the effect being more pronounced in preterm more than term infants.


**Keywords:** Gestational age, Growth monitoring, Head circumference, Preterm

## INTRODUCTION

The birth weight of infant is the single most important determinant of his/her chances of survival, healthy growth and development [1]. LBW has been defined as a birth weight <2.5 kg, the measurement being taken preferably within the first hour of life, before significant postnatal weight loss has occurred [2]. LBW includes both appropriately grown preterm neonates (<37 completed weeks of gestation) and term and preterm growth-restricted neonates (<10$^{th}$ centile of weight for gestational age) [2].

Globally, 15-20% is estimated to be LBW [3]. According to the data in 2015, LBW occupies about 20.5 million live births and in these 91% from low-and-middle-income countries, 48% in Southern Asia, and 24% at sub Saharan Africa [4]. According to National Family Health Survey (NFHS), in India the prevalence of LBW in 2015-2016 was 16.4% [5].

Birth weight is an important marker of maternal and foetal health, predicting mortality, stunting, and adult-onset chronic conditions [3]. In addition to the high-risk of mortality and morbidity, LBW babies show a pattern of growth different from normal term babies. Two major determinants of postnatal growth are genetics and nutrition. It has been noted that better nutrition in the early postnatal phases in preterm infants results in higher verbal Intelligence Quotient (IQ) scores and improved cognitive function in the long-term [6]. The postdischarge period is a critical period of development and LBW infants are particularly vulnerable initially after hospital discharge and failing to meet nutrient requirements can lead to poor long-term functional outcomes, including growth deficits, neurodevelopment abnormalities and behavioural issues [7].

Abundant literature is available on postnatal growth of infants born with very LBW and extremely LBW [8,9]. Studies done on postnatal growth of LBW infants in other countries showed good catch-up growth which was accompanied by risk of overweight [10]. Similar data is lacking in Indian population. Hence, present study was conducted with the objective of studying the postnatal growth pattern of babies born with LBW over first six months of life, determining the proportion of infants who are underweight, have short stature or microcephaly at the end of six months and to compare the anthropometric indices between “term LBW” and “preterm LBW” babies.

## MATERIALS AND METHODS

This prospective cohort study was conducted in newborn intensive care unit and follow-up out-patient department of Kilpauk Medical College, a tertiary care centre in South India over a period of one year from September 2019 to August 2020. The study was commenced after obtaining approval from Institutional Ethics Committee (IEC) (Protocol ID no. 246/2019).

**Inclusion criteria:** Neonates, both term and preterm whose birth weight was <2500 gm were included in the study.

**Exclusion criteria:** Babies with severe perinatal asphyxia, major congenital malformations, known genetic syndromes, serious complications such as intraventricular haemorrhage, hydrocephalus, bronchopulmonary dysplasia and necrotising enterocolitis were excluded from the study.

**Sample size:** Sample size was calculated using n master software based on study done by Borah M and Baruah R who reported the proportion of infants with underweight at six months to be 77%, with an allowable error of 5%, to calculate 95% confidence interval, the minimum required sample was 272. To account for 10% loss to follow-up, a minimum of 299 participants had to be recruited [11]. After obtaining written informed consent from parents, 310 neonates who were discharged from new born intensive care unit and postnatal wards fulfilling inclusion criteria were enrolled in the study.

**Data collection:** Demographic and clinical data were collected using structured proforma. Gestational age was recorded as per obstetrical estimates based on first trimester ultrasound or if not available by Naegle's rule based on date of last menstrual period. Neonates with gestational age <37 weeks were classified as preterm infants. Anthropometric measures such as weight, length and head circumference of babies at birth were noted from case records and plotted on appropriate charts and given to the parents. The other clinical details included gender of the neonate, order of birth, length of stay in the nursery, maternal morbidity, and neonatal morbidity, if any. Follow-up dates for term infants were given according to the chronological age and for preterm infants corrected ages of three and six months. The babies who came for follow-up within seven days of expected dates were only considered. To ensure appropriate follow-up reminders were sent to parents through phone calls one week prior to the expected date.

On follow-up visit, the type of feeding and any need for readmission were enquired and noted down. Anthropometric measurements were taken by standard methods. Weight was recorded on electronic weighing scale rounded to the nearest 10 grams without diapers with baby being unclothed. The weighing scale was calibrated at regular intervals. Length was measured in infantometer, with the help of an assistant to the nearest millimetre in the recumbent position. Head circumference was measured using a flexible non stretchable tape which runs from the supraorbital ridge to the occiput as the maximum occipitofrontal circumference. To obviate errors due to interobserver variations, all measurements were made by one paediatric resident involved in this research. Anthropometric measurements were recorded and plotted serially at birth, at corrected ages of three and six months.

For interpretation of growth parameters, the World Health Organisation (WHO) growth charts were used for term babies [12]. For preterm babies the intergrowth- 21st preterm postnatal growth standards were used [13]. Anthropometric indices were converted into standard deviation score (SD score) based on appropriate charts and compared [14]. Weight below the third percentile on a standard growth curve was considered underweight. Length of less than two standard deviation from length for age was considered short stature. Head circumference of more than two standard deviation below the mean for a given age, sex, and gestation was considered microcephaly [15].

## STATISTICAL ANALYSIS

Data was entered in Microsoft excel and statistical analysis was done using statistical software International Business Machines (IBM) Statistical Package for the Social Sciences (SPSS) version 23.0. Numerical data was summated as mean±SD after checking for normality. Categorical data was expressed as proportion. The outcome variable was expressed as proportion with 95% confidence interval. SD score of various anthropometric measures were compared using ANOVA test and the proportion of infants with growth faltering between term and preterm was compared using Chi-square test p-value <0.05 was considered significant.

## RESULTS

In present study, out of 310 infants, included in the study, 172 (55.5%) were females. Majority, 200 (64.5%) babies were born at term while 110 (35.5%) were preterm. In present study, mean duration of hospital stay was 8.10±7.65 days [Table/Fig-1].

| Variable | Proportion n (%) |
|---|---|
| **Gender** | |
| Girls | 172 (55.5) |
| Boys | 138 (44.5) |
| **Maturity** | |
| Term | 200 (64.5) |
| Preterm | 110 (35.5) |
| **Order of birth** | |
| First | 192 (62) |
| Second | 92 (30) |
| Third | 26 (8) |
| **Hospital stay*** | 8.10±7.65 |
| **Follow-up** | |
| 3 months | 289 (93) |
| 6 months | 286 (92) |
| **Feeding (n=286)** | |
| Exclusive breastfeeding | 228 (79) |
| Partial breastfeeding | 58 (21) |
| Exclusive formula feeding | 0 |
| **Hospitalisation in postneonatal period** | 26 (9) |

**[Table/Fig-1]:** Descriptive demographic data of all the study participants. *Hospital stay expressed in days as mean±standard deviation

Neonatal morbidity was present in 187 (60.3%) babies with 89 (28.7%) babies having meconium-stained amniotic fluid, 46 (14.8%) babies with respiratory distress, 31 (10%) babies with sepsis, 15 (4.8%) babies for Infant of Diabetic Mother (IDM) care and six babies (1.9%) with seizures [Table/Fig-2].

| Parameter | N (%) |
|---|---|
| **Maternal morbidity** | |
| Hypothyroidism | 31 (10) |
| Pregnancy induced hypertension | 22 (7) |
| Gestational diabetes | 15 (4.8) |
| Rh incompatibility | 14 (4.5) |
| Anaemia | 12 (4) |
| Premature rupture of membrane | 9 (3) |
| Others | 25 (8.1) |
| Total | 128 (41.3) |
| **Neonatal morbidity** | |
| Meconium stained amniotic fluid | 89 (28.7) |
| Respiratory distress | 46 (14.8) |
| Sepsis | 31 (10) |
| Infant of diabetic mother | 15 (4.8) |
| Seizures | 6 (1.9) |
| Total | 187 (60.3) |

**[Table/Fig-2]:** Maternal and neonatal morbidities.

All the anthropometric indices namely weight, length and head circumference increased from birth to three months and at six months with time reflecting growth of children is shown in [Table/Fig-3].

| Age | Number | Weight in kg Mean±SD | Length in cm Mean±SD | Head circumference in cm Mean±SD |
|---|---|---|---|---|
| At birth | 310 | 2.11±0.29 | 45.62±2.92 | 32.26±1.71 |
| 3 months | 289 | 4.36±0.67 | 55.13±3.06 | 38.02±1.63 |
| 6 months | 286 | 5.91±0.81 | 60.78±3.25 | 40.5±1.64 |

**[Table/Fig-3]:** Weight, length and head circumference at birth, 3 months and 6 months.

In present study, the SD score of weight of term babies improved on follow-up, whereas that of preterm decreased. The SD score of length and head circumference of both term and preterm babies decreased with time implying growth faltering though the amplitude was more in preterm than term infants [Table/Fig-4].

| Parameter | Time point | Term (Mean±SD) | Preterm (Mean±SD) | p-value* |
|---|---|---|---|---|
| Weight SDS | At birth | -2.52±0.56 | -0.46±1.17 | <0.001 |
| | 3 months | -2.59±1.17 | -2.32±1.39 | 0.087 |
| | 6 months | -2.15±1.15 | -1.88±1.17 | 0.056 |
| Height SDS | At birth | -1.54±1.13 | -0.01±1.57 | <0.001 |
| | 3 months | -2.33±1.32 | -2.83±1.98 | 0.011 |
| | 6 months | -2.4±1.43 | -2.65±1.65 | 0.181 |
| Head circumference SDS | At birth | -1.13±1.16 | 0.18±1.28 | <0.001 |
| | 3 months | -1.39±1.35 | -1.89±1.65 | 0.007 |
| | 6 months | -1.49±1.29 | -2.06±1.43 | 0.001 |

**[Table/Fig-4]:** Comparison of serial SD score of term and preterm babies.
* calculated using ANOVA test

The prevalence (95% confidence interval) of underweight on six month follow-up was 54.9% (48.93-60.76) while the prevalence (95% confidence interval) of short stature on six month follow-up was 62.2% (56.34-67.88) and the prevalence (95% confidence interval) of microcephaly on six month follow-up was 30.7% (25.47-36.47). The higher number of preterm infants experienced growth faltering than term infants and this difference was statistically significant (p<0.05) [Table/Fig-5].

| Growth abnormality | Term (n=181) Number (%) | Preterm (n=105) Number (%) | p-value* |
|---|---|---|---|
| Underweight | 88 (48.6) | 69 (65.7) | 0.002 |
| Short stature | 95 (52.4) | 83 (79) | <0.001 |
| Microcephaly | 46 (25.5) | 42 (40) | 0.005 |

**[Table/Fig-5]:** Comparison of growth abnormalities in term and preterm at 6 months.
*calculated using Chi-square test

## DISCUSSION

The growth pattern of LBW infants during first six months is well brought out by this study. While more than half of them faltered in length (62%) and weight (55%) at six months of age, almost one in three of them also lagged behind in head circumference. This growth faltering was more pronounced in preterm infants compared to term infants and this was found to be statistically significant. Among the anthropometric indices, head growth of the LBW infants was found to be minimally hampered since brain growth is very rapid during infancy and it is unaffected by mild to moderate degrees of undernutrition.

The number of LBW infants who were underweight at six months in present study was less than that reported in a study done in Assam, while it was higher than that reported in an Iranian study in which 18.4% were underweight, 34.7% stunted and 8.2% had microcephaly [9,14]. A pattern similar to that brought out in present study was noted in that study with linear growth being compromised most in both followed by weight and head circumference being compromised the least. Overall, there was fall in growth trajectories as demonstrated by fall in SD scores.

In humans, other than genetic factors nutrition is a major contributor to the rate of growth, particularly in early postnatal life. International and National guidelines strongly advocate exclusive breastfeeding as the preferred feeding strategy for LBW infants [15,16]. As much as 79% of the mothers practised exclusive breastfeeding and the rest partial breastfeeding. None of the babies were exclusively formula fed. The breastfeeding rates noted in present study was better than that reported by few other studies [17,18]. But a study has shown the weight to be consistently below 5$^{th}$ centile at six months of age in exclusively breastfed babies [19]. Further, as per a systematic review, better nutrition resulted in better neurodevelopmental outcome in preterm babies on follow-up [20]. [Table/Fig-6] shows comparison of present study with other published studies.

| S. no. | Author, publication year | Place of the study | Sample size | Results |
|---|---|---|---|---|
| 1 | Present study, 2023 | Chennai | 310 | Around 55% LBW infants remained underweight at six months. |
| 2 | Borah M and Baruah R, 2014 [11] | Assam | 60 | 77% LBW infants were underweight at six months. |
| 3 | Islami Z et al., 2012 [16] | Iran | 50 | Around 18% LBW infants were underweight at six months. |
| 4 | Faisal M et al., 2010 [21] | Aligarh | 484 | Monthly weight gain of around 0.5 kg observed in exclusively breastfed LBW infants. |
| 5 | Hajnal BL et al., 2003 [8] | Switzerland | 438 | Among LBW infants, Small for gestational age (SGA) infants and appropriate-for-gestational age (AGA) infants with catch down growth had lower development index. |

**[Table/Fig-6]:** Comparison with other studies [8,11,16,21].

Though catch-up growth is no longer considered ideal, it is ideal for LBW infants to continue in their growth trajectories and not dip down on the SD scores. In contrast, present study clearly shows that LBW infants dip down on their SD scores as they grow, which is of concern. Though the feeding guidelines recommend exclusive breastfeeding as ideal, it also recommends addition of human milk fortifiers for those who falter in growth [15,16]. Inspite of high exclusive breastfeeding rates (79%), more than half of present study population had growth faltering. Hence, it is obvious that exclusive breastfeeding may not be sufficient to sustain adequate growth in majority of LBW infants.

Hence, it is recommended frequent growth monitoring with atleast fortnightly visits to measure anthropometry, asses breastfeeding and anticipate and look for growth faltering. If growth faltering is detected despite appropriate breastfeeding, the infant may be started on LBW special infant formula in addition to breast feeding. Though Paediatricians continue to remain vehement proponents of exclusive breastfeeding, a scientific approach has to be adopted weighing the risks against the benefits. The addition of formula milk cannot be a general recommendation, but care of each LBW

infant has to be individualised and formula milk has to be used as a drug prescribed for the disease-growth faltering. This will go a long way in bringing down the morbidity and mortality of LBW infants [21,22].

### Limitation(s)

The limitations of the study are shorter duration of follow-up, lack of data on neurodevelopmental outcome and it was data from a single centre caring for people from single socio-economic stratum.

## CONCLUSION(S)

More than half of LBW infants experienced growth faltering with compromise of body size and linear growth. Head size was compromised in one-third infants. This growth faltering was more severe in infants born as preterm rather than term. The point of concern is this growth faltering is encountered inspite of optimal breastfeeding practices. Further multicentric studies involving hospitals caring for different socio-economic strata, with follow-up of longer duration, with data on neurodevelopmental outcome will throw more light on the growth pattern of LBW infants which will be more generalisable.

## REFERENCES


[1] Chhabra S, Sharma S. Variables affecting foetal weight. Indian Journal of Maternal and Child Health. 1994;5(3):61-64.

[2] World Health Organization. International statistical classification of diseases and related health problems, tenth revision, 2nd ed. World Health Organization; 2004.

[3] Organization WH. Global nutrition targets 2025: Low birth weight policy brief. Geneva: World Health Organisation; 2014.

[4] Blencowe H, Krasevec J, de Onis M. National, regional, and worldwide estimates of low birthweight in 2015, with trends from 2000: A systematic analysis. The Lancet Global Health. 2019;7(7):e849-e60.

[5] Government of India. Ministry of Health and Family Welfare. State fact sheets -National Family Health Survey-4, 2015-2016. Available from: http:// www.rchiips.org/NFHS/pdf/NFHS4/TN_FactSheet.pdf. Accessed on 4 November 2021.

[6] Franz AR, Pohlandt F, Bode H. Intrauterine, early neonatal and post discharge growth and neurodevelopmental outcome at 5.4 years in extremely preterm infants after intensive neonatal nutritional support. Pediatrics. 2009;123:e101-09.

[7] ESPGHAN Committee on Nutrition; Aggett PJ, Agostoni C, Axelsson I, De Curtis M, Goulet O, Hernell O, et al. Feeding preterm infants after hospital discharge: A commentary by the ESPGHAN Committee on Nutrition. J Pediatr Gastroenterol Nutr. 2006;42:596-603.

[8] Hajnal BL, Siebenthal KV, Kovari H, Bucher HU, Largo RH. Postnatal growth in VLBW infants: Significant association with neurodevelopmental outcome. J Pediatr. 2003;143(2):163-70.

[9] Claus MJ, de Vries LS, Koopman C, Uniken Venema MM, Eijsermans MJ, Bruinse HW, et al. Postnatal growth of preterm born children ≤ 750g at birth. Early Hum Dev. 2011;87(7):495-507. Doi: 10.1016/j.earlhumdev.2011.04.009. Epub 2011 May 6. PMID: 21550187.

[10] Han J, Jiang Y, Huang J. Postnatal growth of preterm infants during the first two years of life: Catch-up growth accompanied by risk of overweight. Ital J Pediatr. 2021;47:66. https://doi.org/10.1186/s13052-021-01019-2.

[11] Borah M, Baruah R. Physical growth of low birth weight babies in first six months of life: A longitudinal study in a rural block of Assam. Natl J Community Med. 2014;5:397-400.

[12] WHO | The WHO Child Growth Standards [Internet]. WHO |World Health Organization. Available from: http://www.who.int/childgrowth/standards/en/. Accessed on 4 November 2021.

[13] Villar J, Giuliani F, Bhutta ZA. International Fetal and Newborn Growth Consortium for the 21st Century (INTERGROWTH-21st). Postnatal growth standards for preterm infants: The preterm postnatal follow-up study of the INTERGROWTH- 21st Project. Lancet Glob Health. 2015;3(11):e681-91.

[14] Statistics how to. Available from https://www.statisticshowto.com/probability-and-statistics/z-score/. Accessed on 4 November 2021.

[15] World Health Organization. Training course on child growth assessment. 2008. Available from https://www.who.int/childgrowth/training/module_c_interpreting_ indicators.pdf. Accessed on 4 November 2021.

[16] Islami Z, Fallah R, Mosavian T. Growth parameters of NICU admitted low birth weight preterm neonates at corrected ages of 6 and 12 month. Iran J Reprod Med. 2012;10(5):459-64.

[17] World Health Organization. Guidelines on Optimal feeding of low birthweight infants in low-and middle-income countries. 2011. Available from https://www.who.int/ maternal _child_adolescent/documents/9789241548366.pdf. Accessed on 4 November 2021.

[18] National Neonatology Forum, India. Clinical Practice Guidelines. Feeding of low birth weight neonates. 2020. Available from http://www.nnfi.org/assests/pdf/cpg-guidelines/FeedingofLBW.pdf. Accessed on 4 November 2020.

[19] Thakur SK, Roy SK, Paul K. Effect of nutrition education on exclusive breastfeeding for nutritional outcome of low birth weight babies. Eur J ClinNutr. 2012;66(3):376-81.

[20] Berkat S, Sutan R. The effect of early initiation of breastfeeding on neonatal mortality among low birth weight in Aceh Province, Indonesia: an unmatched case control study. Adv Epidemiol. 2014;2014:358692.

[21] Faisal M, Ali SM, Khan MJ. Weight gain pattern of exclusively breastfed low birth weight and normal weight babies during the first six months of life. Curr Pediatr Res. 2010;14(1):05-08.

[22] Chan SH, Johnson MJ, Leaf AA. Nutrition and neurodevelopmental outcomes in preterm infants: A systematic review. Acta Paediatr. 2016;105:587e99.



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