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TO LAY DOWN THE REFERENCE VALUES OF INTRAUTERINE GROWTH WITH PARTICULAR REFERENCE TO BODY MASS INDEX OF PRETERM, TERM AND POST TERM NEONATES

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Abstract

Background: Combining two anthropometric measurements has proven to be more effective in assessing body composition and proportions in children, with special emphasis on the Body Mass Index, which connects weight to length. Body mass index values for the newborn period, however, have not yet been established. The Body mass index of newborns at various gestational ages is displayed in this study. **Materials and Methods:** Retrospective study including 1,000 appropriate for gestational age newborns from 29 to 42 weeks of gestational age. Weight and length were measured following standard procedures. The body mass index was calculated based on the formula: [weight (kg)/ length (m)2], and mean , standard deviation and nine selected percentiles (3, 5,10, 25, 50, 75, 90, 95, 97) were determined for all gestational ages. **Result:** Both genders body mass index values for gestational age up to 42 weeks indicate a continuous rise in all percentiles. The rise in BMI from 27th week to 43rd week in both sexes is, from (7.33 ±0.30) to (13.34 ±0.54) in males and from (7.45 ±0.23) to (13.47 ±1.17) in females. **Conclusion:** The findings demonstrate a direct relationship between gestational age and body mass index in the upper nine percentiles for both sexes and can be used as a useful benchmark when evaluating intra-uterine proportional growth.

INTRODUCTION

Gestational age and birth weight were understood to be important factors of survival, future growth and overall development of the child. Fetal growth is dependent on genetic, placental and maternal factors. Morbidity and mortality in newborns are directly correlated with gestational age and weight.

An estimated 15 million babies are born too early every year. That is more than 1 in 10 babies. Approximately 1 million children die each year due to complications of preterm birth.[1] India is a major contributor to the global preterm birth numbers; estimates from 2010 and 2014 suggest that India contributed 23–24% of the global average, with nearly one in six (13%-17%) of live births being preterm.[2,3] Proportion of deaths due to preterm birth in India is higher in the early than in the late neonatal period.[4]

Two major factors influence fetal growth: the inherent growth potential of the fetus and the growth support it receives by the way of “supply line”- the placenta and the maternal organism. Before the third trimester, the “supply line” far exceeds the needs of the fetal organism and growth is determined by the inherent fetal potential. By the third trimester, the adequacy of the “supply line” becomes the limiting factor in fetal growth.

Winick et al,[5] (1967) have shown a cessation of cell division in the placenta about one month before term. In pregnancies associated with growth retarded foetuses, the placenta has a reduced cell number in comparison to control. The nutritional assessment of the newborn has been a challenging issue and any deviation from the normal is associated with an increased risk of morbidity and mortality. Body mass index has been mentioned as growth parameter from birth onwards till 18-20 years till growth goes on. But it is irony that there are no standards for its measurement in babies in whom the growth is fastest during the intrauterine life.

Weight has been the most important age old criteria for assessment of growth but it only picks up changes occurring acutely which may be days to a few weeks. Length on the other hand is a better index of growth in sub-acute and sub-acute to chronic stage of deprivation or excess. Head circumference on the contrary would assess the growth in totality particularly so in chronic states.

Therefore, to assess the true growth in totality we should incorporate a combination of all these factors to pick up all the cases where growth may get affected. To circumvent this problem of assessment of growth, a parameter which involves weight and length i.e. BMI and ponderal index which involves weight and length would be the ideal parameters of true growth in utero.

National Center for Health Statistics (NCHS), Indian Council of Medical Reasearch (ICMR) and other curves done in the past have not been updated to cover body mass index as the growth parameters but Centers for Disease Control and Prevention (CDC),[6,7] (2000) and World Health Organisation (WHO),[8,9] (2006) have incorporated body mass index and they are accepted as better curves for reference.

There are no curves of growth of body mass index in preterm babies from 25 weeks till birth which is known to be the maximum period of growth. Therefore we decided to have a “reference” standard of body mass index as a growth parameter during this period from 25 weeks onwards till 43weeks, at the same time to identify any difference in values of body mass index according to sex.

Infants born with low birth weight suffer from extremely high rates of morbidity and mortality from infectious disease, and underweight, stunting or wasting, beginning in the neonatal period throughout the childhood and an increased risk of chronic diseases including high blood pressure, non-Insulin dependent diabetes mellitus, coronary heart disease and stroke in adulthood.[10-16]

Aims and Objectives

1. To lay down the reference values of intrauterine growth with particular reference to body mass index of preterm, term and post term neonates from 25 weeks to 43 weeks of gestation.
2. To observe the sex difference if any in body mass index in the neonates.

MATERIALS AND METHODS

All consecutively selected singleton born intramural births in Teerthankar Mahaveer Institute of medical sciences and research, Moradabad, from 1st January 2019- 31st December 2019 between the gestational ages of 25 weeks to 43 weeks were included after obtaining clearance from Institutional Ethical Committee and informed consents.

Exclusion Criteria

All extramural births, mothers not knowing date of last menstrual period, Multiple births, Gross discrepancy of >2 weeks in assessment of gestational age by last menstrual period and modified Ballard’s score, Congenital malformed baby, Chronic maternal disease/ obstetrical complications known to compromise fetal growth.

Weight and length were recorded according to standard pediatric measurement procedures.[17]

The weight was taken in totally unclothed babies within 4-8 hrs after birth: using an electronic digital weighing machine, weighing up to 10 kgs, with an accuracy of 0.1 gram. Length was measured to the nearest 0.1 cm on an infantometer with the baby lying supine, knees fully extended and soles of feet held vertically and firmly against the footboard and head touching the fixed board. The reading was recorded in centimetres to nearest millimetres and then was converted into meters for calculation of BMI. The length was recorded between 36 to 48 hours of birth to minimize discrepancies due to problems of head moulding and oedema in soft tissue (ICMR 1957)

To establish an accurate gestational age for each infant, the date of the last normal menstrual period was considered first, followed by the gestational age confirmed by the postnatal examination method (Modified Ballard’s Scoring).[18]

The overall sample size was determined by the need to obtain sufficient data for valid calculation of percentile values from 29 to 42 weeks, total 1000 newborns. The BMI was calculated based on the formula: [weight (kg)/ length (m)2], and mean, standard deviation and nine selected percentiles (3, 5,10, 25, 50, 75, 90, 95, 97) were determined for all target gestational ages.

In the BMI-for-gestational-age curve the gestational ages in weeks were represented on the “x” axis and the BMI (kg/m2) on the “y” axis.

RESULTS

Out Of the 1000 subjects studied, 452 (45.2%) were females and 548 (54.8%) were males. 359 newborns were preterm (<37 weeks), 557 were term (37-40 weeks) and 84 were post term newborns.

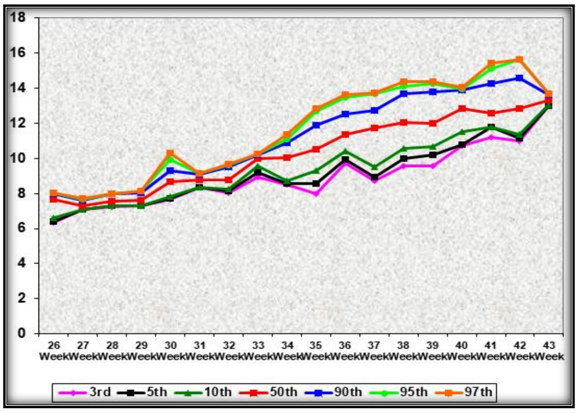

Figure 1: Percentile charts of BMI of male newborns of each gestation age

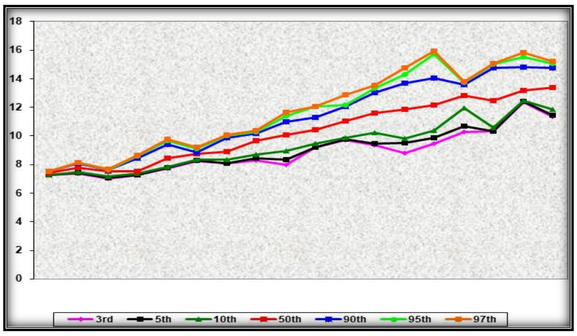

Figure 2: Percentile charts of BMI of female newborns of each gestation age

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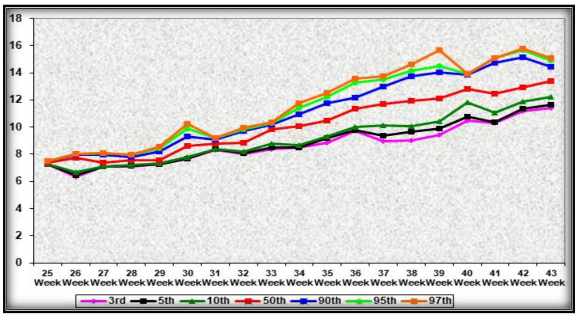

Figure 3: Percentile charts of BMI of newborns of each gestation age

The proportion of cases in each gestational week (25 to 43) was not evenly divided. The largest section was formed by the 38 and 39 weeks (17.3%) while the extremes accounted for the smallest portions, namely 0.3% by 25, 0.5% by 26 and 0.6 % by 27, 2.7% by 42 weeks and 0.7% by 43 weeks.

[Table 1 and 2] shows the mean, standard deviation and the 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles of BMI of male and female newborns. There is a rise in BMI from 27th week to 43rd week in both sexes, from (7.33 ±0.30) to (13.34 ±0.54) in males and from (7.45 ±0.23) to (13.47 ±1.17) in females.

[Table 3] shows the mean, standard deviation and the 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles of BMI of newborns. There is a rise in BMI from 25th week (7.39 ±0.14) to 43rd week (13.33 ±1.27).

Table 1: Percentile charts of BMI of male newborns of each gestation age BMI Male

GA	N	Mean	Std. Dev.	Percentile						
				3rd	5th	10th	50th	90th	95th	97th
26	4	7.38	0.82	6.32	6.40	6.59	7.64	7.97	8.01	8.02
27	4	7.33	0.30	7.06	7.07	7.09	7.27	7.63	7.69	7.71
28	9	7.60	0.27	7.25	7.27	7.32	7.55	7.97	8.00	8.00
29	10	7.64	0.30	7.29	7.30	7.30	7.61	8.06	8.12	8.14
30	13	8.71	0.84	7.68	7.72	7.84	8.69	9.32	9.93	10.29
31	9	8.78	0.28	8.36	8.36	8.37	8.80	9.09	9.14	9.16
32	19	8.80	0.52	8.04	8.16	8.24	8.75	9.53	9.60	9.68
33	15	9.87	0.44	8.92	9.19	9.55	10.01	10.21	10.25	10.28
34	17	9.91	0.90	8.52	8.54	8.71	10.05	10.89	11.11	11.38
35	30	10.48	1.26	7.96	8.55	9.28	10.51	11.91	12.71	12.84
36	33	11.42	1.13	9.74	9.96	10.40	11.34	12.52	13.50	13.62
37	49	11.45	1.36	8.71	8.94	9.52	11.72	12.76	13.68	13.76
38	83	11.97	1.42	9.57	10.00	10.57	12.07	13.71	14.09	14.36
39	90	12.16	1.33	9.58	10.22	10.70	12.01	13.82	14.26	14.36
40	28	12.85	1.02	10.74	10.79	11.53	12.86	13.89	13.96	14.08
41	21	12.91	1.27	11.19	11.76	11.76	12.58	14.25	15.12	15.44
42	16	12.87	1.31	10.99	11.17	11.38	12.85	14.58	15.64	15.65
43	2	13.34	0.54	12.98	12.99	13.03	13.34	13.65	13.69	13.70

Table 2: Percentile charts of BMI of female newborns of each gestation age BMI Female

GA	N	Mean	Std. Dev.	Percentile						
				3rd	5th	10th	50th	90th	95th	97th
25	3	7.39	0.14	7.26	7.27	7.28	7.40	7.50	7.51	7.52
26	1									
27	2	7.77	0.56	7.39	7.41	7.45	7.77	8.08	8.12	8.14
28	8	7.45	0.23	7.04	7.07	7.15	7.52	7.62	7.65	7.66
29	11	7.72	0.48	7.27	7.29	7.36	7.53	8.45	8.60	8.66
30	10	8.59	0.73	7.73	7.76	7.84	8.44	9.39	9.67	9.79
31	13	8.67	0.30	8.26	8.30	8.36	8.74	8.87	9.08	9.20
32	17	9.01	0.61	8.08	8.10	8.35	8.92	9.85	10.00	10.05
33	27	9.55	0.58	8.31	8.43	8.72	9.64	10.19	10.29	10.38
34	18	10.01	1.04	7.97	8.34	8.95	10.08	10.98	11.37	11.65
35	40	10.47	0.81	9.18	9.19	9.45	10.45	11.31	12.06	12.06
36	46	11.16	0.96	9.70	9.77	9.86	11.05	12.06	12.18	12.87
37	81	11.65	1.17	9.37	9.46	10.23	11.60	13.02	13.33	13.52
38	90	11.74	1.51	8.81	9.52	9.82	11.83	13.66	14.29	14.76
39	83	12.28	1.64	9.46	9.88	10.38	12.17	14.06	15.70	15.90
40	53	12.69	0.93	10.29	10.68	11.93	12.82	13.58	13.74	13.79
41	29	12.77	1.56	10.30	10.35	10.57	12.46	14.76	15.02	15.07
42	11	13.47	1.17	12.38	12.40	12.45	13.17	14.79	15.52	15.81
43	5	13.32	1.55	11.32	11.46	11.83	13.36	14.76	15.06	15.19

Table 3: Percentile charts of BMI of newborns of each gestation age BMI Total

GA	N	Mean	Std. Dev.	Percentile						
				3rd	5th	10th	50th	90th	95th	97th
25	3	7.39	0.14	7.26	7.27	7.28	7.40	7.50	7.51	7.52
26	5	7.44	0.84	6.34	6.43	6.66	7.76	7.97	8.01	8.02
27	6	7.48	0.41	7.07	7.08	7.11	7.37	7.95	8.06	8.10
28	17	7.53	0.26	7.10	7.17	7.22	7.54	7.80	7.97	7.99
29	21	7.68	0.40	7.27	7.29	7.31	7.56	8.18	8.45	8.57

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30	23	8.65	0.78	7.66	7.70	7.81	8.59	9.33	9.90	10.25
31	22	8.72	0.29	8.30	8.35	8.35	8.76	9.06	9.18	9.18
32	36	8.90	0.56	8.05	8.09	8.22	8.85	9.72	9.84	9.96
33	42	9.66	0.55	8.37	8.51	8.79	9.81	10.20	10.32	10.33
34	35	9.96	0.96	8.50	8.51	8.65	10.05	10.91	11.40	11.76
35	70	10.48	1.01	8.86	9.18	9.29	10.48	11.78	12.25	12.54
36	79	11.27	1.04	9.69	9.79	10.03	11.32	12.18	13.26	13.54
37	130	11.57	1.24	8.93	9.37	10.12	11.67	13.00	13.51	13.75
38	173	11.85	1.47	9.02	9.68	10.09	11.92	13.71	14.12	14.61
39	173	12.22	1.48	9.41	9.88	10.44	12.10	14.01	14.49	15.65
40	81	12.75	0.96	10.49	10.77	11.83	12.82	13.83	13.89	13.89
41	50	12.83	1.43	10.32	10.37	11.06	12.48	14.73	15.07	15.10
42	27	13.11	1.27	11.19	11.35	11.89	12.94	15.13	15.65	15.79
43	7	13.33	1.28	11.43	11.65	12.20	13.36	14.45	14.91	15.09

DISCUSSION

Most of the workers studying intrauterine growth in reference to BMI have constructed growth curves for that particular geographical region and representative population. Most of these workers have stressed the need to construct such curves for local use.[19-22] Studies show differences in growth curves in different regions and population. It has therefore been felt necessary to construct such curves for our region. Aim of the study was to lay down the reference values of intrauterine growth with particular reference to BMI for our region and population. The BMI was calculated and compared with other studies. There is a paucity of Indian published data for comparison whereas there are few foreign studies from developed countries for comparison.

The population characteristics and sample size in this study match with Singhal and Purohit,[19] which is also an Indian study in terms of being a regional study predominantly mixed(rural and urban), with a large proportion belonging to rural poor.

A measure of weight relative to length provides a more complete and better information about the growth status of preterm infant that is currently not quantified in the NICU. As an infant grows and is plotted on curves for weight, length and head circumference, there is no quantification of proportionality of growth. It can be estimated visually but not easily calculated. We believe that quantifying disproportionate growth will provide information to individualize and better target nutritional care, complications and risk factors if any.

In this study, mean values of BMI show a progressive increase from 25 (7.39 ±0.14) to 43 weeks (13.33±1.27).Our values fall in the higher range when compared to the study done by Singhal and Purohit.[19] This can be attributed by the fact that this study was done at a tertiary referral center of the state, patients came to the hospital referred from all over Rajasthan.

As can be seen, the values obtained in the present study are consistently lower than the values obtained in the other studies conducted outside India. The differences could be accounted for by the fact that all characteristics and factors related with affluence and developed world like ethnicity, socio-economocultural, geographic conditions could be responsible for this variability. Comparing among the literature from abroad the mean values are lower for the more recent studies when compared to the older ones even though the background remains similar.[20-22] This could be due to large sample sizes or better estimation of gestational ages but also could be due to the changing anthropometric values over the years as expected with rise in health standards and antenatal care.

All studies have documented a steady rise in BMI progressively from 28 weeks onwards till 37 week,[19-22] though the increase in velocity is variable. These studies show a slowing down of growth in later gestation. Since, we do not have the master charts of these studies, so we are not able to comment on this variation seen week vise. The growth in the earlier period of growth is not widely different. This could be explained by the theory that in early trimester growth achieved by all fetuses are almost the same after which limitation of fetal supply line (mother and placenta) restrict growth.

In our study, we observed the values of BMI according to sex, we found that in female newborns the value of BMI show a rise from 26 weeks (7.38) to 43 weeks (13.34) with some discrepancy in 27th and 42nd week whereas the BMI of male newborns also show a similar pattern of increase in BMI from 25 weeks (7.39) to 43 weeks (13.32) with discrepancy in 28th and 43rd weeks. This discrepancy could be explained by low number of subjects in these weeks in each sex group. So we found an increase in BMI in each sex but there was no significant difference in the values of both sexes in each gestational age. These results colaborates with the study done by Brock et al,[19] found no statistical difference between the BMI values for the sexes in the 9 percentiles evaluated, except in the 32 week gestational age, where a statistical difference was detected (p= 0.044).

Our reference results for birth weight, birth length and BMI for term infants' 37-42weeks gestation are very similar to the corresponding WHO growth reference data 8, 9 increasing the validity of our data. CDC being a developed world study have higher values at birth 6, 7. As our values at term are similar to that of WHO, we can conclude that the values of initial weeks should be relevant, since we do not have standards to compare.

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CONCLUSION

These values for preterm BMI can't be used as standards but can be used as reference values for our region for further research and use in our hospital setting to assign the babies as high risk and low risk neonates for the future reference and follow-up.

Limitations of the study - The major limitation of this study is the small size of the sample population (1000) which when divided for each gestational age further reduces the sample size at the extremes i.e. 25, 26,27,28,42 and 43 weeks. This may account for the skewing which is the most notable at these gestational ages.

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