Research Article

Association of Postnatal growth with birth weight, gestational age, sex and intrauterine growth in very low birth weight Infants

Rabindran[1], Parakh H[2], Ramesh JK[3] , Reddy P[4]

[1]Dr.Rabindran, Junior Consultant Neonatologist, [2]Dr.Hemant Parakh, Consultant Neonatologist, [3]Dr.Ramesh J K, Consultant Pediatrician, [4]Dr.Prashant Reddy, Consultant Pediatrician. All are affiliated with Sunrise Superspeciality Children's Hospital, Hyderabad.

Address for correspondence: Dr Rabindran, E mail: rabindranindia@yahoo.co.in

Abstract

Introduction: The postnatal growth pattern is dependent on many biological factors. **Objective:** To analyse the effect of birth weight, gestational age, sex and intrauterine growth on the postnatal growth pattern of VLBW babies. **Methods:** Retrospective case analysis of 129 neonates between January-2012 to December-2014. Weight was serially measured from birth till discharge and respective z scores were calculated as per data from Fenton's 2013 references. **Statistical Analysis:** All data were collected in validated preformatted proforma sheet & analysed using appropriate statistical methods. **Results:** The mean birth weight & gestational age at birth were 1.292 kg & 32.24 weeks respectively. The mean z scores for weight at birth was -1.3989 which decreased to -2.1 by day 7. There was significant difference in gestation at birth & discharge and total duration of hospitalization based on birth weight. There was significant difference in gestation at birth & discharge and total duration of hospitalization, lowest weight, time to regain birth weight & day 1 & day 7 z scores based on gestation. Though SGA infants had more weight loss initially, they exhibited desired catch up growth during hospital stay and time to regain birth weight & total days of hospitalization were significantly less. **Conclusion:** Gestation is the predominant determinant of growth pattern followed by birth weight. There is no significant difference in growth between male & female babies. SGA babies demonstrated significant catch up growth despite initial significant weight loss.

Keywords: Postnatal Growth, Very low birth weight, small for gestational age

Introduction

Postnatal growth of Very Low Birth Weight (VLBW) infants (birthweight <1500g) remains a subject of concern. The care of VLBW infants has improved over the years with continuing changes in medical and nutritional management [1][2][3] . Despite this improvement, they continue to suffer growth lag during neonatal period [4]. In view of these changes, there is a need to study the pattern of postnatal weight gain. Previous investigators have analysed growth based on both intrauterine and extrauterine life but most of them are based upon cross-sectional data and most data are derived by linear extrapolation [5][6][7][8][9][10] . Longitudinal analysis of growth based on daily weights is more sensitive in analyzing postnatal growth. Infants born VLBW are at increased risk for impaired growth, due to certain factors during intrauterine life. It is well established that infants will lose weight in the first few days of life [11]. The postnatal growth pattern is dependent on biological factors like birth weight, gestational age, sex and intrauterine growth. Information on normal weight gain and weight loss in the first seven days of life has important clinical implications. It gives health workers a valuable adjunct in the assessment of the clinical state of an infant in resource poor settings where the capacity for alternative investigations is extremely limited [12].

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Objectives

To analyse the effect of birth weight, gestational age, sex and intrauterine growth on postnatal growth pattern of very low birth weight babies.

Methodology

This is a retrospective case analysis between January-2012 to December-2014 in a single centre. Gestational age was recorded as per obstetrical estimates based on first trimester ultrasonography or if not available, by date of last menstrual period. Infants were classified as SGA if the birth weight was below 10th centile as per Fenton's growth charts [13]. Mean z scores for weight of the whole cohort as per Fenton's growth charts 2013, were compared at birth & 7 days. Similar comparisons were made between SGA & AGA infants, between male & female. For further analysis, the cohort was classified into gestational age groups; and also categorized by 100g birthweight intervals.

Interventions/ Measurement: Weight of each infant (unclothed, without diaper) was determined each morning before feeding on a calibrated electronic scale to the nearest 10 g. The values on day 1 & day 7 were converted to z-scores adjusted for gestational age and gender as per Fenton growth chart 2013 [13]. Parenteral and enteral feeding according to the routine unit protocol was started. Bolus nasogastric feeding with breast milk or premature infant formula was begun as early as possible and advanced in a stepwise fashion. The study was approved by the Hospital Research and Ethics Committee.

Fluid and nutrition policy: VLBW infants were started on 80 mL/kg/d of fluid on first day of life. Enteral feeds were initiated as soon as possible, preferably on first day of life, if haemodynamically stable. Increments of 20mL/kg/d were made as tolerated. Human milk was preferred and if human milk was not available, a low birth weight infant formula was used. Infants who were not expected to be on total enteral feeds within first 5 days of life, were started on partial parenteral nutrition on first day with protein of 1.5g/kg/d and lipid intake of 1g/kg/d. Daily increments of 1g/kg/d were made up to a maximum intake of 3.5 g/kg/d of protein & 3 g/kg/day of lipid.

Statistical Analysis

All the data were collected in validated preformatted proforma sheet and analysed using software Statistical Package for Social Sciences. Analysis of variance was used to compare the groups, and data were expressed as mean ± standard deviation. A p-value of < 0.05 was considered significant. The z scores for weight for each gestation were calculated based on means and standard deviations from Fenton's reference data.

Results

Postnatal weight patterns of 129 VLBW babies were examined. The mean birth weight was 1.292 kg (range 790g to 1500g) & the mean gestational age at birth was 32.24 wk (range 29 to 39 weeks). The mean weight at discharge was 1.350 kg & the mean gestational age at discharge was 34.32 wk. About 66 babies (51.16%) were SGA & 68 babies (52.71%) were male. The mean z scores for weight, at birth was -1.3989 which decreased to -2.1 by day 7 of life. The mean age to regain birth weight was 10.11 days & the mean total days of hospitalization were 16.64 days. Both SGA and AGA infants exhibited a decrease of z score in the first week of life.

Table 1 – Birth Weight Based Distribution of Postnatal Growth

		0.7-0.8	0.8-0.9	0.9-1	1-1.1	1.1-1.2	1.2-1.3	1.3-1.4	1.4-1.5	ANOVA P
	TOTAL	1	9	6	10	13	20	16	54	
GESTATION AT BIRTH	MEAN	28	30	30.3333	31.1111	30.0769	32.5	32.1875	33.6296	
	SD		1.9365	3.5024	3.1798	2.2899	2.5854	1.797	2.1917	<0.001
GESTATION AT DISCHARGE	MEAN	32	33.7778	31.8333	34.4444	32.6923	34.75	34.25	35.037	
	SD		1.3944	3.5449	3.1667	1.9742	2.5521	1.5706	2.1453	0.004
LOWEST WEIGHT	MEAN	0.715	0.8184	0.87	0.9333	1.0896	1.1897	1.2713	1.3676	
	SD		0.243	0.03975	0.07053	0.06606	0.07166	0.07562	0.08967	0.099
TIME TO REGAIN BIRTH WEIGHT	MEAN	8	9.3333	11.5	12.6667	11.7692	8.85	10.9375	9.4074	
	SD		8	8.3606	8.8034	4.1464	4.6371	5.3225	5.4062	0.554
Z SCORE ON DAY 1	MEAN	-1.22	-1.5267	-1.6133	-1.5456	-0.9531	-1.7275	-1.1244	-1.7344	
	SD		0.8126	2.0448	1.5192	0.9589	1.2984	0.9608	1.0468	0.323
Z SCORE ON DAY 7	MEAN	-1.59	-1.9922	-2.2667	-2.2956	-1.3454	-2.231	-1.7712	-2.3583	
	SD		0.6904	2.1218	1.6838	1.1723	1.3365	0.9896	1.1626	0.263
TOTAL DAYS OF HOSPITALISATION	MEAN	32	28.8889	23.3333	24.1111	18.9231	16.55	15.25	12.1481	
	SD		9.8925	13.3367	10.8909	8.8831	7.2	6.7181	5.7344	<0.001

Infants were categorized by 100 g birth weight intervals starting from 700g to 1500 g. Applying ANOVA, there was statistically significant difference in the gestational age at birth & discharge and total duration of hospitalization between the subgroups. There was no significant difference in the lowest weight, time to regain birth weight & day 1 & day 7 z scores between the subgroups based on birth weight.

Table 2 – Gestational Age Based Distribution of Postnatal Growth

		27	28	29	30	31	32	33	34	35	36	37	38	39	ANOVA P
	TOTAL	1	17	3	18	8	26	7	24	6	13	4	1	1	
GESTATION	MEAN	32	31.2941	32	32.7222	33	34.0385	35.2857	35.6667	36.1667	36.6923	38.25	40	40	
AT DISCHARGE	SD		1.0467	1.7321	1.2744	2.7255	0.9584	1.1127	0.9168	0.4082	2.3939	0.5			<0.001
WEIGHT	MEAN	0.9	1.0639	1.1783	1.2517	1.2088	1.304	1.3507	1.405	1.4408	1.4112	1.245	1.43	1.5	
AT BIRTH	SD		0.1643	0.04856	0.1999	0.2357	0.2054	0.09387	0.1278	0.08429	0.1527	0.2116			<0.001
LOWEST	MEAN	0.73	0.9632	1.026	1.1567	1.1013	1.196	1.2429	1.3096	1.3575	1.37	1.235	1.405	1.4	
WEIGHT	SD		0.1482	0.04414	0.1759	0.2126	0.2032	0.08113	0.133	0.09353	0.1535	0.2207			<0.001
TIME TO REGAIN	MEAN	29	11.3529	14.3333	11.8333	15.25	10.2692	10.8571	8.5833	7.1667	6.2308	4.25	8	7	
BIRTH WEIGHT	SD		5.8088	2.5166	4.5922	7.8695	7.1809	3.7161	3.5499	2.7869	2.5217	2.63			<0.001
WEIGHT	MEAN	1.055	1.2315	1.1917	1.3689	1.305	1.3094	1.4136	1.4015	1.4283	1.4846	1.3238	1.4	1.465	
AT DISCHARGE	SD		0.1646	0.1042	0.1873	0.1588	0.2063	0.1077	0.1258	0.09928	0.2034	0.263			0.009
Z SCORE	MEAN	-0.27	-0.5647	-0.11	-0.5333	-0.925	-1.1142	-1.6229	-1.9558	-2.4567	-3.1562	-4.4675	-4.3	-4.74	
ON DAY 1	SD		0.4736	0.02646	0.4866	0.6621	0.5681	0.2846	0.346	0.2009	0.4734	0.8145			<0.001
Z SCORE	MEAN	-1.36	-0.7347	-0.91	-0.955	-1.5912	-1.7715	-2.4014	-2.6758	-3.185	-3.8015	-4.9575	-4.99	-5.38	
ON DAY 7	SD		0.441	0.1212	0.5089	0.5748	0.6202	0.1945	0.3491	0.2062	0.6666	1.0787			<0.001
TOTAL DAYS OF	MEAN	37	24.4706	21.6667	20.3333	24	14.9615	16.8571	12.5833	10.1667	10.8462	9	17	7	
HOSPITALISATION	SD		8.3675	10.7858	9.7135	11.5758	6.5878	8.2144	6.6458	3.1252	5.4749	3.3665			<0.001

Infants were categorized based on gestational age into subgroups starting from 27 weeks to 39 weeks. Analysis of variance was used to compare the groups. There was statistically significant difference in the gestational age at discharge, total duration of hospitalization, time to regain birth weight & day 1 & day 7 z scores between the subgroups based on gestational age

Table 3 - Gender Based Distribution of Postnatal Growth

		MALE	FEMALE	ANOVA P
	TOTAL	68	61	
GESTATION AT BIRTH	MEAN	32.3235	32.1639	
	SD	2.6113	2.853	0.741
GESTATION AT DISCHARGE	MEAN	34.3235	34.3279	
	SD	2.4824	2.3074	0.992
WEIGHT AT BIRTH	MEAN	1.3026	1.2807	
	SD	0.2113	0.1964	0.543
LOWEST WEIGHT	MEAN	1.1937	1.1844	
	SD	0.8837	0.2019	0.344
TIME TO REGAIN BIRTH WEIGHT	MEAN	10.5735	9.6066	
	SD	5.6286	5.9869	0.346
WEIGHT AT DISCHARGE	MEAN	1.374	1.3248	
	SD	0.1928	0.1712	0.13
Z SCORE ON DAY 1	MEAN	-1.5932	-1.4559	
	SD	0.9812	1.3353	0.504
Z SCORE ON DAY 7	MEAN	-2.1747	-2.04	
	SD	1.0262	1.4743	0.545
TOTAL DAYS OF HOSPITALISATION	MEAN	17.3382	15.8689	
	SD	9.1515	8.9972	0.36

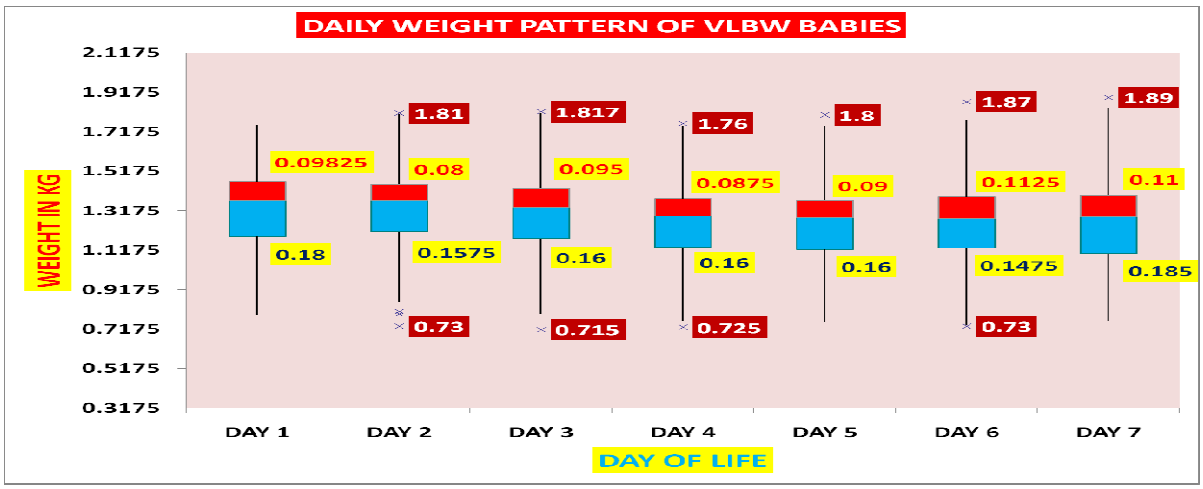
Analysis of variance was used to compare the groups, and data was expressed as mean ± standard deviation. There were 68 male babies & 61 female babies in the study population. The mean gestation at birth was around 32 weeks & mean gestation at discharge was around 34 weeks in both male & female babies. The weight at birth, lowest weight & weight at discharge were comparable between male & female babies & there was no significant difference in the time to regain birth weight & total duration of hospitalization.The mean z score ± standard deviation on day 1 among male was -1.5932 ± 0.9812; among female was -1.4559 ± 1.3353 (**Anova p= 0.504; not significant).** The mean z score ± standard deviation on day 7 among male was -2.1747 ± 1.0262; among female was -2.04 ± 1.4743 (**Anova p= 0.545; not significant).**

Table 4 – Intrauterine Growth Based Distribution of Postnatal Growth

		AGA	SGA	ANOVA P
	TOTAL	63	66	
GESTATION AT BIRTH	MEAN	30.1111	34.2879	
	SD	1.657	1.8125	<0.001
GESTATION AT DISCHARGE	MEAN	32.6508	35.9242	
	SD	1.416	2.0101	<0.001
WEIGHT AT BIRTH	MEAN	1.2723	1.3214	
	SD	0.191	0.2129	0.096
LOWEST WEIGHT	MEAN	1.2617	1.2494	
	SD	0.9182	0.2106	0.312
TIME TO REGAIN BIRTH WEIGHT	MEAN	12.0317	8.2879	
	SD	6.0906	4.8857	<0.001
WEIGHT AT DISCHARGE	MEAN	1.3255	1.3749	
	SD	0.1786	0.187	0.127
Z SCORE ON DAY 1	MEAN	-0.591	-2.423	
	SD	0.3972	0.9125	<0.001
Z SCORE ON DAY 7	MEAN	-1.0913	-3.0844	
	SD	0.5441	0.9211	<0.001
TOTAL DAYS OF HOSPITALISATION	MEAN	18.7619	14.6212	
	SD	8.4942	9.2083	0.009

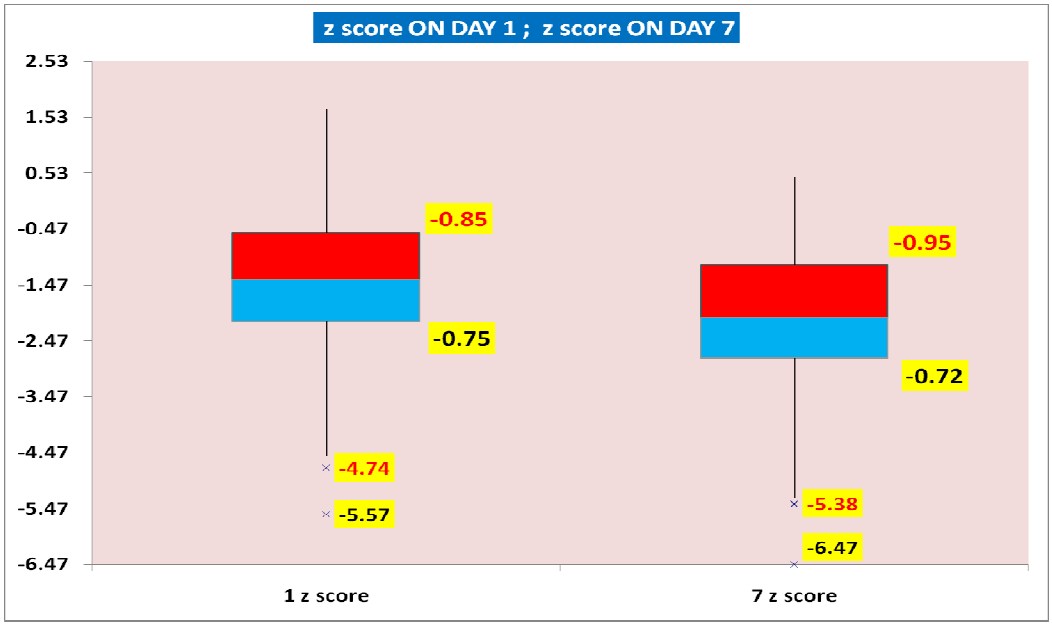
Analysing the postnatal growth between AGA & SGA babies, there was significant difference in the mean gestation ± standard deviation at birth (**Anova p<0.001; significant)** & the mean gestation ± standard deviation at discharge (**Anova p<0.001; significant).** The weight at birth, lowest weight & weight at discharge were comparable between AGA & SGA babies. The time to regain birth weight & total duration of hospitalisation was significantly more among AGA babies when compared to SGA babies. The mean z score ± standard deviation on day 1 was -0.591 ± 0.3972 among AGA & -2.423 ± 0.9125 among SGA babies (**Anova p<0.001; significant).** The mean z score ± standard deviation on day 7 among AGA was -1.0913 ± 0.5441; among SGA was -3.0844 ± 0.9211 (**Anova p<0.001; significant).**

Figure 1 – Daily Weight Pattern of Vlbw Babies During The First Week Of Life



Box & Whisker plot for daily weight from day 1 to day 7 of life. Solid line between red and blue box shows median z score; top of the box is 25th interquartile range & bottom of the box is 75th interquartile range within the range of the data. The mean weight on day 1 was 1.36 kg, day 2 was 1.37 kg, day 3 was 1.33 kg, day 4 was 1.29 kg , day 5 was 1.28 kg, day 6 was 1.27 kg & on day 7 was 1.28 kg. The median weight on day 1 was 1.29 kg, day 2 was 1.31 kg, day 3 was 1.28 kg, day 4 was 1.24 kg, day 5 was 1.23 kg, day 6 was 1.24 kg & on day 7 was 1.24 kg.

Figure 2 – Box & whisker plot for z scores on day 1 & day 7 for weight.



Box & Whisker plot for z Scores on day 1 & day 7 for weight. Solid line between red and blue box shows median z score; top of the box is 25th interquartile range & bottom of the box is 75th interquartile range within the range of the data. The mean z scores for weight at birth was -1.3989 which decreased to -2.1 by day 7 of life.

Discussion

The mean birth weight among VLBW babies in our study population was 1.292 kg. The mean birth weight was 1.097 kg in a study by Trebar B et al [14], 1.140 kg in a study by Bertino E et al [15], 1.255 kg (range 530 to 1500 g) in a study by Hasan Ozkan et al [16], 1.257 ±190.7 in a study by satish saluja et al[4] & 1.364 kg in a study by Fewtrell et al[17]

The mean gestational age at birth in our study was 32.24 weeks. The mean gestational age at birth was 29.17 weeks in the studies by Trebar B et al [14] & Hovi P et al [18] , 29.5 ± 2.3 weeks (range 24 to 34 weeks) in a study by Hasan Ozkan et al[16], 30.4 weeks in a study by Bertino E et al[15], 31 weeks in a study by Fewtrell et al[17] & 31.7 ± 2.35 weeks in a study by satish saluja et al[4]. This variation in the mean birth weight among VLBW babies in the above studies may be due to racial & ethnic differences among the study populations.

About 52.71 % were male in our study as compared to 51.85 % in a study by P Khandelwal et al [19], 53 % in a study by Hasan Ozkan et al[16] & 58.8 % in a study by satish saluja et al[4]. About 51.16 % were SGA in our study. The proportion of SGA was 22 % in a study by Lemons JA et al[20], 33.1 % in a study by Hovi P et al[18], 38.5 in a study by Bertino E et al[15] , 55.3 % in a study by Trebar B et al[14] & 60 % in the study by Hasan Ozkan et al[16].

The daily mean weight was nonlinear in our study. Hasan Ozkan et al on analyzing the longitudinal data of infants also showed that the daily mean weight gain pattern was nonlinear [16]. In our study the mean z scores for weight at birth was -1.3989 which decreased to -2.1 by day 7 of life. This initial period of weight loss is partly attributable to the reduction of total body water that occurs after birth, higher loss of water due to evaporation, negative energy and nitrogen balance due to inadequate nutrition [21]. Sathish saluja etal also observed that the mean z scores for weight at birth was -1.17 which decreased to -2.16 at discharge [4]. Anchieta et al observed that the postnatal growth was characterized by weight loss during the 1st week (4-6

days) ranging from 5.9 to 13.3% (the greater the percentage, the lower the birth weight), recovery of birth weight within 17 and 21 days, and increasingly higher rates of weight gain after the 3rd week [22]. Gairdner and Pearson [6] reported that weight increases are not linear in premature infants and have four phases, the first of weight loss, the second parallel to a fetal weight curve, the third of growth acceleration and the fourth of stability along the individual centile. Use of z-scores in our study has enabled a better description of growth.

Role of Birth Weight in Postnatal Growth: In our study, infants were categorized by 100 g birth weight intervals starting from 700g to 1500 g. Applying ANOVA, there was statistically significant difference in the gestational age at birth & discharge and total duration of hospitalization between the subgroups. There was no significant difference in the lowest weight, time to regain birth weight & day 1 & day 7 z scores between the subgroups based on birth weight. Smith SL et al., studied the postnatal growth of VLBW & ELBW babies. He noted a significant difference in the maximum percent weight lost between the two groups, with the ELBW group losing a mean of 14.77% of birth weight and the VLBW group losing a mean of 11.35% of birth weight ($t = 2.45$, $p < 0.05$) [23]. No significant difference was noted in the time to return to birth weight between the two groups, with a mean of 15 days to return to birth weight. [23].The mean age to regain birth weight was 10.11 days in our study. Other studies by A.M. Euser et al[24], Pauls J et al[25], Bertino E et al[15] & Ehrenkranz RA et al[26] also showed that birth weight is usually regained in the period between the 8th to the 24th day of life, but earlier in infants with higher birth weights.

Role of Gestational Age in Postnatal Growth: Preterm birth is defined by the estimated gestational age as a proxy of maturity [24]. In very preterm and/or VLBW infants, gestational age is a better predictor of short-term survival than birth weight [27]. Our study population was analysed in gestational age subgroups starting from 27 weeks to 39 weeks. Applying ANOVA, there was statistically significant difference in the gestational age at birth & discharge and total duration of hospitalization, lowest weight, time to regain birth weight & day 1 & day 7 z scores between the subgroups based on gestational age.

Gestational age at delivery is a strong determinant of birth weight and postnatal survival [28]. In the second half of intra-uterine life, there is a rapid weight gain especially in the last trimester when the weight triples and the length doubles as body stores of protein, fat, iron, and calcium increase. About 75% of the birth weight is gained during this period at a rate of about 700gms per month. The rapid weight increase is accounted for by an increase in size and maturation of the organs formed earlier on [29]. If however, gestation is terminated before term, birth weight is likely to be low and the growth pattern of the preterm, low birth weight infant differs significantly from what might have been expected had the baby remained in utero [28].

In our study, the time to regain birth weight was 29 days for babies with gestational age of 27 weeks which was comparable to the study by O.F Xjokanma et al [28] who observed that the time to regain birthweight was 23.3 days among babies with gestational age between 26-28 weeks. The time to regain birth weight was 11.8-14.3 days & 10.2-15.2 days for babies with gestational age between 29-30 weeks & 31-32 weeks respectively, which was comparable to 16.4 days & 15.9 days in the study by O.F Xjokanma et al.[28]. The time required was 8.5-10.8 days & 6.2-7.1 days for babies with gestational age between 33-34 weeks & 35-36 weeks respectively, which was comparable to 14.2 days & 5.9 days in the study by O.F Xjokanma et al [28].Bertino E et al [30], Zaw W et al [31] & Marsal K et al [32] observed that the infants born prematurely are usually smaller than the fetuses of corresponding gestational age that later deliver at term.The degree of initial weight loss, age at nadir weight and age of regaining birth weight were all inversely related to gestational age in the study by O.F Xjokanma et al [28]. We also noted that the time to regain birth weight was more as gestation decreased. Our findings agree with earlier series in which babies of lower gestational age and birth weight tended to lose more weight and to grow more slowly than more mature ones [33].

Role of Sex in Postnatal Growth: The mean gestation at birth was around 32 weeks & mean gestation at discharge was around 34 weeks in both male & female babies. The weight at birth, lowest weight & weight at discharge were comparable between male & female babies & there was no significant difference in the time to regain birth weight & total duration of hospitalization. The mean z score ± standard deviation on day 1 among male was -1.5932 ± 0.9812; among female was -1.4559 ± 1.3353 (Anova p= 0.504; not significant). The mean z score ± standard deviation on day 7 among male was -2.1747 ± 1.0262; among female was -2.04 ± 1.4743 (Anova p= 0.545; not significant).

Role of Intrauterine Growth in Postnatal Growth: We noted that both AGA and SGA infants had a significant drop in their growth Z scores during hospital stay. Satish saluja et al[4] also noted that both AGA and SGA infants had a significant drop in their growth Z scores during hospital stay. In our study the change in z score was more among SGA babies as compared to AGA babies (-2.423 on day 1 to -3.0844 on day 7 among SGA as compared to -0.591 on day 1 to -1.0913 on day 7 among AGA babies). Even though SGA infants had more fall in their growth parameters as compared to AGA, they exhibited desired catch up growth during hospital stay and time to regain birth weight was significantly lower (8.2 days in SGA as compared to 12.03 days among AGA, Anova p <0.001). The total days of hospitalization was also less among SGA babies (14.62 days in SGA as compared to 18.76 days among AGA, Anova p =0.009). Ehrenkranz RAet al., also observed faster weight gains among SGA infants in his study [26]. However Saluja et al noted that SGA and AGA VLBW infants had comparable growth velocity during hospital stay[4]. Gutbrod T et al observed that SGA infants are at double jeopardy; in addition to intrauterine growth restriction, many are born pre-maturely [34]. Bertino E et al [11] & Radmacher PG et al[35] also observed that SGA infants continue to grow slow during early postnatal life. O.F Xjokanma et al., observed that one of the most important factors affecting the quality of postnatal growth of born preterm or with low birth weight babies is the quality of intrauterine growth [28].

Summary

There was statistically significant difference in the gestational age at birth & discharge and total duration of hospitalization between the subgroups based on birth weight. There was statistically significant difference in the gestational age at birth & discharge and total duration of hospitalization, lowest weight, time to regain birth weight & day 1 & day 7 z scores between the subgroups based on gestational age. The weight at birth, lowest weight & weight at discharge were comparable between male & female babies & there was no significant difference in the time to regain birth weight & total duration of hospitalization. In our study the change in z score was more among SGA babies as compared to AGA babies. Even though SGA infants had more fall in their growth parameters as compared to AGA, they exhibited desired catch up growth during hospital stay and time to regain birth weight & total days of hospitalization was significantly less among SGA babies as compared to AGA babies.

Conclusion

Postnatal growth pattern of VLBW babies is non linear. Gestational age is the most predominant determinant of the growth pattern followed by birth weight. There is no significant difference in the growth pattern between male & female babies. SGA babies demonstrated a significant catch up growth despite initial significant weight loss. The present study is limited because the study population is small and the study period is short. However, a good initial database is presented and can be useful for future research in this region. If substantiated by future prospective studies, these data may help clinicians to counsel families who are concerned about the weight gain regarding the postnatal growth pattern & total duration of hospitalisation based on gestation, sex, intrauterine growth and birth weight.

Keywords: Postnatal Growth, VLBW, Z score

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References

1. Bregman J, Kimberlein L VS, Developmental outcome in extremely premature infants. Ped Clin North Am 1993; 40: 937-953. doi: 10.1542/peds.103.3.684 .

2. Fanaroff A, Wright LL, Stevenson DK. Very-low-birth-weight outcomes of the National Institude of Child Health and Human Development Nenonatal Research Network, May 1991-December 1992. Am J Obstet Gynecol 1995; 173: 1423-1431 .

3. Perlman M, Claris O, Hao Y, Pandit P, Whyte H, Chipman M, Secular changes in the outcomes in eighteen to twenty-four months of age: extremely low birth weight infants, with adjustment for changes in risk factors and severity of illness. J Pediatr 1995 Jan; 126(1): 75-87 . DOI; http://dx.doi.org/10.1016/S0022-3476(95)70507-4

4. Satish Saluja, Manoj Modi, Avneet Kaur, Anil Batra, Arun Soni, Pankaj Garg, Neelam Kler, Growth of Very Low Birth-Weight Indian Infants During Hospital Stay. Indian Pediatrics : Oct 2010;47:851 - 856 . *PII:*

S097475590900516-1

5. De Curtis M, Bland JM, Paone MC,Vetrano G, Paludetto R, Ciccimarra F. Birth weight of Italian infants of 30 weeks'gestation or less. Eur J Pediatr. 1988 Nov;148(2):136–138.

6. Gairdner D, Pearson J. A growth chart for premature and other infants. Arch Dis Child. 1971 Dec;46(250):783–787.

7. Babson SG, Benda GI. Growth graphs for the clinical assessment of infants of varying gestational age. J Pediatr. 1976 Nov;89(5):814–820.

8. Lubchenco LO, Hansman C, Dressler M, Boyd E. Intrauterine growth as estimated from live born birth-weight data at 24 to 42 weeks of gestation. Pediatrics 1963 Nov; 32: 793-800.

9. Brooke OG, Mclntosh N. Birthweights of infants born before 30 weeks gestation. Arch Dis Child 1984 Dec ; 59 (12): 1189-1190.

10. Karlberg P, Niklasson A, Ericson A. A methodology for evaluating size at birth.Acta Paediatr Scand 1985; 319 (suppl): 26-37.

11. Bertino E, Coscia A, Boni L, Rossi C, Martano C, Giuliani F. Weight growth velocity of very low birth weight infants: role of gender, gestational age and major morbidities. Early Hum Dev 2009;85(6) : 339-347. doi: 10.1016/j.earlhumdev.2008.12.014. Epub 2009 Feb 1.

12. Claudia Turner, Verena Carrara, Naw Aye Mya Thien, Naw Moo Ku Paw, Marcus Rijken1, Rose McGready, François Nosten; Changes in the body weight of term infants, born in the tropics, during the first seven days of life. BMC Pediatrics 2013, 13:93 .doi:10.1186/1471-2431-13-93

13. Tanis R Fenton* and Jae H Kim, A systematic review and metaanalysis to revise the Fenton growth chart for preterm infants. BMC Pediatrics 2013 13:59. doi:10.1186/1471-2431-13-59

14. Trebar B, Traunecker R, Selbmann HK, Ranke MB. Growth during the first two years predicts pre-school height in children born with very low birth weight (VLBW): results of a study of 1,320 children in Germany. Pediatr Res 2007 Aug ; 62 (2):209-214.

15. Bertino E, Coscia A, Mombro M, Boni L, Rossetti G, Fabris C. Postnatal weight increase and growth velocity of very low birth weight infants. Arch Dis Child Fetal Neonatal Ed 2006; 91:F349-F356. doi: 10.1136/adc .

16. Hasan Ozkan, Aysen Uguz, Sebnem Haberal; Postnatal Weight Velocity Patterns in Very Low Birthweight Infants. Indian J Pediatr May-June 1997; 64(3):383-388

17. Fewtrell MS, Cole TJ, Bishop NJ, Lucas A. Neonatal factors predicting childhood height in preterm infants: evidence for a persisting effect of early metabolic bone disease? J Pediatr 2000 Nov; 137 (5):668-673.

18. Hovi P, Andersson S, Eriksson JG, Jarvenpaa AL, Strang- mKarlsson S, Makitie O. Glucose regulation in young adults with very low birth weight. N Engl J Med 2007 May; 356 (20):2053-2063.

19. P. Khandelwal, V. Jain, A. K. Gupta, M. Kalaivani, V. K. Paul; Association of early postnatal growth trajectory with body composition in term low birth weight infants. Journal of Developmental Origins of Health and Disease (2014) Jun, 5(3), 189–196.

20. Lemons JA, Bauer CR, Oh W, Korones SB, Papile LA, Stoll BJ. Very low birth weight outcomes of the National Institute of Child health and human development neonatal research network, January 1995 through December 1996. NICHD Neonatal Research Network. Pediatrics 2001; 107(1):E1.

21. Forsyth JS, Murdock N, Crighton A. Low birthweight infants and total parenteral nutrition immediately after birth IH Randomised study of energy substrate utilisation, nitrogen balance, and carbon dioxide production. Arch Dis Child 1995, 73: F 13-F 16.

22. Anchieta, L.M.; Xavier, C.C, Colosimo, E.A. Souza, M.F.. Weight of preterm newborns during the first twelve weeks of life. Braz J Med Biol Res . 2003, vol.36(6), pp. 761-770. ISSN 1414- 31X. http://dx.doi.org/10.1590/S0100-879X2003000600012.

23. Smith SL, Kirchhoff KT, Chan GM, Squire SJ; Patterns of postnatal weight changes in infants with very low and extremely low birth weights.Heart & Lung : the Journal of Critical Care [1994, 23(6):439-445].

24. A.M. Euser, C.C. de Wit, M.J.J. Finken, M. Rijken, J.M. Wit; Growth of preterm born children. Hormone Research 2008; 70: 319-328.

25. Pauls J, Bauer K, Versmold H. Postnatal body weight curves for infants below 1000 g birth weight receiving early enteral and parenteral nutrition. Eur J Pediatr 1998; 157(5) :416-421.

26. Ehrenkranz RA, Younes N, Lemons JA, Fanaroff AA, Donovan EF, Wright LL. Longitudinal growth of hospitalized very low birth weight infants. Pediatrics 1999 Aug ; 104(2) : 280-289.

27. Verloove P, Verwey RA, Brand R, Keirse MJ. Importance of gestational age. Lancet 1986; 1:1494.

28. O.F Xjokanma, M.T.C Egri-Okwaji, J.O Babalola . Early postnatal growth of preterm low birth weight, appropriately-sized infants . Nigerian Journal of Clinical Practice ; June 2008; 11(2):104-110

29. Sadler TW. Langman's Medical Embryology. Seventh Edition. Philadelphia. Lippincott Williams and Wilkins. 1995: 90-92.

30. Bertino E, Milani S, Fabris C, De Curtis M. Neonatal anthropometric charts: what they are, what they are not. Arch Dis Child Fetal Neonatal Ed 2007; 92 (1):F7–F10.

31. Zaw W, Gagnon R, da Silva O. The risks of adverse neonatal outcome among preterm small for gestational age infants according to neonatal versus fetal growth standards. Pediatrics 2003;111:1273–1277.

32. Marsal K, Persson PH, Larsen T, Lilja H, Selbing A, Sultan B. Intrauterine growth curves based on ultrasonically estimated fetal weights. Acta Paediatr 1996;85:843–8.

33. Babson SG. Growth of low birthweight infants. J Paediatr l970 Jul ;77 (1): 11 18.

34. Gutbrod T, Wolke D, Soehne B, Ohrt B, Riegel K. Effects of gestation and birth weight on the growth and development of VLBW small for gestational age infants: A matched group comparision. Arch Dis Child Fetal Neonatal Ed 2000; 82: F 208-214.

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