

Original Research Article

Time for awareness of centile charts for anthropometry in Indian neonates: need of the hour?

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ABSTRACT

Background: There is overestimation and underestimation of babies, the consequence being many AGA neonates labeled as SGA, and LGA neonates being overlooked and misinterpreted by using western based growth charts. So there is necessity to design Indian based growth charts for our babies. The objective is to construct gestational age and sex specific centile charts approximately for birth weight, length and head circumference for neonates born between 33 - 42 weeks of gestation and to compare with the other western growth charts.

Methods: All babies were delivered in Institute of Obstetrics and Gynecology and nomograms for birth weight, head circumference and length of neonates were noted in time period between July 2016 and June 2017. Gestational age and sex specific smoothened centile curves were created for both sexes separately by Lamda Mu Sigma (LMS) method. Our new centile charts were compared with standard western growth charts.

Results: Gestational age and sex specific raw and smoothened curves for birth weight, length and head circumference centiles were created from 8100 (4026 males, 4074 females) neonates. Female neonates were lighter than the male neonates. Birth weights of our Indian babies were lower with no change in length and head circumference centiles across all gestations.

Conclusions: The growth charts designed in our study can be used as wide reference charts for birth weight, height and head circumference for Indian ethnic neonates for stratification of neonates into SGA, AGA and LGA unlike western charts, which extrapolates or misclassifies our neonates thereby minimizing unnecessary interventions and complications.

Keywords: Anthropometry, AGA, Growth charts, LGA, SGA

INTRODUCTION

The growth charts are used to monitor the growth of neonates. The available growth charts are western-based charts, which are not suitable for Indian babies.

Hence, there is a necessity to design separate growth charts for Indian babies as growth charts developed for western populations exhibit ethnic, socioeconomic, environmental, nutritional and hereditary diversity.¹ The growth pattern of Indian fetuses differs from western

fetus and there is overestimation in the incidence of SGA (Small for gestational age) and underestimation of LGA (Large for gestational age) babies, with result being many AGA (Appropriate for gestational age) neonates classified as SGA, and LGA neonates being overlooked and misinterpreted by using western based growth charts.²

So, there is necessity to design Indian based growth charts for our babies.

METHODS

All live born singleton neonates from 34 to 42 weeks of gestational age during the study period were eligible for the study. Neonates with major congenital anomalies and those with uncertain gestational age were excluded.

The weights were measured using digital weighing machine with variability of ± 10 grams. The head circumference was measured using a non-stretchable tape and recorded in centimetres and length of infant was measured using infantometer and measured in centimetres. All relevant risk factors for neonates and mothers were noted from the maternal and neonatal database and from the case records.

The LMS method was applied for normalizing the raw data.³ The centiles (3rd, 10th, 25th, 50th, 75th, 90th, 97th) appropriate for birthweight, length and head circumference was calculated using LMS method which uses the Box-Cox power transformation to obtain normally distributed data within each group.

The scatter data plots and Z scores obtained from the LMS method were used to identify the outliers. Observations lying beyond $\pm 3Z$ score were deleted. Six sets of charts were constructed based on sex of the infant corresponding to birthweight, length and head circumference.

The normal distribution of Z scores resulting from the fitting of the LMS models within each group was verified by obtaining normal probability plots (Q-Q plots).⁴ Centiles were calculated using LMS Chart Maker software and the other analyses was carried out using SPSS, version 16.

RESULTS

Fifteen thousand and two hundred and thirty-six were born alive in hospital during the study period. 216 neonates were products of multiple pregnancies. 3653 neonates were gestational age of less than 34 and more than 42 weeks.

Gestational age could not be ascertained in 3267 neonates of the total neonates enrolled in our study. Hence total data was available for 8100 neonates that is 4026 male neonates and 4074 female neonates for plotting of birth weight, length and head circumference centiles. Antenatal registered cases were 45% in our hospital before 20 weeks of pregnancy and 58% of the neonates were born to primiparous mothers.

Of these 4026 male neonates, mean birth weight was 2980 ± 394 grams and the 10th percentile was 2509 grams, 50th percentile was 2902 grams, and 90th centiles were 3383 grams. The mean length was 33.54 ± 1.6 cm and the 10th percentile was 49.92 cm, 50th percentile was 48.86 cm, and 90th centiles was 51.53 cm.

Table 1: Mean, standard deviation and percentiles for birth weight.

Sex	Birth weight (grams)			
	Mean \pm SD	P25	P50	P75
Boy	2980 \pm 394	2700	2970	3245
Girl	2906 \pm 373	2630	2890	3140

Table 2: Mean, standard deviation and percentiles for length.

Sex	Length (cm)			
	Mean \pm SD	p25	p50	p75
Boy	33 \pm 1.6	33	34	34
Girl	33 \pm 1.5	32	33	34

Table 3: Mean, standard deviation and percentiles for head circumference.

Sex	Head circumference (cm)			
	Mean \pm SD	P25	P50	P75
Boy	49 \pm 2.8	48	49	51
Girl	48 \pm 2.4	47	49	50

The mean head circumference was 49.22 ± 2.8 cm and the 10th percentile was 31.76 cm, 50th percentile was 33.25 cm, and 90th centiles was 34.82 cm.

Of these 4074 female neonates, mean birth weight was 2906 ± 373 grams and the 10th percentile was 2412 grams, 50th percentile was 2902 grams, and 90th centiles were 3278 grams. The mean length was 33.18 ± 1.5 cm and the 10th percentile was 45.64 cm, 50th percentile was 48.57 cm, and 90th centiles was 51.33 cm.

The mean head circumference was 48.81 ± 2.4 cm and the 10th percentile was 31.44 cm, 50th percentile was 32.99 cm, and 90th centiles was 34.66 cm. The mean gestational age for boys was 38 ± 1.2 weeks and the 10th percentile was 37 weeks, 50th percentile was 39 weeks, and 90th centiles was 39 weeks. The mean gestational age for girls was 38 ± 1.2 weeks and the 10th percentile was 37 weeks, 50th percentile was 39 weeks, and 90th centiles was 39 weeks. The Q-Q plot for z scores of births weight, length and head circumference displayed good correlation for the data between 3rd and 97th centiles.

A hump was noted between 50th and 90th percentile from 38 to 41 weeks in crude curve observed from the raw data of male neonates.

The crude curves of female neonates were relatively smoother. Though male babies were heavier than female, there was no statistical significance observed in length and head circumference. Antenatal complications were diabetes (13.8%), Hypertension (15.4%), severe anemia (9.2%) and other disorders complicating pregnancy (10.9%).

On superimposing our charts on Lubchenco intrauterine growth charts, the 10th centile birth weights were higher and the 50th and 90th centile birthweights were lower in

the both the sexes. However, length and head circumference centiles were similar to that of Lubencho charts in the both male and female.⁵

Table 4: Gestational age specific centiles for birth weight (grams)-boys.

GA in weeks	C3	C10	C25	C50	C75	C90	C97
34	2078.39	2235.12	2407.53	2618.56	2854.86	3094.42	3362.04
35	2085.62	2252.15	2436.37	2663.28	2919.10	3180.25	3474.03
36	2114.57	2287.48	2479.21	2716.00	2983.77	3257.93	3567.28
37	2188.65	2366.76	2564.16	2807.81	3083.17	3364.94	3682.68
38	2344.09	2517.88	2708.74	2941.95	3202.57	3466.26	3760.26
39	2441.87	2613.69	2801.48	3029.74	3283.36	3538.47	3821.23
40	2503.31	2672.45	2856.66	3079.68	3326.42	3573.55	3846.29
41	2580.06	2741.29	2915.76	3125.51	3355.76	3584.60	3835.20
42	2660.92	2810.96	2972.06	3164.09	3372.94	3578.59	3801.75

Table 5: Gestational age specific centile chart for length(cms)-boys.

GA in weeks	C3	C10	C25	C50	C75	C90	C97
34	41.55	43.62	45.11	46.47	47.76	49.06	50.66
35	42.05	44.26	45.86	47.30	48.67	50.05	51.75
36	42.45	44.81	46.50	48.03	49.48	50.93	52.72
37	43.10	45.48	47.19	48.74	50.21	51.68	53.49
38	43.99	46.23	47.84	49.31	50.70	52.10	53.83
39	44.66	46.78	48.32	49.72	51.06	52.40	54.06
40	45.03	47.10	48.60	49.97	51.27	52.59	54.22
41	45.37	47.47	48.98	50.36	51.68	53.01	54.66
42	45.94	47.97	49.44	50.79	52.07	53.37	54.98

Table 6: Gestational age specific centile chart for head circumference(cms)-boys.

GA in weeks	C3	C10	C25	C50	C75	C90	C97
34	29.86	30.73	31.47	32.23	33.01	33.81	34.79
35	30.01	30.91	31.69	32.49	33.30	34.14	35.18
36	30.35	31.25	32.01	32.80	33.60	34.43	35.45
37	30.69	31.59	32.36	33.14	33.95	34.77	35.79
38	31.02	31.92	32.69	33.48	34.29	35.11	36.14
39	31.18	32.10	32.89	33.70	34.53	35.38	36.43
40	31.43	32.34	33.11	33.90	34.71	35.54	36.56
41	31.69	32.54	33.27	34.02	34.78	35.55	36.51
42	31.87	32.67	33.35	34.04	34.75	35.47	36.36

Table 7: Gestational age specific centile chart for birth weight (grams)-girls

GA in weeks	C3	C10	C25	C50	C75	C90	C97
34	2045.20	2180.62	2330.37	2513.39	2716.24	2918.05	3137.49
35	2084.56	2228.74	2388.79	2585.24	2803.99	3022.65	3261.54
36	2135.52	2289.02	2460.02	2670.73	2906.40	3142.99	3402.59
37	2197.84	2358.45	2537.64	2758.83	3006.70	3256.01	3530.11
38	2275.88	2438.97	2620.59	2844.33	3094.47	3345.50	3620.86
39	2350.50	2516.18	2700.40	2926.96	3179.79	3433.03	3710.29
40	2409.94	2578.45	2765.68	2995.75	3252.26	3508.96	3789.75
41	2435.97	2606.30	2795.55	3028.10	3287.38	3546.85	3830.67
42	2436.93	2606.88	2795.66	3027.58	3286.07	3544.68	3827.48

On superimposing our charts on the most widely used Fenton intrauterine growth charts, the 10th centile birth weights were higher, the 50th centile birth weights were similar and the 90th centile birthweights were lower in

the both the sexes. However, length and head circumference centiles were similar or lower to that of Fenton charts in the both sexes.⁶

Table 8: Gestational age specific centile chart for length (cms)-girls

GA in weeks	C3	C10	C25	C50	C75	C90	C97
34	43.03	44.57	45.79	46.98	48.14	49.27	50.62
35	43.21	44.83	46.11	47.36	48.56	49.75	51.16
36	43.33	45.06	46.43	47.75	49.03	50.29	51.78
37	43.60	45.40	46.84	48.22	49.56	50.87	52.42
38	44.08	45.89	47.33	48.71	50.06	51.38	52.93
39	44.59	46.36	47.77	49.12	50.44	51.73	53.26
40	44.86	46.68	48.12	49.51	50.86	52.19	53.75
41	44.69	46.70	48.30	49.83	51.32	52.77	54.48
42	44.10	46.44	48.29	50.05	51.75	53.41	55.35

Table 9: Gestational age specific centile chart for head circumference(cms)-girls

GA in weeks	C3	C10	C25	C50	C75	C90	C97
34	29.84	30.69	31.43	32.20	33.00	33.82	34.83
35	29.99	30.85	31.61	32.32	33.20	34.04	35.06
36	30.21	31.07	31.83	32.62	33.43	34.27	35.29
37	30.44	31.29	32.05	32.83	33.64	34.48	35.50
38	30.69	31.53	32.27	33.04	33.84	34.65	35.6
39	30.91	31.75	32.48	33.25	34.03	34.84	35.83
40	31.06	31.92	32.67	33.45	34.26	35.09	36.11
41	31.12	32.01	32.79	33.60	34.44	35.31	36.37
42	31.14	32.05	32.86	33.71	34.58	35.48	36.58

Table 10: Mean, standard deviation and percentiles for gestational age.

Sex	Gestational age (weeks)			
	Mean±SD	P25	P50	P75
Boy	38±1.2	37	38	39
Girl	38±1.2	38	38	39

DISCUSSION

This is the first study from south India involving neonates from 34 to 42 weeks of gestation and this study represents centile, mean, standard deviation and smoothened growth curves of birth anthropometry in a large cohort of neonates corresponding for weight, length and head circumference. Another important implication noted in our study was our stratifications were based on sex unlike other studies done in India. The study population enrolled in our study was representative of the entire population in South India as our hospital is biggest tertiary care hospital in South East Asia with referrals from all over south India with significant antenatal complication disorders noted during pregnancy. Our study fulfilled required criteria for construction of an ideal reference growth chart.⁷ Growth curves were

constructed based on important parameters importantly gestational age (based on first trimester based ultrasound dating) and from same ethnic origin.⁸ Gestational age assessment was mandatory for our hospital admission. The gold standard LMS method was used for calculating centiles and for smoothening of the centile curves.

Like most of the recent studies, our study also has shown a secular trend of increasing birthweight at higher gestational ages.⁹ In our study, the 10th centile birth weights were higher due to increasing prevalence of gestational diabetes during pregnancy and conception following infertility treatment is on the rise and 50th and 90th centile birth weights were lower in the both sexes due to increased maternal anemia and malnutrition noted during second and third pregnancy.¹⁰⁻¹² However, length and head circumference centiles were similar to that of Lubench charts in the both male and female.

Most of the units in our country still use Lubchenko et al charts for classifying the neonates at birth into small for gestation (SGA) and large for gestation (LGA). However, our data in comparison with that of Lubchenko, et al. suggest that 10th and 90th centiles of our babies are lower compared to western neonates. This leads to

overestimation in the incidence of SGA and underestimation of LGA babies, the consequence being many AGA neonates labeled as SGA, and LGA neonates being overlooked as they are misclassified as appropriate for gestational age (AGA). On comparing with other western growth charts, birthweights of our babies were lower across all the gestations and centiles probably due to socioeconomic, ethnic and cultural factors.¹³ Population specific and updated growth charts should be used for the appropriate classification of neonates into SGA or LGA or AGA thereby minimizing unnecessary interventions and complications.

In spite of best effort in calculating the centiles using large cohort and also best statistical methods, this study still has few limitations. Gestational age estimation was not ultrasound based in all included neonates. There was Inter-observer variability in measuring anthropometry. This growth data is from all socioeconomic strata and hence might reflect the ideal potential for construction of specific growth centile curves.

CONCLUSION

The growth charts designed in our study can be used as wide reference charts for weight, height and head circumference for Indian ethnic neonates for stratification of neonates into SGA, AGA and LGA unlike western charts, which extrapolates or misclassifies our neonates into SGA, AGA and LGA thereby minimizing unnecessary interventions. The added advantage of this new growth charts is, which can be used by multipurpose community level workers at gross root level in Indian population. The data presented in our study are birth weight, length and head circumference centiles curves. However, further multicenter study with large data is required to substantiate it in future.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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