

# Comparison of neonatal growth in normal, low and very low birth weights until 18 months

Sohaila Ehsanpour<sup>1</sup>, Elaheh Hemmati<sup>2</sup>, Zahra Abdeyazdan<sup>3</sup>

## ABSTRACT

**Background:** Birth weight is considered as the most important index of neonates' growth as well as the most important determinant of infants' mortality. This study was conducted to investigate the growth pattern in normal, low and very low birth weight neonates for 18 months in the health care centers of Isfahan, Iran.

**Materials and Methods:** In a cross-sectional and retrospective study, 214 neonates (90 with normal, 90 with low and 34 with very low birth weights) were enrolled in the health care centers of Isfahan and their growth in the 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 9<sup>th</sup>, 12<sup>th</sup>, 15<sup>th</sup> and 18<sup>th</sup> months were investigated. The data collection tool was a 3-part questionnaire which was validated using content validity. A part of data was completed based on the health file of the family.

**Findings:** The mean of weight, height and head circumference in the months 2, 4, 6, 9, 12 and 15 in the three groups with normal, low and very low birth weights were significantly different. In the ages of 6, 15, 12 and 18 months, there was the highest frequency of horizontal trend in the growth pattern of children in the three groups. In the growth rate of neonates with low birth weight, there was the highest frequency of horizontal trend at the age of 12 months and there was the highest frequency of descending trend in the 15<sup>th</sup> months.

**Conclusions:** The findings showed that according to National Center for Health Statistics (NCHS) percentiles, low and very low birth weight infants had lower growth in weight, length and head circumference compared to normal birth weight infants. Therefore, special attention should be given to healthcare and post-birth growth surveillance of these two groups to maintain and improve the health level of them.

**Key words:** Neonate, very low birth weight, low birth weight, children, growth surveillance

<sup>1</sup> MSc, Department of Midwifery, Nursing and Midwifery Care Research Center, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.

<sup>2</sup> MSc, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.

<sup>3</sup> MD, Associate Professor, Nursing and Midwifery Care Research Center, Department of Pediatrics, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran.

**Address for correspondence:** Zahra Abdeyazdan, MD, Associate Professor, Nursing and Midwifery Care Research Center, Department of Pediatrics, School of Nursing and Midwifery, Isfahan University of Medical Sciences, Isfahan, Iran  
E-mail: abdeyazdan@nm.mui.ac.ir

Research Article of Isfahan University of Medical Sciences, No: 387101.

## INTRODUCTION

Studying health is the most important issue in pediatrics. It is also the most valuable aspect of child care. Knowledge of normal growth and development is necessary for providing care. One of the goals of pediatrics is children's achievement of maximum growth and development. Periodic surveillance of normal growth and development and screening for abnormalities are the major ways to achieve this goal.<sup>[1]</sup> To this end, birth weight is considered the most important index of neonates' growth and the most important determinant of infants' mortality.<sup>[2]</sup> Low birth weight along with congenital abnormalities has a considerable role in physical and mental problems of childhood. In addition, a high percentage of mortality during infancy and neonatal period is associated with low birth weight neonates.<sup>[1]</sup> Very low birth weight neonates (VLBW) include 1.4% of the total births, while 50% of the neonatal mortality and 50% of neonatal disabilities are associated with them.<sup>[3]</sup> Failure to thrive (FTT) risk in preterm infants is higher than term born infants.<sup>[4]</sup> It is expected that VLBW neonates reach to growth parameter as full term neonates at the end of their 2<sup>nd</sup> year. This growth occurs faster in the preterm neonates with larger sizes.<sup>[3]</sup>

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A study in Ghana in 2000 on the growth and survival of LBW infants from the age of 0 to 9 years old showed that growth impairment in those children continued during childhood and that a partial compensatory growth had occurred within the first three years of their lives.<sup>[5]</sup>

Attention to growth and development is important in preventing children from mortality, but it is more important to prevent them from physical, mental and social disorders and their complications in the future.<sup>[4]</sup> One of the most important measures in this regard is to monitor and follow children's growth.<sup>[6]</sup>

The prevalence of LBW neonates in 1999 in the urban areas of Isfahan was 6.3% <sup>[6]</sup> while it was reported to be 6.8%  $\pm$  0.6% in 2005 and 2006. Furthermore, the prevalence of VLBW neonates in 2005 was reported to be 1.3%  $\pm$  0.2%.<sup>[7]</sup>

In recent years many intensive care units has been developed in Iran, so the mortality rate of VLBW infants had decreased but the growth pattern of LBW and VLBW infants are monitored as normal birth weight (NBW) infants by NCHS growth charts.

Because of the importance of neonates' growth and especially VLBW neonates as the important index of neonates' health status, this research aims to compare growth trend in the normal, low and very low birth weight neonates until the age of 18 months.

We are seeking to find answers for the mean of weight, height and head circumference in normal, low and very low birth weight neonates until the age of 18 months as well as any lack of increase in the weight growth curve for these neonates.

## MATERIALS AND METHODS

This is a retrospective, descriptive-comparative study. The Study population in this research consists of all the neonates born with normal weight, low or very low weight that were 18 months old at the time of sampling, which attended health care centers in the city of Isfahan and had health care files. In this study considering  $\alpha = 5\%$ , 90 children having normal birth weight and 90 children having low birth weight and 34 children with very low birth weight ( $d = 0.8$ ) (214 children in total) comprised the study population.

The data gathering tool was a researcher-made questionnaire with 3 sections:

The first section covered the demographics of the parents including questions about the father's job and education, the mother's job, education, age, number of pregnancies and the kind of delivery.

The second section comprised of questions about the children's demographics like the child's gender, weight, height and head circumference at birth, the birth order, the birth spacing with previous siblings, the duration of breast feeding, manner feeding and child's age at the time of starting the supplementary feeding.

The third section consists of questions about weight, height, head circumference, horizontal trend or decreasing trend of growth curve (lack of increasing growth curve) at the end of 2, 4, 6, 9, 12, 15 and 18 months of the subjects. Content validity was used to validate data collection tools, and the reliability of the questionnaire was approved through re-test.

Inclusion criteria included single pregnancy, being 18 months at the time of completing the questionnaire, and a complete health care profile for the months of 2, 4, 6, 9, 12 and 15.

Exclusion criteria include suffering from congenital abnormality, non-Iranian nationality, being an adopted child, normal birth weight, and low birth weight caused by intra uterine growth retardation (IUGR), history of hospitalization in neonatal period for normal birth-weight neonates and after neonatal period for low and very low birth weight babies.

### Sampling

From all health care centers in Esfahan city, 29 centers were selected using simple random sampling. For determining samples considered for all three groups (NBW, LBW, VLBW) childcare notebooks in the departments of family healthcare centers were used. All the care given to children is registered in these notebooks with dates of admission. The selection of low birth weight and normal birth weight children in the healthcare centers was made based on the regular random sampling, in such a way that using childcare notebooks, the 18 month neonates with LBW and NBW who were registered, were extracted and in cases of having the inclusion criteria, they were selected using table of random numbers. In order to select the sample for VLBW group, because of inadequate number of such babies, the subjects whom had inclusion criteria were selected by census.

After selecting the samples, one of the researchers called the baby's mother and requested her to bring her baby for routine childcare visit on the arranged date at health care center. At the time of completing the questionnaire, the researcher attended healthcare center accompanied by the questioner and recorded the information from the date of birth to 15 months old; however the assessment at the 18<sup>th</sup> month was made by the researcher. For data analysis, the descriptive and inferential statistical method (analysis of variance, Kruskal-Wallis, Spearman correlation coefficient and chi-square tests) were used. The statistical software applied in the study was SPSS software version 18 (SPSS Inc. Chicago, IL. USA).

## FINDINGS

The mean weight, height and the head circumference is shown in table 1, 2 and 3, respectively. Table 1 indicates that the mean weight in children with very low birth weight at 4, 12 and 18 months old is 3.5, 6 and 7 times as that at birth respectively; that for children having low birth weights was 2.5, 3.5 and 4 times as much, and that for children having a normal birth weight was 2, 3 and 3.5 times as much, respectively.

The variance analysis was used for comparing means of weight, height and head circumference in the three groups. The results showed the mean weight of children at the age of 2 months ( $p < 0.001$ ,  $F = 240.45$ ), 4 months ( $p < 0.001$ ,  $F = 164.54$ ), 6 months ( $p < 0.001$ ,  $F = 77.47$ ), 9 months ( $p < 0.001$ ,  $F = 49.96$ ), 12 months ( $p < 0.001$ ,  $F = 42.67$ ), 15 months ( $p < 0.001$ ,  $F = 32.39$ ) and 18 months ( $p < 0.001$ ,  $F = 26.29$ ) was significantly different in the three groups.

In addition, the mean height in children at 2 months ( $p = 0.00$ ,  $F = 134.44$ ), 4 months ( $p < 0.001$ ,  $F = 113.20$ ), 6 months ( $p < 0.001$ ,  $F = 93.55$ ), 9 months ( $p < 0.001$ ,  $F = 50.77$ ), 12 months ( $p < 0.001$ ,  $F = 47.30$ ), 15 months ( $p < 0.001$ ,  $F = 33.39$ ) and 18 months old ( $p < 0.001$ ,  $F = 37.25$ ) was significantly different in the three groups.

The mean of head circumference of children at 2 months ( $p < 0.001$ ,  $F = 112.04$ ), 4 months ( $p < 0.001$ ,  $F = 62.27$ ), 6 months ( $p < 0.001$ ,  $F = 40.66$ ), 9 months ( $p < 0.001$ ,  $F = 31.90$ ), 12 months ( $p < 0.001$ ,  $F = 23.30$ ), 15 months ( $p < 0.001$ ,  $F = 21.28$ ) and 18 months old ( $p < 0.001$ ,  $F = 19.64$ ) was significantly different in the three groups.

Regarding the frequency distribution of horizontal growth curve, the results showed that there are no

horizontal growth curves in the children studied at the age of 2, 4 and 9 months.

In children with normal birth weights, the relative frequency of horizontal growth curve at 6, 15 and 18 months were 9.2%, 8.2% and 5.6%, respectively. In children with low birth weight the relative frequency of horizontal growth curve was 2.2% at 12 months old and for all other ages, there were no horizontal growth curves. Also, there were no horizontal growth curves in children having very low birth weights except at 18 months of age and for this age; the relative frequency was 2.9% (Table 4).

With respect to frequency distribution of descending growth curve, the results showed that no descending trend in the children's growth curve was observed in ages 2, 4, 6 and 9 months among children in the three groups; however, descending trend was noticed in 2.2%, 3.3% and 8.9% of children having normal birth weights at months 12, 15 and 18 respectively. In low birth weight group there was a descending trend of growth curve in 1.1% and 3.3% of the samples at post natal months 12 and 15.

In relation with demographic characteristics, the chi-square test showed that the father's education ( $p = 0.007$ ), mother's education ( $p = 0.01$ ), feeding manner ( $p = 0.001$ ), and the time for commencement of complementary feeding ( $p = 0.001$ ) showed a significant difference among three groups, Kruskal-Wallis test showed that the breast feeding duration ( $p < 0.001$ ) and mother's age at birth ( $p = 0.04$ ) have a significant difference among the three groups.

## DISCUSSION

The results showed that there is a statistical difference among three groups in terms of growth indices until 18 months of age. However, the comparison of growth indices mean within different months demonstrates that the mean weight of children having very low birth weights in ages of 4, 12 and 18 months has raised to 3.5, 6 and 7 times, respectively. The increase of weight in low birth weight group was 2.5, 3.5 and 4 times and in normal birth weight group were 2.3 and 3.3 times at the same ages.

In this very context, Van Der Mei *et al.* in 2000 showed that there was lower mean weight in MLBW and VLBW children at 2, 6, 18, 48 and 96 months in comparison with the reference group.<sup>[5]</sup> Powers *et al.* in 2008 conducted a study entitled growth and development of VLBW children after being discharged from hospital till 3 years of age. The results showed that during the first twelve months weight gain pattern of children with the

**Table 1: Mean and standard deviation of the weights of normal birth weight, low birth weight and very low birth weight children at 2, 4, 6, 9, 12, 15 and 18 months**

Weight group	Month		At birth													
			2 months		4 months		6 months		9 months		12 months		15 months		18 months	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NBW	3139.67	255.2	5267.78	541.9	6530.56	610.5	7446.11	857.9	8586.11	1020.3	9403.33	1122.2	10005.56	1253.0	10487.78	1303.7
LBW	2364.22	179.9	4482.78	640.9	5787.78	611.5	6749.00	661.9	7856.11	835.5	8585.56	902.7	9168.89	1010.1	9685.56	1105.4
VLBW	1282.35	184.0	2635.59	613.2	4258.24	690.3	5558.82	728.0	6744.71	912.9	7577.94	979.7	8238.24	1121.5	8790.29	1219.2

**Table 2: Mean and standard deviation of the heights of normal birth weight, low birth weight and very low birth weight children at 2, 4, 6, 9, 12, 15 and 18 months**

Weight group	Month		At birth													
			2 months		4 months		6 months		9 months		12 months		15 months		18 months	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NBW	49.18	1.93	57.30	2.40	62.60	2.23	66.30	2.25	71.15	2.95	74.79	2.83	78.16	2.94	81.39	3.08
LBW	46.45	1.95	55.00	2.44	60.60	2.50	64.80	2.40	69.27	2.48	73.05	2.42	76.57	2.62	79.59	2.42
VLBW	39.13	3.34	48.20	4.18	55.00	3.15	59.18	3.73	65.00	4.28	69.30	3.59	73.48	3.29	76.45	3.37

**Table 3: Mean and standard deviation of the head circumferences of normal birth weight, low birth weight and very low birth weight children at 2, 4, 6, 9, 12, 15 and 18 months**

Weight group	Month		At birth													
			2 month		4 month		6 month		9 month		12 month		15 month		18 month	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NBW	34.69	1.20	38.93	1.27	41.14	1.27	42.90	1.37	44.60	1.50	45.80	1.44	46.68	1.40	47.38	1.39
LBW	32.79	1.52	37.68	1.40	40.07	1.33	41.95	1.34	43.70	1.29	44.90	1.34	45.76	1.41	46.44	1.42
VLBW	27.92	2.66	34.38	2.22	38.13	1.62	40.37	1.66	42.37	1.55	43.95	1.55	44.93	1.50	45.70	1.60

**Table 4: The frequency distribution of horizontal trend in growth curve of children with NBW, LBW and VLBW at 2, 4, 6, 9, 12, 15 and 18 months**

Weight group	Months						
	2 months N (%)	4 months N (%)	6 months N (%)	9 months N (%)	12 months N (%)	15 months N (%)	18 months N (%)
NBW	0 (0 %)	0 (0 %)	0 (0 %)	0 (0 %)	2(2.2%)	3(3.3%)	8(8.9%)
LBW	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1.1%)	3(3.3%)	4(4.4%)
VLBW	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	0(0%)	2(5.9%)

gestational age  $\geq 27$  weeks is not appropriate. However, it increased from 18 months old faster than first year and became desirable up to 30 months of age, whereas, the growth delay continued till age of 3 in children whose gestational age was  $\geq 26$ .<sup>[8]</sup>

In the present study, we did not review the children's growth on the basis of gestational age and this may be considered as one of the constraints of this study.

In light of the table 2, the mean of height in children with very low birth weight raised 30.14 cm from birth to 12 months old. In children with low birth weight, the mean height increased till the age of 12 months up to 26.6 cm, whereas, it was 25.6 cm in children having normal weights. From 1 year old to 18 months old, the height of children with low birth weight and also normal birth weight increased about 6.5 cm and that for children with very low birth weight increased about 7 cm.

Ford et al. in 2000 showed that VLBW children at ages of 2, 5, 8 and 14 months are significantly shorter than children born with normal weights.<sup>[9]</sup> In the present study, we examined the trend of VLBW children's height growth up to the age of 18 months. At birth, the difference between the mean height of VLBW children and NBW group was 10.05 cm, and at month 18 it was 4.94 cm. However, by considering the little difference in terms of height of these neonates as compared to NBW neonates at the age of 18 months, the results would have been different from that of made by Ford if the study of children's growth had been conducted for a longer duration. Thus, it is suggested that more studies should be conducted in long-term.

The findings about the head circumference showed that the mean head circumference within studied durations was lower in LBW neonates as compared to NBW ones and also in VLBW neonates is also lower compared to the other two groups. Nonetheless, taking table 3 into consideration, the increase of head circumference mean from birth till 12 months of age in VLBW children was

16.03 cm and in LBW children was 12.11 cm, while in NBW children it was 11.11 cm. From 12 till 18 months of age the increase of mean head circumference in LBW children and also NBW children was about 1.5 cm and in the VLBW children it was about 1.8 cm.

Van Der Mei et al. demonstrated that the increase of head circumference in moderately low birth weight and VLBW children during the first two months after birth was less than that in LBW children and from 2 to 4 months of age it was more than the reference group and after that, the increase in head circumference was similar for both groups.<sup>[5]</sup>

The results of the study conducted by Constantinou et al. in 2005 showed that in extremely low birth weight group (ELBW) the mean of head circumference at 4, 18 and 30 months was significantly lower than the mean in VLBW group.<sup>[10]</sup>

In the present study, due to having some limitations, we did not deal with the growth of ELBW neonates as an independent group and we considered all ELBW and VLBW neonates as one group (VLBW). Perhaps, if we had examined this group separately, we would have gained different results.

In general, the results of the present study indicate the desirable growth of LBW and VLBW groups of children compared to the NBW group. These children have the potential to make up for their low weight after birth and also perhaps the attention and sensitivity of the parents toward these children in terms of nutrition and healthcare regardless of their low weights can be considered as an evidence for their desirable growth rates. It is worth mentioning that although it is expected that the physical growth of LBW neonates with the absence of congenital abnormalities, injury of the central nervous system and VLBW increase up to a term in infant by the end of the 2<sup>nd</sup> year, these children have a relatively high amount of differences with normal birth weight children in terms of growth indices at 18 months old. Therefore, it is

necessary to conduct some studies in this regard, prospectively and over a long period of time in order to guess exactly at what time LBW and VLBW Iranian children are able to be similar to the NBW children in terms of growth, because this criterion might not be true for the Iranian infants.

Another necessary point with respect to LBW and VLBW children's growth is having a specific growth chart for them. This is because currently, the growth status of such infants is examined on the basis of charts for neonates having normal birth weights.

The present study showed that there was horizontal trend in growth curve of normal birth weight children at ages of 6, 15 and 18 months, in low birth weight children at 12 months and also in children with very low birth weight merely at the age of 18 months.

It may be stated that at the beginning of supplementary feeding and at the start of consuming family food, or starting to walk and its subsequent increased activity, children will experience a period of no increase in growth curve and this can be more noticed in children having normal weight compared to low birth and very low birth weight children. It seems that all the attention and care given by the parents in relation to growth curve in children with low birth weight, in particular, children with very low birth weight, resulted in the fact that they were immediately taken care of once they suffered from any growth disorder.

Considering the results obtained by the research, the need for taking more effective measures for preventing birth of low birth weight neonates is more felt and in view of this, the role played by all the employees and authorities of health care system, obstetricians and midwives regarding anticipation and control of the factors affecting on low birth weight in neonates are highly important.

The healthcare authorities are recommended to provide a growth curve suitable for each one of the weight groups so that the children of every group birth weight can be

examined and compared based on that curve.

## ACKNOWLEDGMENT

This study was financially sponsored by the research deputy of Isfahan University of medical sciences. Appreciations go to the authorities of health care centers' staff and managers. Furthermore, we would appreciate parents of the infants participated in the study.

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**How to cite this article:** Ehsanpour S, Hemmati E, Abdeyazdan Z. Comparison of neonatal growth in normal, low and very low birth weights until 18 months. *Iranian Journal of Nursing and Midwifery Research* 2012; 17(2): S131-S136.

**Source of Support:** Isfahan University of Medical Sciences, **Conflict of Interest:** None declared.