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Santosh Pathak,[1] Nagendra Chaudhary,[2] Prativa Dhakal,[3] Shyam Kumar Mahato,[2] Sandeep Shrestha,[2] Bal Dev Bhatia,[4] Ajay Kumar Bansal,[5] Om Prakash Kurmi,[6] Kailash Nath Agarwal[2]

[1]Department of Pediatrics, Chitwan Medical College, Bharatpur, Nepal, [2]Department of Pediatrics, Universal College of Medical Sciences, Bhairahawa, Nepal, [3]Department of Nursing, Chitwan Medical College, Bharatpur, Nepal, [4]Department of Pediatrics, Heritage Institute of Medical Sciences, Varanasi, India, [5]University College of Medical Sciences (UCMS-GTBH), Delhi, Shahdara, India, [6]Nuffield Department of Population Health, Clinical Trial Service Unit & Epidemiological Studies Unit, University of Oxford, United Kingdom.

ABSTRACT

Introduction: Measurement of birth weight, crown-heel length, head circumference and chest circumference used to assess the intrauterine growth of a baby vary with altitude, race, gender, socio-economic status, maternal size, and maternal diseases. The study aimed to construct centile charts for birth weight, crown-heel length and head circumference for new born at different gestational ages in Western Nepal.

Methods: This was a descriptive cross-sectional study done over a period of 15 months in a tertiary care hospital of Western Nepal. Birth weight, length, head circumference and chest circumference were measured within 12-24 hours of birth. Gestational age was estimated from the first day of last menstrual period and New Ballard's scoring system. Microsoft 2007 Excel and SPSS-16 was used for data analysis. Cole's Lambda Mu Sigma method was used for constructing centile curves.

Results: Out of 2000 babies analysed, 1910 samples were used to construct smoothed intrauterine growth curve of birth weight, crown-heel length, and head circumference from 33-42 weeks of gestation. Among all, 1147 (57.35%) were male and 853 (42.65%) were female, mean gestational age was 38.13±2.44 weeks. The means of birth weight, crown-heel length, head and chest circumference were 2744.78 gm, 47.80 cm, 33.18 cm, and 30.20 cm with standard deviations of 528.29, 3.124, 1.78, and 2.35 respectively.

Conclusions: This necessitates the update in the existing growth charts and development in different geographical regions of a country.

Keywords: *age specific growth curves; growth curves for Western Nepal; intrauterine growth curves; post-natal curves.*

INTRODUCTION:

Birth weight (BW), crown-heel length (CHL), head circumference (HC) and chest circumference (CC) are used to assess the intrauterine growth of a baby. BW is one of the most important characteristics in evaluation of the well-being of a child at birth which is not only a reflection of the intrauterine development, but also is determined by the duration of pregnancy.[1]

Intrauterine charts were first developed by Lubchenco et al in 1963.[2] It was found that Lubchenco intrauterine charts and many other studies either underestimated or overestimated infants at the same gestational age.[3,4]

Correspondence: Dr. Santosh Pathak, Department of Pediatrics, Chitwan Medical College, Bharatpur, Nepal. Email: drsan2s4u@gmail.com, Phone: +977-9855061520.

Since then many studies have been conducted showing that intrauterine growth curves vary with altitude, race, gender, socio-economic status, maternal size, and medical conditions during pregnancy.[5] Although charts from Kathmandu valley are available,[6,7] they do not represent the whole country population due to climate, altitude and population variances.

METHODS

This is a descriptive cross-sectional study done over a period of 15 months (1st Jan 2014 to 1st April 2015) in the labour ward, operation theatre, neonatal intensive care unit and post natal ward of Universal College of Medical Sciences, Bhairahawa, Nepal. The hospital is a tertiary care referral hospital. Ethical approval was obtained from the Institutional Research Committee. A written consent was taken from the parent(s).

All live born babies (both vaginal delivery and caesarean section) between 28-44 weeks were included. Their BW, CHL, HC and CC were measured within 12-24 hours of birth. Gestational age was estimated from first day of last menstrual period. In cases where LMP was unknown or in clinically discrepant cases, it was confirmed by clinical assessment using New Ballard's scoring system. Maternal age, weight, height and hemoglobin levels were also recorded. Babies less than 28 weeks, still births, twin pregnancies, with gestational diabetic mothers and with gross congenital anomalies were excluded.

Birth weight was measured within 12-24 hours of birth on the electronic weighing machine named Goldtech Digital Baby Scale, to the nearest ±5 gm. Crown-heel length was recorded to the nearest fraction of cm using an infantometer. Head circumference (largest occipitofrontal diameter) and chest circumference (at the level of the nipples) were measured with a fiber glass tape in cm.

Microsoft 2007 Excel and SPSS 16 was used for data analysis. The mean, standard deviation, and 3rd, 10th, 25th, 50th, 75th, 90th, 97th centiles of each variable at each gestation were computed for all neonates. Cole's Lambda Mu Sigma (LMS) method[8] was used for constructing centile curves. This method estimates three age specific parameters: a Box-cox power transformation of skewness (L), median (M), and coefficient of variation (S) that correspond to the relationships in the following formulas: $Z = \{(x/M^{L} - 1)/LS\}$, where X is the measured value of weight, length, or HC; and $Centile = M(1 + LSZ)^{1/L}$, where Z is the z-score that corresponds to a given percentile. A smoothed percentile curve or an individualized score was obtained from the smoothed values of L, M, and S.

RESULTS

Total 2030 live borns were enrolled where 30 [Imperforate anus (2), cleft lip and palate (2), spina bifida (1), collidion baby (1) and twins (24)] were excluded from analysis for not meeting the inclusion criteria. Finally, 1910 study samples were used for making smoothed intrauterine growth curve of BW, CHL and HC from 33-42 weeks of gestation with excluding 90 subjects between 28-32 weeks of gestation and 43-44 weeks of gestation (sample size too small for developing smoothed curve).

The mean maternal age was 24.8±4.56 yrs, with 925 (46.25%) neonates born to mothers between 21-25 years. Among 2000 deliveries, 1269 (63%) of babies were born by vaginal delivery and 731 (37%) were by LSCS. Mean maternal hemoglobin level was 11.90±1.85 gm/dl. Total number of babies along with gestational age (GA) and sex was depicted (Table 1).

The mean BW, length, HC and CC of all gestations were 2744.8 gm, 47.80 cm, 33.2 cm, 30.2 cm with the standard deviations of 528.29 gm, 3.12 cm, 1.78 cm, 2.36 cm respectively (Table 1). Among all 1442 (72.1%) of the newborns had normal BW and almost one quarter of the newborns 515 (25.1%) had low BW.

Smoothed percentile values (3rd, 10th, 25th 50th, 75th, 90th, 97th) of BW (gm), CHL (cm), HC (cm) and CC (cm) for each gestation from 33-42 weeks were calculated (Tables 2, 3, 4 and 5).

Table 1. Mean birth weight, mean CHL, mean HC, mean CC and their standard deviations.

GA (Wks)	Birth weight (gm)		Crown-heel Length (cm)		Head Circumference (cm)		Chest circumference(cm)		Female	Male	Total
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	n	n	n (%)
28	1378.1	243.62	37.5	1.41	27.3	1.13	22.8	1.00	2	6	8 (0.4)
29	1559.4	411.46	39.8	3.03	28.7	2.28	24.4	2.82	3	6	9 (0.4)

30	1633.3	213.98	39.6	3.29	28.7	1.08	24.8	1.13	4	2	6 (0.3)
31	1856.3	253.57	42.5	3.99	30.8	1.54	26.6	1.92	1	7	8 (0.4)
32	1915.5	509.14	42.4	3.78	30.1	2.31	26.1	3.00	15	10	25 (1.2)
33	2130.6	545.82	44.4	3.08	30.9	2.03	27.4	2.61	11	13	24 (1.2)
34	2177.7	361.93	44.0	3.03	31.4	2.22	27.6	2.05	42	63	105 (5.2)
35	2405.2	369.58	46.1	2.05	32.2	1.28	28.6	1.90	15	40	55 (2.8)
36	2479.5	428.85	46.4	2.58	32.3	1.49	28.9	2.06	87	104	191 (9.6)
37	2592.4	459.57	47.2	2.59	32.6	1.54	29.5	2.11	77	100	177 (8.8)
38	2778.9	367.13	48.1	2.26	33.4	1.18	30.6	1.72	185	253	438 (21.9)
39	2870.5	467.79	48.6	2.43	33.7	1.40	30.8	1.91	147	200	347 (17.4)
40	3028.8	426.79	49.5	2.28	34.1	1.27	31.4	1.66	151	228	379 (19.0)
41	2978.1	508.66	49.1	2.92	33.9	1.41	31.3	1.90	71	54	125 (6.2)
42	3119.4	600.51	49.6	3.21	34.1	1.97	31.5	2.17	27	42	69 (3.4)
43	2821.0	504.36	48.5	2.15	33.4	1.55	30.4	2.20	12	14	26 (1.3)
44	3184.0	641.92	49.1	2.13	33.8	0.96	31.3	1.03	3	5	8 (0.4)

Mean Gestational age ±SD=38.1±2.44; SD standard deviation, N number

Table 2. **Smoothed percentile values of birth weight for each gestation from 33 to 42 weeks.**

GA (Wks)	Smoothed percentiles (n = 1910)						
	c3	c10	c25	c50	c75	c90	c97
33	1278.454	1477.587	1694.782	1954.483	2233.663	2501.696	2781.939
34	1443.922	1656.198	1883.69	2150.85	2432.873	2699.181	2973.466
35	1603.801	1824.966	2058.485	2328.661	2609.679	2871.536	3138.048
36	1746.554	1972.876	2208.779	2478.254	2755.056	3010.129	3267.183
37	1876.342	2107.863	2345.954	2614.354	2886.523	3134.486	3381.877
38	1995.078	2235.437	2479.433	2751.062	3023.2	3268.531	3511.043
39	2081.81	2340.881	2600.292	2885.371	3167.517	3419.211	3665.767
40	2124.289	2410.017	2691.883	2997.467	3296.181	3559.896	3815.966
41	2103.648	2423.479	2732.768	3062.377	3379.761	3656.556	3922.631
42	2051.777	2414.95	2757.162	3114.317	3452.281	3743.034	4019.494

(c3= 3rd centile, c10= 10th centile, c25= 25th centile, c50= 50th centile, c75= 75th centile, c90= 90th centile, c97= 97th centile.)

Table 3. **Smoothed percentile values of CHL for each gestation from 33 to 42 weeks.**

GA (Wks)	Smoothed percentiles (n = 1910)						
	c3	c10	c25	c50	c75	c90	c97
33	36.675	39.025	41.155	43.295	45.248	46.876	48.382
34	38.405	40.484	42.422	44.416	46.270	47.840	49.309
35	40.061	41.896	43.654	45.505	47.263	48.776	50.212
36	41.456	43.110	44.725	46.454	48.122	49.576	50.971
37	42.554	44.121	45.652	47.295	48.881	50.265	51.595
38	43.394	44.958	46.468	48.067	49.594	50.913	52.169
39	44.002	45.637	47.185	48.796	50.309	51.599	52.814
40	44.296	46.078	47.721	49.391	50.929	52.219	53.418
41	44.119	46.110	47.887	49.649	51.236	52.546	53.746
42	43.732	45.966	47.895	49.759	51.405	52.743	53.955

(c3= 3rd centile, c10= 10th centile, c25= 25th centile, c50= 50th centile, c75= 75th centile, c90= 90th centile, c97= 97th centile.)

Table 4. Smoothed percentile values of head circumference for each gestation from 33 to 42 weeks.

GA(Wks)	Smoothed percentiles (n = 1910)						
	c3	c10	c25	c50	c75	c90	c97
33	25.07	27.00	29.00	30.00	32.00	33.10	34.00
34	28.00	30.00	30.00	32.00	32.00	33.00	35.00
35	29.68	30.00	32.00	32.00	33.00	34.00	34.32
36	29.00	30.00	32.00	32.00	33.00	34.00	35.24
37	30.00	30.00	32.00	33.00	34.00	34.00	35.00
38	31.00	32.00	33.00	34.00	34.00	35.00	36.00
39	31.00	32.00	33.00	34.00	34.00	35.00	36.00
40	31.00	32.00	33.00	34.00	35.00	36.00	36.00
41	31.00	32.00	33.00	34.00	35.00	36.00	36.22
42	28.24	32.00	33.00	34.00	35.00	36.00	36.00

(c3= 3rd centile, c10= 10th centile, c25= 25th centile, c50= 50th centile, c75= 75th centile, c90= 90th centile, c97= 97th centile.)

Table 5. Smoothed percentile values of chest circumference for each gestation from 33 to 42 weeks.

GA (Wks)	Smoothed percentiles (n = 1910)						
	c3	c10	c25	c50	c75	c90	c97
33	21.00	23.00	24.25	26.00	28.00	30.10	31.93
34	24.18	25.00	26.00	28.00	28.50	30.00	32.82
35	25.68	26.00	27.00	29.00	30.00	31.00	32.64
36	26.00	26.00	28.00	28.00	30.00	32.00	33.00
37	25.00	26.80	28.00	30.00	31.00	32.00	32.66
38	27.00	28.00	30.00	31.00	32.00	32.00	33.00
39	26.00	28.00	30.00	32.00	32.00	32.00	33.00
40	27.00	29.00	30.00	32.00	32.00	33.00	34.00
41	26.00	28.00	30.00	32.00	32.00	33.00	34.00
42	26.00	28.00	30.00	32.00	33.00	33.00	34.00

(c3= 3rd centile, c10= 10th centile, c25= 25th centile, c50= 50th centile, c75= 75th centile, c90= 90th centile, c97= 97th centile.)

An increase in birth weight was seen with an increase in the gestational age.

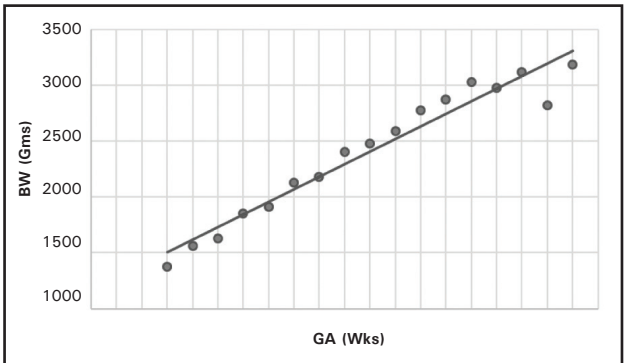

Figure 1. Relationship of birth weight with gestational age.

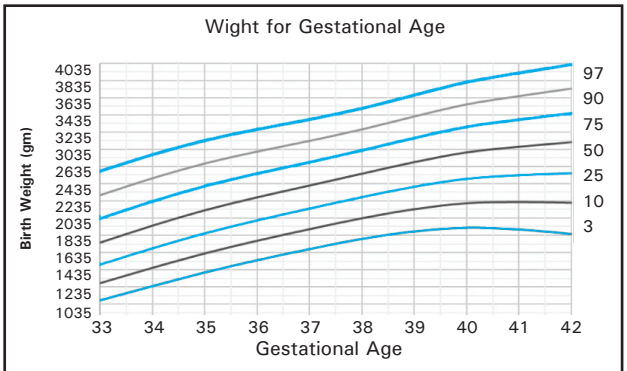

Figure 2. Smoothed curve for birth weight.

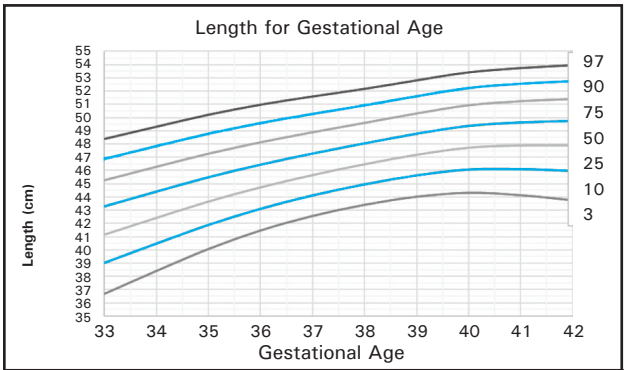

Figure 3. Smoothed curve for crown-heel length.

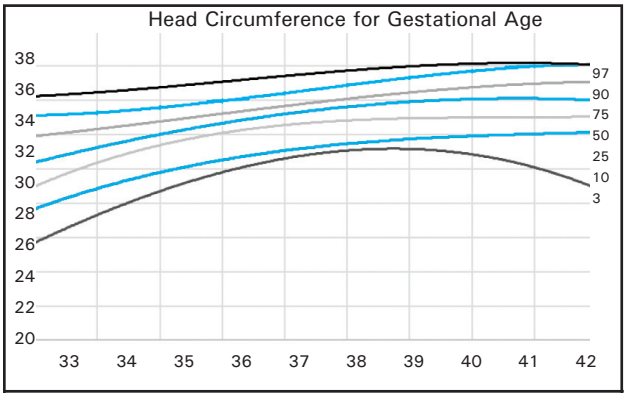

Figure 4. Smoothed curve for head circumference.

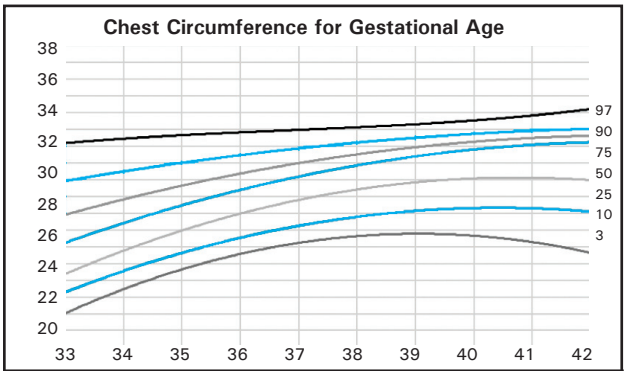

Figure 5. Smoothed curve for chest circumference.

After the GA = 40 weeks, there is decrease in birth weight which may be due to a small number of babies (Table 1). Smoothed curves of 3rd, 10th, 25th, 50th, 75th, 90th, 97th centiles for weight, CHL, HC and CC were also prepared (Figures 2-5).

The birth weight from 33 to 42 weeks in 50th centile ranged from 1954.50 gm to 3114.30 gm. The 50th centile of CHL in the same gestation ranged from 43.30 cm to 49.80 cm. The HC and CC from 33 to 42 weeks in the 50th centile ranged from 30- 34 cm and 26-32 cm respectively.

DISCUSSION

The present study was aimed to develop growth charts for BW, CHL, HC and CC of babies born at different gestational ages in mixed group of population not only from Bhairahawa but also from the neighbouring areas. Further the number of preterm babies were almost three times more in Rupandehi as compared to Kathmandu.[6,7] In the present study, majority (46.2%) of the mothers were in the age group 21-25 years with mean age 24.8 ± 4.56 years, more than half (62.7%) of the mothers were educated below lower secondary and only few (2.4%) had bachelor level degrees. Recent study done in South India depicted 41.7% of the women in the age group 25-29 years followed by 40.1% in the age group 20-24 years demonstrated the impact of maternal education "on growth of babies" (28.6% of the mothers were graduates and 13.6% had secondary education). This suggests that better education in the South Indian mothers may have been an important factor for their heavier babies in the study conducted by Kumar et al.[9] Another study conducted in rural Varanasi, India in 2002 showed 72.6% of normal BW neonates which is almost similar to our study.[10] One other previous Indian study in 1971 conducted by Ghosh et al. also showed smaller babies compared to our study.[11] Therefore, the cut off values would differ from one country to another country and different regions of any country and time to time for which the growth curves should be revised.

For Rupandehi's data, the centiles are obtained after doing the necessary corrections for skewness by LMS method as suggested by Cole et al.[8] Also in the Rupandehi data, sample size is small at the lower and higher gestational ages (Table 1). For length data values are closer for 10th and 50th centiles but higher at 90th centile for Kathmandu babies as compared to the Rupandehi data but for birth weight, Kathmandu and Rupandehi's data centiles are similar at 50th centile only. A study done in Pokhara, Nepal estimated a mean BW of 3029 gm (SD 438) which is more in comparison to the present study.[12] Similarly a hospital based study done in Kathmandu by Manandhar et al, found 82.5% of normal BW babies, 16.1% low BW babies and 1.4% babies weighing more than 4000 gm, possibly due to higher socio-economic status, better antenatal care and maternal nutrition status in mothers.[7]

The main limitation of the present the study chart is the absence of the intrauterine growth percentiles from 28 to 32 weeks and after 42 weeks due to the insufficient number of newborns to calculate the percentile for these groups. This study has shown only the unisex intrauterine growth curve because of small sample size which might be different from the gender specific

intrauterine growth curves.

The gestational age is calculated only from LMP and New Ballard Scoring System. This study has not used early ultrasound estimation which is found as one of the accurate methods of gestational age estimation. This study also lacks data regarding the maternal nutrition, maternal smoking and weight gain during pregnancy which influences the intrauterine growth pattern. This study has not excluded the maternal diseases like gestational hypertension, gestational diabetes mellitus, anemia which affect the intrauterine growth curve.

Another drawback for these types of charts is their cross-sectional nature of data collection. Larger studies comprising longitudinal data on intrauterine fetuses would be more accurate for assessing fetal growth velocity, though costly to collect.

CONCLUSIONS

The data of the present study represent intrauterine growth curves for weight, length, head and chest circumference for the Western Nepal (Rupandehi district). These weight data were similar to Kathmandu district's data at 50th centile but differed at 10th and 90th centiles. For length at Kathmandu and Rupandehi's data were similar at 10th and 50th centiles while the former were significantly higher at the 90th centile. These differences suggest that for intrauterine growth assessment local data be used and updated time to time.

This data of the present study can be merged with the data of other countries to make a single intrauterine growth curve which represents the whole country.

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Conflict of Interest: None.

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