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Growth, pace and variations in physical aspects of preterm and term babies a longitudinal-comparative analysis

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Abstract

The in-hand research study was designed contemporaneously with the developmental aspects and milestones* of child development in order to find out variations in the growth patterns, specifically in terms of Weight*, Length*/Height* of preterm and term babies. The research was conducted in Chandigarh and Mohali. The sample consisted of two groups; Preterm* and Term babies. The data related to the subjects was collected through the Doctors and Parents. The said parameters were recorded over the period of two years from birth. The data was minutely, carefully and authentically taken & assessed. It was found that although initially the preterm babies lagged in their length and weight measurements, but amazingly, it was witnessed that there was no variation in the later months where mainstreaming* was notified in the physical growth among Preterm and Term babies.

Keywords: Preterm, Milestones, Weight, Length, Height, Mainstreaming.

1. Introduction

Children of the same age can be seen in all shapes and sizes. Some kids look tiny next to their peers, while others literally stand head and shoulders above their classmates. As easy as it is to make these comparisons and to draw conclusions about what is seen, the reality is that kids grow at their own pace. Big, small, tall, short, and many more there is a wide range of healthy shapes and sizes among children. Genetics, gender, nutrition, physical activity, health problems, environment, hormones, and lifestyle factors like nutrition and physical activity all influence a child's height and weight. And many of these factors can vary widely from family to family. A doctor uses growth charts to assess the child's height and weight measurements to ensure whether he is developing on track or not. Growth charts are a standard part of any checkup, and they show health care providers how kids are growing compared with other kids of the same age and gender. They also allow doctors and nurses to see the pattern of kids' height and weight gain over time, and whether they're developing proportionately. Physical growth in stature and weight occurs over the 15–20 years following birth, as the individual changes from the average weight of 3.5 kg and length of 50 cm at term birth to full adult size. As stature and weight increase, the individual's proportions also change, from the relatively large head and small torso and limbs of the neonate, to the adult's relatively small head and long torso and limbs. The child's pattern of growth is in a head-to-toe direction, or cephalocaudal, and in an inward to outward pattern (center of the body to the peripheral) called proximodistal. The speed of physical growth is rapid in the months after birth, and then slows, so birth weight is doubled in the first four months, tripled by age 12 months, but not quadrupled until 24 months. Growth then proceeds at a slow rate until shortly before puberty (between about 9 and 15 years of age), when a period of rapid growth occurs. Growth is not uniform in rate and timing across all body parts. At birth, head size is already relatively near to that of an adult, but the lower parts of the body are much smaller than adult size. In the course of development, then, the head grows relatively little, and torso and limbs undergo a great deal of growth. Physical growth refers to an increase in body size (length or height and weight) and in the size of organs. From birth to about age 1 or 2 years, children grow rapidly. After this time, growth slows. As growth slows, children need fewer calories and parents may notice a decrease in appetite. Two-year-old children can have very erratic eating habits that sometimes make parents anxious. Some children may seem to eat virtually nothing yet continue to grow

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and thrive. During the preschool and school years, growth in height and weight is steady. Children tend to grow a similar amount each year until the next major growth spurt occurs in early adolescence. Children who are beginning to walk have an endearing physique, with the belly sticking forward and the back curved. They may also appear to be quite bow-legged. By 3 years of age, muscle tone increases and the proportion of body fat decreases, so the body begins to look leaner and more muscular. Doctors report how children are growing in relation to other children their age and monitor the children's weight gain compared to their height. Doctors measure length in children too young to stand. They measure height once the child can stand. In general, length in normal-term infants increases about 30% by age 5 months and more than 50% by age 12 months. Infants typically grow about 10 inches (25 centimeters) during the first year, and height at 5 years is about double the birth length. In boys, half the adult height is attained by about age 2. In girls, height at 19 months is about half the adult height. Newborns normally lose 5 to 8% of their birth weight during the first few days of life. They regain this weight by the end of the first 2 weeks. After this period of time, newborns typically gain about 1 ounce per day during the first 2 months, and 1 pound per month after that. This weight gain typically results in a doubling of birth weight by age 5 months and a tripling by 1 year. In recent years, more children have developed obesity. Some children become obese at an early age. Preterm birth, also known as premature birth, is the birth of a baby at less than 37 weeks gestational age. These babies are known as preemies or premmies. Preterm babies need regular follow up so that an expert can monitor their physical progress. Depending on how premature a baby was born and whether there were other complications, premature infants may be at risk for physical disabilities. Sometimes, these conditions are diagnosed during the first year of a baby's life. Most healthy, full-term newborn babies double their birth weight by four months and triple it by their first birthday. All babies grow at their own pace. A small or large baby may be perfectly healthy. Also, babies have growth spurts and fluctuations in their rate of weight gain. The development timeline is apparently different for premature babies. While full-term babies are evaluated based on their actual age, a preemie is assessed based on her corrected age (also called adjusted age), or how old she'd be if she had been born on her due date. Take, for example, a baby born three months early: When she's 6 months old, we don't expect her to do 6-month-old tasks -- we expect her to do 3-month-old tasks. If she's meeting the 3-month milestones, then she's developing appropriately for her corrected age. By age 2, the range of normal development is so wide that there aren't distinctions. Vaccines are the one exception to the corrected-age rule. Immunizations should be given based on a child's chronological age. A preterm baby's physical growth is also assessed based on adjusted age. Your child's doctor will be looking at how quickly your baby is growing and will want to see that he is growing parallel to the growth curve, even if his height or weight (or both) is below the average for his age group. Premature babies who were born extremely early, who were extremely small for their gestational age, or who have severe ongoing medical problems, may be small compared to their peers for some years. Many of them will continue to grow somewhat faster than their peers through the elementary school years, catching up to the average, year by year, for quite a while. Growth and development after prematurity is initially different. Premature birth may or may not affect the way child develops and the earlier the child was born, the

higher the risks, so parents need to keep an eye out for any area where they think there could be a delay. However, it's all about striking a balance: every child develops in their own unique way, and your baby's development will depend on a range of factors, including his genetic make-up, and the environment and influences around him. Early intervention is important, so assessments from your healthcare team are crucial in ensuring that the baby gets the right care. Premature babies start small, and although they do tend to catch up as they get older. However, as our knowledge of nutrition continues to develop, and with extra supplements available to support premature babies' dietary needs, this may change. As premature babies develop through childhood and adulthood, it becomes harder to know which of their traits and characteristics are a result of premature birth rather than other factors. As well as looking at how the baby is developing, the healthcare team should regularly check his weight, head circumference and height (also known as length) to make sure he is growing as expected. Personal Child Health Record, or 'red book', has growth charts to help plot baby's growth and compare it with the average growth for his age. Babies born at less than 32 weeks are plotted in the low-birth weight chart. Babies born at 32-37 weeks are plotted in the preterm chart until two weeks after their estimated due date and from then on are plotted in the main charts, but with their gestationally corrected age. There are separate charts for girls and boys, as boys tend to be heavier. Rather than 'targets' to be measured, it's more helpful to view milestones as signals that some premature babies might need extra help. Throughout the child's early life, the healthcare team will observe his development and measure his progress against milestones. These are usually carefully worked out targets based on the average age at which children tend to develop certain skills. For example, 8-18 months is the average age when a child will start trying to walk on his own. The milestones have been designed to help professionals spot problems early. Early babies take time to catch up. If your baby is born prematurely, his milestones will be assessed from the time of his due date, not from when he was actually born. By the age of two, his development will often even out with his peers, and you can use his actual birth date instead. In very premature babies, sometimes this is extended to three years of age.

2. Method

The methodology involved was purely scientific, authentic and corroborated with the doctors' opinion. It was, at the same instance, crystal clear and transparent for the subjects' parents and guardians. The sample consisted of two groups of total 200 subjects including girls as well as boys from varied families and different areas of the nation. The first group Group-A consisted of 100 Preterm babies, followed up through eminent doctors and reputed hospitals in Chandigarh. The second group Group-B comprised of 100 term babies followed up through eminent doctors and reputed hospitals in Chandigarh and Mohali, although the subjects hailed from different parts of the country. The subjects ruled under study were between 0-2 years of age. Efforts were made to keep the follow-up regular and as per the directions of the doctors. Data collected was taken under the supervision of the specialists and doctors and the privacy ethics were ensured and maintained the data was flawlessly collected (zero error implemented), scientifically compiled, technically analysed and statistically concluded. Permission was sought and Rapport was built with the subjects, parents and guardians. As much as possible time was spent with them. Parents and Guardians were told about

the significance of the present research study and the privacy ethics were ensured and followed strictly. The follow up was taken by regular and periodic interaction with the doctors, subjects, parents and guardians. The data was primarily taken in person and through the hospital/centre-card of the subjects maintained by their doctors. The study was tabulated in 5 phases. In the first phase, the Weight and Length of the infants of both the groups was recorded at the Birth, the second phase measurements were recorded at 2 months of age. In third phase, these parameters were taken at 6 months, followed by the recordings at 12 months and at 24 months of age in the next two phases.

2.1 Sample

The sample consisted of two groups of total 200 subjects including girls as well as boys from varied families and different areas of the nation. The first group Group-A consisted of 100 Preterm babies, followed up through eminent doctors and reputed hospitals in Chandigarh. The second group Group-B comprised of 100 term babies followed up through eminent doctors and reputed hospitals in Chandigarh and Mohali, although the subjects hailed from different parts of the country. The subjects ruled under study were between 0-2 years of age. Efforts were made to keep the follow-up regular and as per the directions of the doctors. Data collected was taken under the supervision of the specialists and doctors and the privacy ethics were ensured and maintained.

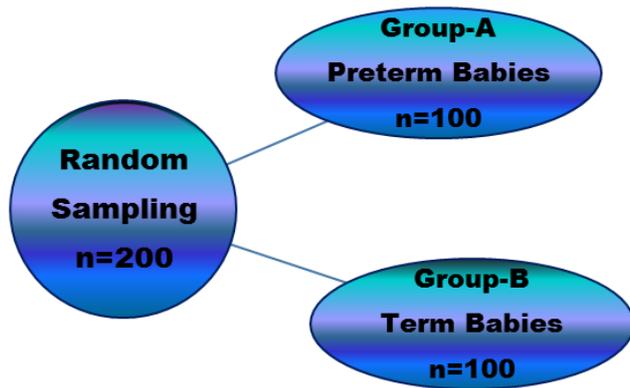


Fig 1: Sampling Procedure

2.2 Procedure

Permission was sought and Rapport was built with the subjects, parents and guardians. As much as possible time was spent with them. Parents and Guardians were told about the significance of the present research study and the privacy ethics were ensured and followed strictly. The follow up was taken by regular and periodic interaction with the doctors, subjects, parents and guardians. The data was primarily taken in person and through the hospital/centre-card of the subjects maintained by their doctors. The study was tabulated in 5 phases. In the first phase, the Weight and Length of the infants of both the groups was recorded at the Birth, the second phase, these measurements were taken at 2 months, followed in 6, 12 and 24 months of age.

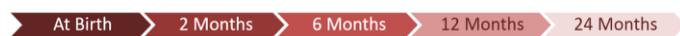


Fig 2: Time interval in various phases

The landmarks & milestones of the weight and height as per the age of the children from birth till 2 years of age were taken and followed for the research, as per the directions of the specialists.

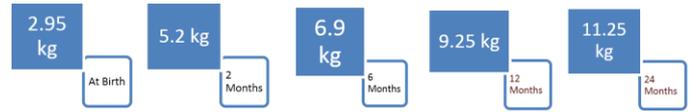


Fig 3: Average weight at the given time/age



Fig 4: Average length/height at the given time/age

2.3 Statistical Analysis

Once the data was obtained, it was coded, tabulated and analyzed, keeping in mind the objectives of the study. Appropriate statistical tools were used to draw meaningful inferences.

Table 1: Statistical tools used for analysis of data

S. No.	Statistical tools	Formula	Purpose
1.	Mean (x)	$X = \frac{\sum X}{N}$ where, X = Variable N = No. of sample	To find out the average scores of variable used in the study.
2.	Percentage (%)	$\% = \frac{X}{N} \times 100$ where x = Derived score n = total score	To find the distribution of subjects with regard to various variables of the study.
3.	Standard Deviation (S.D.)	$\sigma = \sqrt{\frac{\sum x^2}{N} - \frac{(\sum x)^2}{N^2}}$ Where X = Deviation from actual mean X = mean. X = variable. N = number of samples.	To find out deviation from the man scores of the variables.
4.	Standard error of mean (S.E)	$S.E = \frac{\sigma}{\sqrt{n}}$ Where $\sigma = S.D.$ n = number of observations	To find out the degree to which the mean is effected by the error of measurement and sampling.
5.	't' test	$t = \frac{x_1 - x_2}{\sqrt{\frac{n_1 n_2}{n_1 + n_2} (S^2)}}$ where x1 = mean of 1 st sample x2 = mean of second sample S = combine S.D. n1 = number of observations in 1 st sample. n2 = number of observations in 2 nd sample	To compare the average score of any two groups or to find out whether the mean of the two samples vary significantly from each other.

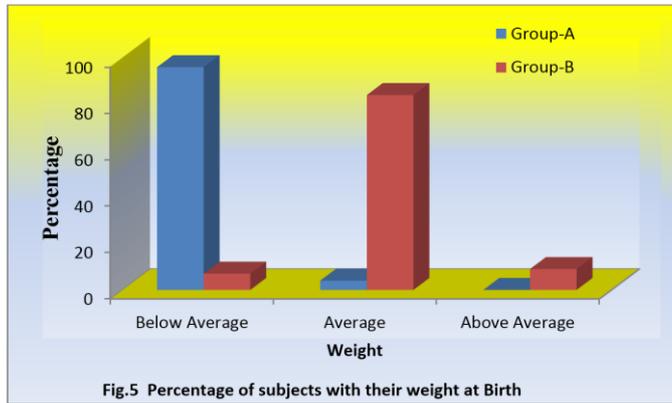
3. Result and discussion

Efforts were made to keep the follow-up regular and as per the directions of the doctors. Data collected was taken under the supervision of the specialists and doctors and the privacy ethics were ensured and maintained the data was flawlessly collected (zero error implemented), scientifically compiled, technically analysed and statistically concluded.

Phase-1

Table 2: Percentage of subjects with their weight at Birth

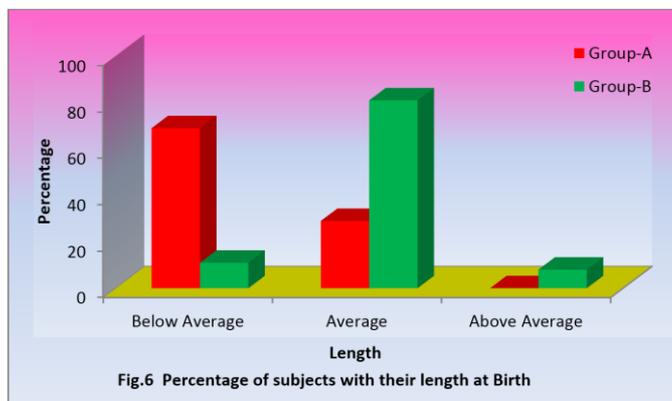
Weight	Group-A (preterm)		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	96	96	7	7
Average	4	4	84	84
Above Average	0	0	9	9



It is evident that majority of preterm babies had below average weight at birth while only 4% of them were recorded weighing average. In case of full-term babies, it can be noticed that 84% of them had average weight at the time of their birth, whereas 7% were below average. However, there were 9% term babies weighing above average.

Table 3: Percentage of subjects with their length at Birth

Length	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	69	69	11	11
Average	31	31	81	81
Above Average	0	0	8	8

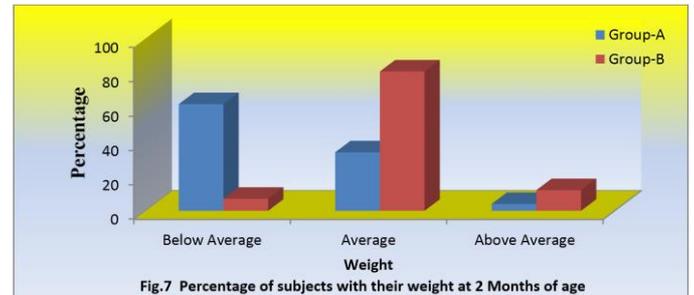


It is evident that 31% of preterm babies had average length at birth while only 69% of them measured below average length. In case of full-term babies, it can be noticed that 81% of them had average length at the time of their birth, whereas 11% were below average. However, there were 8% term babies measuring above average length.

Phase-2

Table 4: Percentage of subjects with their weight at 2 months of age

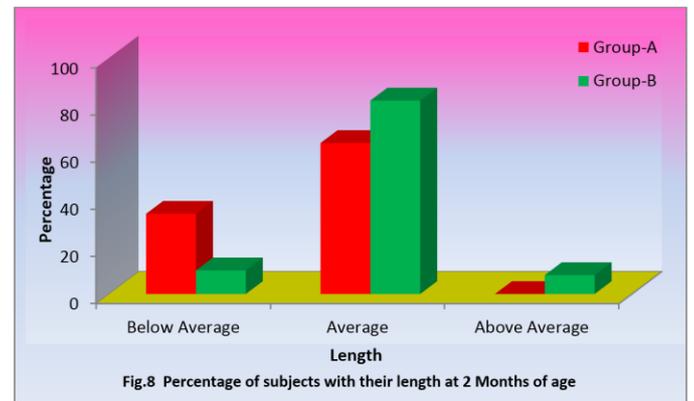
Weight	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	62	62	7	7
Average	34	34	81	81
Above Average	4	4	12	12



It is witnessed that 62% of preterm babies had below average weight at 2 months of age, while 34% of them were recorded weighing average. To a surprise, 4% of them weighed above average at 2 months of age. In case of full-term babies, it can be noticed that 81% of them had average weight at 2 months of age whereas 7% were below average. However, there were 12% term babies and 4% preterm babies weighing above average.

Table 5: Percentage of subjects with their length at 2 months of age

Length	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	36	36	10	10
Average	64	64	82	82
Above Average	0	0	8	8

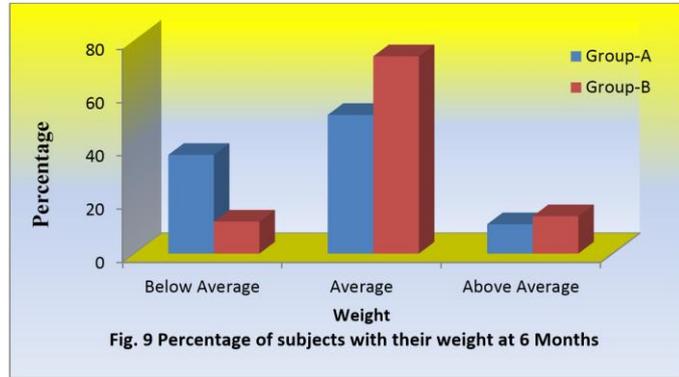


It is witnessed that 64% of preterm babies had average length at 2 months of age, while 36% of them were recorded having length below average. In case of full-term babies, it can be noticed that 82% of them had average length at 2 months of age whereas 10% were below average. However, 8% term babies had length above average.

Phase-3

Table 6: Percentage of subjects with their weight at 6 months of age.

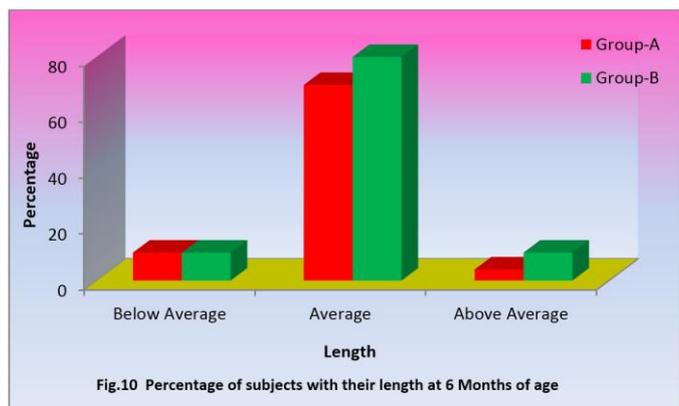
Weight	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	37	37	12	12
Average	52	52	74	74
Above Average	11	11	14	14



It is noticed that 52% of preterm babies had below average weight at 6 months of age, while 52% of them were recorded weighing average. To a surprise, 11% of them weighed above average at 6 months of age. In case of full-term babies, it can be noticed that 74% of them had average weight at 6 months of age whereas 12% were below average. However, there were 14% term babies and 11% preterm babies weighing above average.

Table 7: Percentage of subjects with their length at 6 months of age

Length	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	10	10	10	10
Average	70	70	80	80
Above Average	4	4	10	10

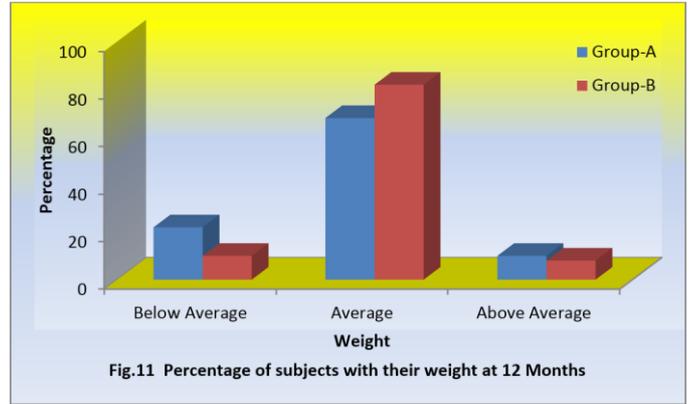


It is witnessed that 70% of preterm babies had average length at 6 months of age, while 10% of them were recorded having length below average. To a surprise, 4% of them had length above average at 6 months of age. In case of full-term babies, it can be noticed that 80% of them had average length at 6 months of age whereas 10% were below average. However, 10% term babies and 4% preterm babies had length above average.

Phase-4

Table 8: Percentage of subjects with their weight at 12 months of age

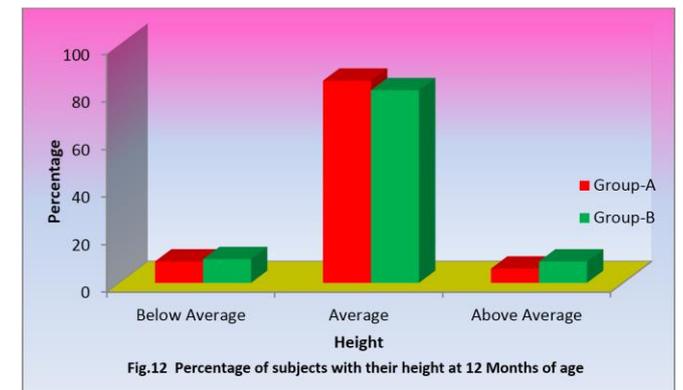
Weight	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	22	22	10	10
Average	68	68	82	82
Above Average	10	10	8	8



It is witnessed that 68% of preterm babies had below average weight at 12 months of age, while 22% of them were recorded weighing average. To a surprise, 10% of them weighed above average at 12 months of age. In case of full-term babies, it can be noticed that 82% of them had average weight at 12 months of age whereas 10% were below average. However, there were 8% term babies and 10% preterm babies weighing above average.

Table 9: Percentage of subjects with their height at 12 months of age

Height	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	9	9	10	10
Average	85	85	81	81
Above Average	6	6	9	9

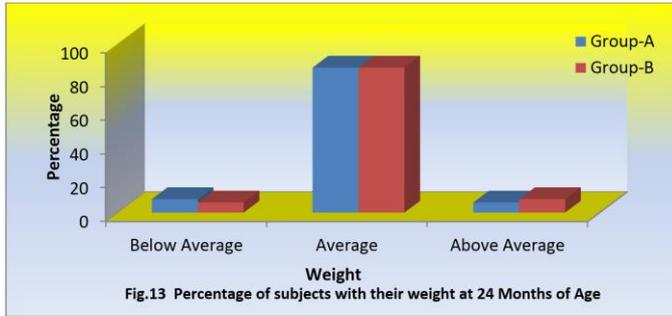


It is witnessed that 85% of preterm babies had average length at 12 months of age, while 9% of them were recorded having length below average. To a surprise, 6% of them had length above average at 12 months of age. In case of full-term babies, it can be noticed that 81% of them had average length at 12 months of age whereas 10% were below average. However, there were 9% term babies and 6% preterm babies measuring length above average by this time.

Phase-5

Table 10: Percentage of subjects with their weight at 24 months of age

Weight	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	8	8	6	6
Average	86	86	86	86
Above Average	6	6	8	8



It is witnessed that 86% of preterm babies had below average weight at 24 months of age, while 8% of them were recorded weighing average. To a surprise, 6% of them weighed above average at this age. In case of full-term babies, it can be noticed that 86% of them had average weight by this stage whereas 6% were below average. However, there were 8% term babies and 6% preterm babies weighing above average 24 months of age.

Table 11: Percentage of subjects with their height at 24 months of age

Height	Group-A		Group-B	
	No. of Subjects	Percentage	No. of Subjects	Percentage
Below Average	9	9	9	9
Average	84	84	82	82
Above Average	7	7	9	9



It is witnessed that 84% of preterm babies had average length at 24 months of age while 9% of them were recorded having length below average. To a surprise, 7% of them had length above average at 24 months of age. In case of full-term babies, it can be noticed that 82% of them had average length at this stage whereas 9% were below average. However, there

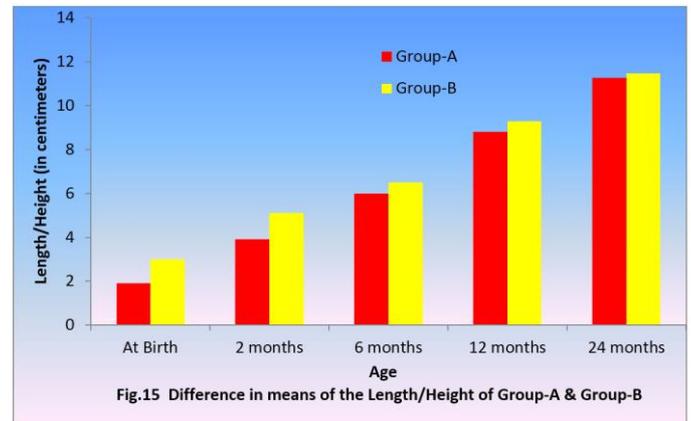
9% term babies and 7% preterm babies had length above average by this age.

Table12: Expected growth trends (weight) in full term normal babies

Age	Average weight (Boys)	Average weight (Girls)	Average weight
At Birth	3.0 kg	2.9 kg	2.95 kg
2 months	5.3 kg	5.1 kg	5.2 kg
6 months	7.2 kg	6.6 kg	6.9 kg
12 months	9.5 kg	9.0 kg	9.25 kg
24 months	11.5 kg	11.0 kg	11.25 kg

Table 13: Mean, Standard deviation, standard error and t-values for Weight

Age Group	Group	Me an	SD	SEM	t - value	Lev. of sig.
At Birth	Group-A	1.9	0.35	0.07	11.8471	Extremely statistically significant
	Group-B	3	0.86	0.21		
2 months	Group-A	3.9	0.45	0.16	16.9047	Extremely statistically significant
	Group-B	5.1	0.549	0.17		
6 months	Group-A	6	0.63	0.38	3.4185	Extremely statistically significant
	Group-B	6.5	1.32	0.925		
12 months	Group-A	8.8	0.96	0.89	5.98	Statistically significant
	Group-B	9.3	1.76	1.42		
24 months	Group-A	11.26	1.0	0.98	1.3	Not Statistically significant
	Group-B	11.46	1.06	0.895		



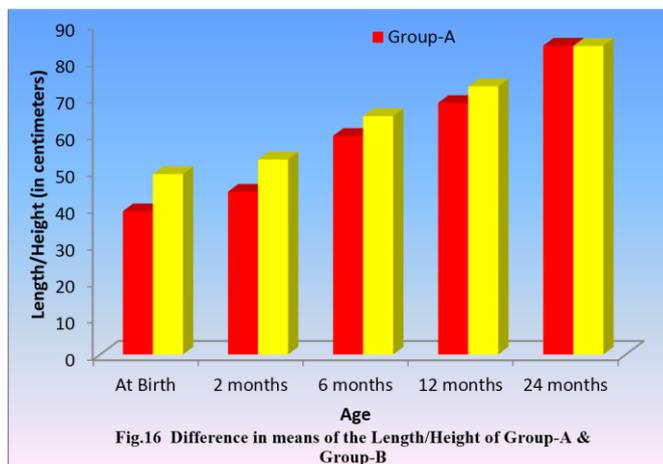
It can be notified that the difference in the mean of weight of subjects in Group A and B kept on declining as the age advanced. At birth, statistically significant difference was witnessed between the groups. In contrast, as noticed, the mean of Group-A seems close to commensurate with that of Group-B at 24 months of age.

Table 14: Expected growth trends (length/height) in full term normal babies

Age	Average length/height (Boys)	Average length/height (Girls)	Average length/height
At Birth	50 cm	48.5 cm	49.25 cm
2 months	53 cm	51 cm	52 cm
6 months	66 cm	64.2 cm	65.1 cm
12 months	75 cm	72.5 cm	73.75 cm
24 months	85.5 cm	84.0 cm	84.75 cm

Table 15: Mean, Standard deviation, standard error and t-values for Length/Height

Age Group	Group	Mean	SD	SEM	t-value	Lev. of sig.
At Birth	Group -A	39	0.25	0.124	30.8909	Extremely statistically significant
	Group -B	49.1	3.26	1.12		
2 months	Group -A	44.3	0.48	0.14	33.92	Extremely statistically significant
	Group -B	53.1	2.549	1.7		
6 months	Group -A	59.5	1.48	0.3	18.2306	Extremely statistically significant
	Group -B	64.9	2.658	1.42		
12 months	Group -A	68.5	3.10	0.896	10.389	Extremely statistically significant
	Group -B	73	3.025	0.85		
24 months	Group -A	84.1	3.196	0.46	0.22	Not Statistically significant
	Group -B	84	3.26	0.895		



It can be notified that the difference in the mean of Length/Height of subjects in Group A and B kept on declining as the age advanced. An statistically significant difference was observed at the time of birth, but the difference was insignificant by the time they grew to 24 months of age.

4. Conclusion

In a nutshell, it is noticed that although initially the preterm babies lagged in their length, height and weight measurements, but amazingly, it was witnessed that there was no variation in the later months where mainstreaming was notified in the physical growth of Preterm and Term babies. It was observed lucidly that majority of preterm babies had low weight at birth, but as the time passes, they caught up their full term counterparts. Likewise, comparatively less in length at the time when born, the pre maturely born later kept pace with the full-term babies of their age. Premature babies start small, yet tend to catch up as they grow to maintain the growth pace with the full term babies.

5. Acknowledgement

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