Growth Patterns of Low-Birth-Weight Babies in the First Year of Life

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Abstract: _Introduction: During the last few decades, the increase in the number of low birth weight (LBW) infants and their improved survival rate has raised the problem of correct evaluation of their post natal growth[1]. In addition to higher risk of morbidity and mortality, these babies show a pattern of growth different from the normal term babies. Objective: To compare the growth parameters (Weight, Length, HC) of low birth weight babies (≤2500) versus normal weight babies (>2500) till the age of 1 year. Methods: As per inclusion criteria 50 cases (≤2500 gms) and 50 control were selected for the study. Low birth weight babies delivered at Teritary care hospital or admitted to NICU of the same were enrolled by purposive sampling technique. This cohort was categorized into four groups based on birth weight. Babies in each sub group were entering a follow-up programme that includes measurement of anthropometric variables (weight, length and head circumference etc.) at 1.5,2.5,3.5 months ± 3 days and at 6, 9, 12months ± 7 days. Results & Conclusion: From the above study we found that lower the birth weight, higher is the increment in all the three parameters(Weight, Length, HC). Head circumference had catch-up growth with the control by the end of 1 year. Length and weight had no catch-up growth in spite of rapid increment. Head circumference of Preterm AGA babies had maximum catch-up growth and almost caught-up with the control babies at the end of the study period._

Keywords: Low birth weight, Growth pattern, Longitudinal follow up

1. Introduction

During the last few decades, the increase in the number of low birth weight (LBW) infants and their improved survival rate has raised the problem of correct evaluation of their post natal growth[1].

These babies are born underprivileged in the race for survival, where 'survival of the fittest' is the rule. In addition to higher risk of morbidity and mortality, these babies show a pattern of growth different from the normal term babies.

Studies carried out so far on growth of LBW infants are not homogenous in criteria of inclusion, number, and frequency of observations and length of follow-up[2, 3]. LBW is a heterogeneous population consisting of preterm appropriate for gestational age (AGA), preterm small for gestational age (SGA) and term SGA babies, all of whose growth may not be comparable. Many studies have considered only weight as the criterion without taking into consideration the gestational age.

When considering the growth of preterm babies many studies have considered chronological age, rather than corrected gestational age, which may give misleading results when comparing the growth velocity and catch up growth. Many studies did not have a control group of appropriate for gestational age[4].

There are not many studies on this subject from India. The only study done was in 2002[5]. Many previous studies used cross-sectional data gathered from separate group of subjects, often in the early months of life. However, only longitudinally collected growth data on the same subject measured at different age for an extended period allow calculation of growth velocity[6]. Hence this is an attempt being made to determine the growth pattern in LBW infants during the first year life.

2. Methodology

a) **Cases:** 50 Low birth weight (<2500 gm) babies delivered at Teritary care hospitalor admitted to NICU during the study period.
b) **Control:** Term babies with weight ≥2500 gm
c) **Type of Study:** Prospective comparative cohort study.

Inclusion criteria:
All the babies born/ admitted at Teritary care hospitalwith Birthweight < 2500gms

Exclusion Criteria:
a) Babies with congenital anomalies
b) Babies with severe birth asphyxia
c) Severe birth trauma
d) Chromosomal anomalies
e) Babies weighing < 1 kg
f) Babies not completing 1 year of follow up

Method of Collection of Data
As per inclusion criteria 50 cases (≤2500 gms) and 50 control were selectedfor the study. Low birth weight babies delivered at Fr. Muller Medical college hospital or admitted to NICU of the same were enrolled by purposive sampling technique. This cohort was categorized into four groups based on birth weight.

Group Birth Weight (grams)
I 1000-1500
II 1501-2000
III 2001-2500
IV >2501

At the time of enrolment a written informed consent was obtained from the parents. A detailed history was elicited from the mother and a thorough assessment was carried out at the time of enrolment.

Weight:

The baby's weight was recorded without the clothes in the lying position on a weighing pan which had 50 gms division.

Length:

Length of each baby was measured on an infantometer while lies supine with legs fully extended at the hips and knees and feet at right angles to the leg. It was measured in centimeters and was rounded to the nearest 0.5 cm decimal.

Head circumference:

Head circumference was measured with a flexible measuring tape with over the occiput at the back and just above the supra-orbital ridge in the front. It was measured in cm to the nearest 0.1 cm. Babies in each sub group were entering a follow-up programme that includes measurement of anthropometric variables (weight, length and head circumference etc.) at 1.5,2.5,3.5 months ± 3 days and at 6, 9, 12 months ± 7 days

Statistical analysis:

Collected data were analyzed by ANOVA (Analysis of Variance) and by chi- square test.

3. Results

Of the total 50 cases, 30 were male and 20 were female.
Of the total 50 controls, 35 were male and 15 were female.

Table 1: Distribution of Male and Female Babies in each group

Group	Male	Female	Total
Group – 1	4	4	8
Group – 2	10	10	20
Group – 3	16	6	22
Group – 4(Control)	35	15	50

Table 2: Mean Gestational Age in each Group

Group	Number	Mean Gestational Age (Weeks)
Group – 1	8	31
Group – 2	20	33.9
Group – 3	22	37
Group – 4 (Control)	50	38.1

Of the 50 cases, 30 were of Appropriate for Gestational Age (AGA) and 20 were small for Gestational Age (SGA). Gestational age of the Babies in our study ranged from 28 weeks to 38 weeks with the mean gestational age in each group as showed in the table.

Weight

Table 3: Weight (Kg) at the end of each follow up visit in the 3 Groups and the Control (>2.5kg)

Age in Months	Group -1 (n= 8)	Group – 2 (n= 20)	Group – 3 (n = 22)	Group – 4 (n = 50)
Birth	1.30±1.20	1.70±0.20	2.25±0.10	2.9±0.25
1 ½	1.39±0.09	2.31±0.36	2.90±0.37	3.67±0.34
2 ½	1.99±0.26	3.18±0.36	3.68±0.48	4.50±0.34
3 ½	2.69±0.50	3.95±0.56	4.50±0.56	5.30±0.35
6	4.28±0.65	5.94±0.73	6.54±0.60	7.05±0.45
9	5.85±0.95	7.08±0.76	7.60±0.65	8.10±0.62
12	6.7±0.85	7.89±0.69	8.40±0.72	8.8±0.60

Weight at each follow up visit in cases and control group increased in linear fashion.

Table 4: Weight at the end of each follow up visit in AGA and SGA Babies

Age in Months	AGA (n = 30)	SGA (n= 20)
Birth	2.1±0.30	1.5±0.40
1 ½	2.71±0.43	1.85±0.62
2 ½	3.48±0.50	2.59±0.81
3 ½	4.29±0.62	3.35±0.92
6	6.31±0.72	5.11±1.13
9	7.44±0.77	6.45±0.97
12	8.3±0.80	7.3±1.0

AGA babies had a mean birth weight of 2.1kg±0.3 and by the end of the study period they had a mean weight of 8.3kg±0.8. SGA babies had a mean birth weight of 1.5kg±0.4 and by the end of the study period they had a mean weight of 7.3kg ±1.

Length:

Table 5: Length (cm) at the end of each follow up visit in the 3 Groups and the Control (>2.5kg)

Age in Months	Group -1 (n= 8)	Group – 2 (n= 20)	Group – 3 (n = 22)	Group – 4 Control (n = 50)
Birth	38.69±2.10	45.2±1.0	46.88±1.88	49.49±1.29
1 ½	43.58±1.73	48.55±2.48	50.52±1.85	52.50±1.08
2 ½	46.75±2.01	52.34±1.88	53.64±3.08	55.70±1.29
3 ½	50.45±2.98	55.88±2.30	57.36±2.13	58.80±1.23
6	58.92±1.78	63.30±1.47	64.19±1.76	65.50±1.05
9	65.10±2.31	68.25±2.34	69.57±2.24	71.20±1.58
12	69.52±2.76	72.59±2.20	73.69±1.70	75±0.20

Lengths at each follow-up visit in cases and control group increased in linear fashion.

Table 6: Length at the end of each follow up visit in AGA and SGA Babies

Age in Months	AGA (n = 30)	SGA (n= 20)
Birth	46.0±2.16	42.5±4.36
1 ½	49.77±2.05	46.09±3.68
2 ½	53.245±1.85	49.26±3.82
3 ½	56.78±2.32	52.85±4.14
6	64.03±1.68	60.76±2.47
9	69.37±2.24	66.51±2.66
12	73.52±2.10	70.9±2.86

AGA babies had mean birth length of 46cm±2.16 and by the end of the study period they had a mean length of 73.52cm ± 2.1. SGA babies had a mean birth length of 42.5cm ± 4.36 and by the end of the study period they had a mean length of 70.9 cm ± 2.86.

Head Circumference:

Table 7: Head circumference (cm) at the end of each follow up visit in the 3 Groups and the Control (>2.5kg)

Age in Months	Group – 1 (n=8)	Group-2 (n=20)	Group-3 (n=22)	Group-4 Control(n=50)
Birth	27.78±0.90	31.77±1.80	32.52±1.30	35±0.88
1 ½	29.02±0.85	34.21±1.06	34.65±1.13	36.00±0.95
2 ½	32.04±1.13	36.30±1.05	36.31±1.20	37.60±0.93
3 ½	34.14±2.16	38.30±1.57	38.56±1.05	39.20±0.98
6	38.40±2.42	41.47±1.55	41.90±0.92	42.10±1.15
9	41.28±1.96	43.72±1.06	43.86±1.99	44.40±4.27
12	43.21±1.55	45.44±0.78	45.59±1.20	45.49±1.40

Head circumference at each follow up visit in cases and control group increasedin linear fashion.

Table 8: Head circumference at the end of each follow up visit in AGA and SGA Babies

Age in Months	AGA (n = 30)	SGA (n= 20)
Birth	32±1.40	34.2±1.10
1 ½	34.42±1.13	35.56±1.48
2 ½	36.34±1.00	36.95±1.63
3 ½	38.44±1.26	38.50±1.54
6	41.79±1.13	41.72±1.37
9	43.83±1.01	43.83±1.25
12	45.4±1.20	45.5±1.20

AGA babies had a mean birth head circumference of 32cm ±1.4 and by the end ofthe study period they had a mean head circumference of 45.4cm ±1.2. SGA babies had a mean birth head circumference of 34.2cm ±1.1 and by the end of study period they had a mean head circumference of 45.5 cm ± 1.2.

Weight:

Table 9: Mean Increment and S.D. at 3 month interval in weight of all thegroups

Weight	0-31/2mo.	P-value	31/2-6mo.	P-Value	6-9 mo	P- Value	9-12 mo	P-Value
Group 1	1.3± 0.54	<0.001	1.6±0.53	>0.05	1.6±0.51	>0.05	0.8±0.16	>0.05
Group 2	2.1±0.52	>0.05	1.9±0.46	>0.05	1.1±0.27	>0.05	0.9±0.21	<0.01
Group 3	2.27±0.57	>0.05	2.1±0.42	<0.005	1.0±0.35	<0.001	0.8±0.31	>0.05

In our study when mean increment in the weight at three monthly intervals was taken, we found that:
- At 31/2 months group-l babies had no catch-up growth with the control which is quite significant (p<0.00l), group-2 and group-3 babies had catch-up growth with the control and were not significant (p>0.05).
- At 6 months group-l and group-2 babies had catch-up growth with the control and was not significant (p >0.05). Group-3 babies had no catch-up' growth with the control and was significant (p<0.05).

- At 9 months, group-1 and group-2 babies had catch-up growth with the control and was not significant (p>0.05). Group-3 babies continued to have no catch-up growth which is quite significant (p<0.001).
- At 12 months, group-1 and group-3 babies had catch-up growth with the control and was not significant (p>0.05). Group 2 babies had no catch-up growth with the control and was significant (p<0.01).

Length:

Table 10: Mean Increment and S.D. at 3 month interval in length of all thegroups

Length	0-31/2mo.	P-value	31/2-6mo.	P-Value	6-9 mo	P- Value	9-12 mo	P-Value
Group 1	10.7± 4.60	>0.05	8.9± 3.15	<0.001	6.1 ±1.98	>0.05	3.8± 1.25	>0.05
Group 2	10.7± 2.40	<0.02	7.4± 2.14	>0.05	4.9±1.94	>0.05	4.4± 1.22	>0.05
Group 3	10.4± 2.23	<0.01	6.8± 2.1	<0.01	5.3±1.64	>0.05	4.1± 1.07	<0.001

In our study we found that:
- At 31/2 months, group-2 and group3 babies had no catch-up growth with the control and was significant (p<0.02 & <0.01 respectively). Group-l babies had catch-up growth with the control and was not statistically significant (p>0.05).
- At 6 months, group-1 and group-3 babies had no catch-up growth with the control and was statistically quite significant (p<0.00l in both the groups). Group-2 babies had catch-up growth with the control and was statistically not significant (p>0.05).

- At 9 months, babies in all the 3 groups had catch-up growth with the control and was statistically not significant (p>0.05).
- At 12 months, group-3 babies had no catch-up growth with the control and was statistically quite significant (p<0.00l). Group-l and group-2 babies had catch-up growth with the control and was statistically not significant (p>0.05). [Table no.13].

Head Circumference:

Table 11: Mean Increment and S.D. at 3 month interval in head circumference of all the groups

Head circumference	0-31/2mo.	P-value	31/2-6mo.	P-Value	6-9 mo	P- Value	9-12 mo	P-Value
Group 1	5.8± 2.27	>0.05	4.6± 1.28	<0.001	3.0± 1.19	<0.01	1.8± 0.70	>0.05
Group 2	6.9± 1.83	<0.001	3.0± 0.81	>0.05	1.8± 0.81	<0.05	1.6± 0.40	>0.05
Group 3	5.9± 1.11	<0.001	3.4± 0.63	<0.001	1.9± 0.85	<0.001	1.6± 0.53	<0.001

In our study we found that:
- At 3 months, group-2 and group-3 babies had no catch-up growth with the control and was statistically quite significant (p<0.00l). Group-2 babies had catch-up growth with the control and was statistically not significant (p>0.05).
- At 6 months, group-l and group-3 babies had no catch-up growth with the control and was statistically quite significant (p<0.00l). Group-2 babies had catch-up

growth with the control and was statistically not significant (p>0.05).
- At 9 months, babies in all. The three groups had no catch-up growth with the control and was statistically quite significant (p<0.0l, <0.05 & <0.001 respectively).
- At 12 months, group1 and group 2 babies had catch –up growth with the control and was statistically not significant (p>0.05). Group 3 babies had no catch-up growth with the control was statistically quite significant

(p<0.00l). [Table no.14]

From the above findings we found that babies with lower birth weight have higher increments in all the four parameters i.e. weight, length and head circumference at subsequent follow up. As our sample size is small and follow up period is less we could not come to any conclusive decision and needs further study for a longer period.

4. Discussion

The amazing advances in the neonatal care in the past decade have improved the survival of premature babies with very low birth weight. However, there is considerable disagreement among experts in the field as to what is optimum growth in preterm infant, in particular growth of preterm SGA infant.

For any longitudinal study, a good follow-up is extremely important. Parents of the babies were well motivated at the time of discharge from NICU and wards. Reminders were sent as and when required. In spite of this we had 20 dropouts in the cases. Babies with VLBW (<1500gm) followed-up regularly without needing any reminders when compared to babies (>1500gm) who needed frequent reminders. Mothers of VLBW (<1500gm) were more concerned about their babies. Control babies (>2500gm) were more problematic for the follow-up. These babies required frequent reminders every month for follow-up. The main attitude of the mothers of babies with weight > 1500gm and control group were that as long as their baby is fine, they don't need any follow-up. When we tried to analyze the difficulties they had in monthly follow-up, it was found that cost factors, domestic responsibility, inconvenient timings of the clinic do not permit them to follow-up at regular intervals.

It is difficult to compare the result of present study with previously published dataof this subject of growth especially of premature.
Besides prematurity growth of a child is affected by many factors such as environmental influence, genetic factors, nutrition, social background ,7 etc. In the midst of diversity of these factors it is impossible to have unity in growth pattern of babies with different birth weight.

Concept of classification of babies on gestational age and birth weight is quite recent and all the studies do not classify newborns on this basis as sample size decreases.

The studies that are published have bias of the population from which data is arrived. Hence standards of growth may be difficult to postulate.

Correction of prematurity is not done in many of the studies.

In our study we had enrolled 50 cases and 50 controls. Correction for gestational age (GCA) was not used in our study. Our LBW babies included term SGA, PretermSGA & Preterm AGA.

The accelerated growth velocity noted in the first year was perhaps only an illusive one as due to a lower birth weight, lesser weight was required for doubling and trebling. The true growth rate, particularly in later years is almost similar to heavier babies and hence the handicap amongst these continues in later years. The need for better psycho-social understanding as well as a true growth potential of these children required further studies, particularly because an increasing number of these infants are likely to survive.

The observations seen in preterm babies are at variance when low birth weight infants are taken, irrespective of their gestational age. The necessity of grouping preterm AGA children as distinct from IUGR infants is obvious as the former showed a distinct advantage of growth in later life [8].

Small for date babies have higher frequency and duration of illness like respiratory infections, GI infections than the normal weight children. The difference in collecting the data, interviewing the mother and written medical records and inability to measure this group of infants at the same time after discharge might contribute to the disparity in the values recorded [9].

Premature babies grow faster than the small for date babies. But when the result is subjected to statistical analysis they just fail to reach significance at the 5% probability level. It is very likely that widening curves may attain a statistical significance at a later age [10].

Although premature babies have found to have a slightly faster growth rates, the growth in no parameter attained statistical significance at the end of one year. Thus the results may be conclusive if the follow-up period is longer and the number of babies is more [11].

The early and temporary increase in rate of increase in head circumference by premature infants allows these infants to approach and even to surpass the projectedcurve for fetal head growth at a corresponding gestational age. This apparent "catch-up"in head size appears to coincide with the unridging of the sutures. The exaggerated increase in head circumference in the small premature infant between one and two months of postnatal age can on occasion give the clinician the false impression of developing hydrocephalus [12].

The head growth in the undergrowth infants of term gestation does not show this early exaggerated increase in size. Yet during the first year head size increases at a faster rate than in either the normal sized term or in premature infants when measured from an age equivalent to that of "term". An increase in the increment of head growth from birthto four years of age has been shown in a larger group of moderately under-sized infants at birth when compared to full-sized control infants.

Bhargava [13] did a longitudinal study of linear physical growth in preterm infants (<2500gm) from birth to 6 years and compared with term control babies (<2500gm). The sample size consisted of 28 preterm babies. They found that at the end of 6 years preterm babies had attained measurement comparable to control in height and head circumference, but at the end of 1 year they had not caught

up with the control babies. Although the difference in weight had diminished significantly between the two groups, as compared to earlier years, the preterm babies continued to be lighter than the control. In our study also we found that by the end of 1 year our preterm AGA babies had catch- up growth in the head circumference and length reducing the margin of difference with the control. Mostly even our preterm AGA babies would have caught up the control babies if it were followed up for further longer period.

Bhargave [14] did a study on the longitudinal study of linear physical growth of infants with birth weight 1500g or from birth to six years. The sample size included 25 VLBW which included preterm AGA and term SGA. This was compared with the control(>2500gm) group at 3, 6, 9 & 12 months ± 1week and every 6 month ± 2 weeks thereafter. They found that the VLBW infants were significantly lighter in weight shorter in height and had smaller head circumference as compared with the control group during the entire study period. The growth velocities in the two groups were almost the same and VLBW weight did not show any catch-up growth.

When increment in length and head circumference were compared with other studies, like Bhargave et. al. (1972), Babson et. al. 1970, Bhargava et. al. (1983), it was found that our study group had similar increment at subsequent follow-up. Our babies were on exclusive direct breast feed and no formula feeds were started.

Conclusion

From the above study we came to following conclusion:
1) Mean weight of Group I, II, III LBW babies and control babies were 6.65kg,7.95kg, 8.42 kg and 8.79kg respectively, at one year.
2) The rate of increase in weight of LBW babies was maximum in first three months i.e. 2.18kg.
3) The mean monthly increment in weight of LBW babies in first, second, third andlast three months were 700gm, 600gm, 400gm & 200gm respectively.
4) Mean length of group I, II, III LBW babies and control babies were 69.43cm, 72.60cm, 73.64cm and 74.90cm respectively at one year.
5) The rate of increase in length of LBW babies was maximum in the first threemonths i.e. 10.7cm.
6) The mean monthly increment in length of LBW babies in first, second, third and last 3 months were 3.5cm, 2.5cm, 1.8 cm and 1.1 cm respectively.
7) Mean head circumference of group I, II, III LBW babies and Control babies were 43.14cm, 45.33cm, 45.53cm and 45.90-cm respectively at one year.
8) The rate of increase in head circumference was maximum in first three monthly i.e. 6.18cm.
9) The mean monthly increment in Head circumference of LBW babies in first, second, third and last 3months were 2.0cm, l.cm, 0.8cm and 0.5cm respectively.
10) Babies with lower the birth weight have higher increment in all the fourparameters.
11) LBW babies had no catch-up growth with the control group babies in weight andlength throughout the study period.

12) Head circumference of LBW babies had maximum catch-up growth and almostcaught-up with the control babies at the end of the study period.

Limitations of the study

Nutritional Deficiencies: LBW babies are at a higher risk of developing nutritional deficiencies, which can further hinder their growth and development.

Chronic Health Conditions: Conditions such as respiratory problems (e.g., bronchopulmonary dysplasia) and gastrointestinal issues (e.g., necrotizing enterocolitis) are more common in LBW infants and can impact their growth trajectories.

Feeding Difficulties: Many LBW babies have trouble with feeding due to underdeveloped sucking and swallowing reflexes, which can impede their ability to take in sufficient nutrition.

Conflicts of interest: There are no conflicts of interest.

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