Original Article

New intrauterine growth percentiles: a hospital-based study in Istanbul, Turkey

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Abstract

Objective: To develop gender and gestation-specific growth percentiles for singleton live-born neonates and to compare new weight for age unisex percentiles with Lubchenco unisex percentiles.

Methods: Cross-sectional birth data were collected from the neonatal registry from January 2000 to April 2006 (n=15.509). After exclusion, the sample included 15.112 neonates.

Results: Newly developed weight for age, charts were compared with Lubchenco unisex percentiles, 91.8% of the subjects were classified in the same way (Kappa=0.74, P<0.001). Small for gestational age (SGA) and large for gestational age (LGA) according to the Lubchenco percentiles differed from the new percentiles (Mc Nemar test, P<0.001). The percentage of SGA neonates was underestimated by Lubcheno percentile (5.8% vs. 10.6%, respectively), whereas the percentage of LGA neonates was overestimated by Lubcheno percentile (10.3% vs. 9.3%, respectively).

Conclusion: New growth chart for newborn delivered at different gestational ages have been established, which can be used to define SGA and LGA in Turkish neonates. Studies comparing the Lubchenco percentiles with new percentiles are needed..

Keywords: Growth percentiles, Small for gestational age, Large for gestational age, Birth weight, Neonate. (JPMA 62: 1070; 2012)

Introduction

Intrauterine growth is a determinant of short- and long-term outcome.[1] Birth weight (BW), as a consequence of intrauterine growth and gestational age is one risk factor for perinatal morbidity and mortality.[2] Small for gestational age (SGA) and large for gestational age (LGA) BW classification by standardized, gender specific and population based intrauterine growth curves is essential for optimal neonatal care.[3-5]

First intrauterine growth percentiles for BW, birth length (L) and birth head circumference (HC) developed by Lubchenco et al are used all over the world and in our hospital neonatal care setting, despite the known effect of high altitude (1.600 m) on the Denver curve.[6-11]

Purpose of this study was to develop gender and gestation specific, BW, L and HC growth percentiles for 28-44 weeks of gestation (WG) singleton live newborns of low-middle socioeconomic status mothers, at sea level, Istanbul, Turkey, and to compare new weight for age unisex percentiles with Lubchenco unisex percentiles.

Methods

Cross-sectional sample of birth data were collected on singleton liveborn of mothers from low-middle socio economic status in neonatal registry of Sisli Etfal Training and Research Hospital from January 2000 to April 2006 (n=15.509). Growth curves for foetal growth by gestational age were created for males and females separately. Gestational age (in completed weeks) was determined by the neonatal team using new Ballard score and it was further confirmed by the last menstrual date and early ultrasound before 20 WG.[12] The study was approved by ethics committee of hospital.

Singleton liveborn neonates of 28-44 WG and neonates born to mothers with medical conditions or complications of pregnancy were included because the aim of the study was to construct community at large centile charts rather than those of a 'healthy' population. Neonates of multiple gestation, gestational age impossible to determine, unrecorded data, moribund condition, congenital malformations, chromosomal abnormalities and under 28 completed WG were excluded

Newborn data comprises (BW, L, HC, gender, type of delivery, gestational age in completed weeks) and about mothers (age (year), preconceptional weight (kg), smoking, education, antenatal visit, consanguinity, working status andparity).

The 3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 97th centiles of each variable at each gestation were

computed for all neonates and separately for the males and females. The constructed unisex BW percentiles were then compared with Lubchenco unisex BW percentiles.[9]

All anthropometric measurements were carried out by the experienced delivery room neonatal team and experienced neonatal care nurses within the first hour of birth using standart equipments.

All infants were weighed nude to the nearest 5 g after drying in the delivery room before infants' transfer to the nurseries. BW was measured using Baby Scale which was accurate to 5 g that measures maximum of 20 kg and minumum of 100 g (company: NAN TARTI Limited company; Product number: 17471 / Istanbul-1997) and calibrated monthly.

The length (L) was measured to the nearest 1 mm from crown to heel using a neonatometer from the top of the head to the sole of the foot with the baby lying supine, hip and knees extended.

The head circumference (HC) was measured to the nearest 1 mm using an inelastic tape measure. The head of the infant was held in the horizontal position with the lower edge of the bony orbit and the ear positioned in the same vertical plane. HC was the maximum circumference level of the point just above the glabella anteriorly and the top of the occipital bone posteriorly. At least, two measurements were taken by the same person. All measurements were taken as per standard guidelines.

SGA (<10th centile for age) and LGA (>90th centile for age) neonates were determined according to Luchenco BW curves.[9] Then, reclassified according to the present constructed BW curves. All measurements were plotted on new charts.

Data was evaluated using SPSS for Windows, version 10.0 to determine intrauterine growth curves by gestational age and gender. For standardization of data by gender and gestational age, MANOVA and chi-square tests were used. Newly developed weight for age percentiles was compared with existing Lubchenco[9] intrauterine unisex weight percentiles using McNemar test. $P<0.05$ was accepted as significant. Statistical analysis was done in Department of Public Health at Cerrahpasa Medical School using the Statistical Analysis System (SAS) software programme.

Results

Of the data from 15.509 liveborn singleton neonates, 49 were from multiple gestations, 272 had no gestational age data, and 76 had unrecorded data. Therefore, after exclusion, 15.112 newborns were recruited into the study with 7.426 females (49.14%) and 7.686 males (50.86%); 1.444 were preterm (9.5% <37 WG; 687 female, 757 male), 67 were postterm (0.4% >42 WG; 30 female, 37 male) and 13,601 were term (90.1% between 37-42 WG; 6.709 female, 6.892 male). There was no difference between males and females with respect to distribution of gender by gestational age.

There were no statistical differences between genders with respect to maternal age, pre-pregnancy weight, education level, smoking history, and number of antenatal visits (at least one visit/trimester) ($P<0.05$).

When type of delivery was evaluated, spontaneous vaginal delivery was the most frequent (73.5%, n=11.097), followed by, in decreasing order, C-section (26.3%, n=3.971), vacuum-extraction (0.2%, n=29) and vaginal breech delivery (0.1%, n=15).

The mean of BW, L and HC values for males were 3163.9±4.95 g, 49.2±0.02 cm and 34.2±0.01 cm, respectively, and were significantly higher than those for females which were

Table-1: Birth weight (g) for gestational week for singleton female and male neonates born in Istanbul.

	Male (percentile)											Female (percentile)								
WG	n	3rd	5th	10th	25th	50th	75th	90th	95th	97th	n	3rd	5th	10th	25th	50th	75th	90th	95th	97th
28	19	550	550	670	750	900	1450	1500	1570	1570	19	500	500	750	980	1150	1450	1500	1500	1500
29	13	750	750	782	925	1350	1600	1600	1600	1600	19	670	670	750	900	1250	1550	1650	1800	1800
30	23	950	960	1000	1050	1580	1750	1930	2070	2100	20	940	940.5	955	1262.50	1425	1700	1795	2037.5	2050
31	26	1070	1080.5	1107	1325	1800	1912	2120	2465	2500	25	920	926	976	1130	1700	1925	2320	2476	2530
32	40	1034.6	1050	1100	1460	1680	2050	2390	2650	2777	25	1150	1150	1180	1250	1650	2075	2700	3007	3010
33	77	1234	1327	1492	1800	2050	2500	2700	2760	3048	68	1253.5	1300	1395	1700	2125	2500	2770	3138.5	3197.9
34	105	1362.6	1486	1580	1975	2550	2750	2800	2864	2900	86	1400	1467.5	1570	1987.50	2535	2762.5	2900	3130	3264.10
35	169	1664	1700	1960	2200	2600	2950	3050	3135	3398	160	1550	1700	1850	2200	2650	2950	3000	3109.5	3358.5
36	277	1803.4	1850	2000	2300	2700	3100	3200	3250	3333	263	1796.8	1860	2050	2300	2600	3050	3200	3300	3358
37	502	2050	2150	2300	2560	2900	3227.5	3500	3692.5	3895.5	584	2100	2172.5	2300	2600	2900	3250	3450	3637.5	3822.5
38	1187	2250	2350	2500	2750	3000	3350	3600	3756	3900	1154	2250	2350	2500	2700	3000	3250	3500	3642.5	3750
39	1871	2408	2500	2650	2900	3170	3450	3700	3850	3996.8	1841	2450	2550	2650	2855	3150	3450	3700	3850	3950
40	1964	2600	2655	2800	3062.5	3350	3600	3900	4050	4150	1834	2550	2700	2800	3000	3250	3550	3800	4000	4100
41	1044	2650	2800	2950	3200	3500	3750	4050	4245	4350	956	2750	2847	2950	3172.50	3450	3750	4000	4200	4400
42	332	2800	2900	3100	3300	3650	3850	4150	4274	4400	342	2750	2874.5	3000	3293.75	3600	3850	4100	4342.5	4400
43	35	2508	2580	2750	2950	3550	3900	4140	4510	4546	27	3100	3100	3140	3300	3600	4050	4270	4380	4400
44	2	2750	2750	2750	2750	3350	3950	3950	3950	3950	3	2800	2800	2800	2800	3250	4550	4550	4550	4550

3133.7±5.03 g, 49±0.02 cm and 34.1±0.01 cm, respectively (P=0.001, P=0.001, P=0.001). The 3rd, 5th, 10th, 25th, 50th, 75th, 90th, 95th and 97th centiles of each anthropometric measurement at each WG were presented separately or male and female neonates in tables 1-3. At 40 WG, the 50th centile for BW, L and HC for males were 3350 g, 50 cm, 35 cm; and for females 3250 g, 50 cm, 34 cm, respectively.

Comparison of gender and gestational age adjusted BW, L, and HC according to gender, consanguinity, maternal working status, maternal smoking, maternal age, preconceptional weight, number of antenatal visits, parity, and maternal education were evaluated. Consanguinity and maternal working status did not effect BW, L and HC (P>0.05). BW, L and HC of the neonates born from mothers ≥35 years old, parity ≥3, with preconceptional weight ≥65 kg, who had no smoking history and had proper antenatal visit were significantly higher than BW, L and HC of those born from mothers <35 years old, especially <25 years old, parity<3, with preconceptional weight <65 kg, especially <50 kg, who smoked and who had inadequate (<3 visit) or no antenatal visit (P<0.05). BW of the neonates whose mothers had at least 5 years primary school education were significantly higher than those whose mothers had no education (P<0.05).

According to new weight for age unisex percentiles, singleton SGA neonates were 10.6% (n=1.597), appropriate for gestational age (AGA) neonates were 80.1% (n=12.046), LGA neonates were 9.3% (n=1.402). According to

Table-2: Birth length (cm) for gestational week for singleton female and male neonates born in Istanbul.

	Male (percentile)										Female (percentile)									
WG	**n**	**3rd**	**5th**	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**	**97th**	**n**	**3rd**	**5th**	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**	**97th**
28	19	30	30	30	32	36	38	39	40	40	19	30	30	33	35	37	39	40	40	41
29	13	30	30	30	34	39	41	42	42	42	19	30	30	32	35	37	39	42	43	43
30	23	35	35	35	37	40	42	44.6	45	45	20	34	34	34.10	37	39.5	42.75	44.80	45	45
31	26	34	34.7	36	38.75	42	43.25	45	47.60	49	25	31	32.20	35.60	38	40	42.75	45.60	51.50	53
32	40	32.38	37	38	40	42	44.75	48.9	49.95	50.77	25	37	37	37	39	41	45	48.40	49.35	49.5
33	77	36.34	37	39	41	44	46	48	49	49.66	68	38	38	39.90	42	45	47	49	50,55	51
34	105	38.18	40	40	44	47	48	49	50	50	86	38	38.35	40.70	43.75	47	48	50	51	51
35	169	39.55	41.5	43	45	48	49	50	51	51	160	41	42	43	45	47	49	50	51	52
36	277	42	43	44	46	48	49	50	51	51.69	263	41	42	43	45	47	49	50	51	51
37	502	44	44	45	47	48	50	51	51	52	584	44	44	45	47	48	50	51	52	52
38	1187	45	46	46	48	49	50	51	52	52	1154	45	45	46	47	49	50	51	52	52
39	1871	45	46	47	48	50	51	52	52	53	1841	46	46	47	48	49	51	52	52	53
40	1964	46	47	48	49	50	51	52	53	53	1834	46	47	47	49	50	51	52	53	53
41	1044	47	47	48	49	50	52	53	53	54	956	47	47	48	49	50	51	52	53	54
42	332	48	48	49	50	51	52	53	54	54	342	47.65	48	48	50	51	52	53	53	53
43	35	46.08	46.8	49	50	51	52	53.4	54	54	27	50	50	50	51	51	53	53.20	54	54
44	2	46	46	46	46	49.50	53	53	53	53	3	42	42	42	42	52	52	52	52	52

Table-3: Head circumference (cm) for gestational week for singleton female and male neonates born in Istanbul.

	Male (percentile)										Female (percentile)									
WG	**n**	**3rd**	**5th**	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**	**97th**	**n**	**3rd**	**5th**	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**	**97th**
28	19	20	20	21.50	24	25	27.50	30	33	33	19	21	21	24.15	25.75	26.50	30	30.55	31	31
29	13	23	23	23.50	27.50	29	31	32.8	33	33	19	23	23	23	24.75	27.50	29	30	30	30
30	23	24	24.20	25	26	29	30.50	31.6	32.80	33	20	20	20	26	27	29	31	32	32.70	32.70
31	26	25	25.35	26.35	27.38	30	31	33.3	34.97	35.50	25	23	23.45	26	27.38	29.75	31.63	34.40	35	35
32	40	24.46	26	27.05	28.13	31	32	34.45	35	38.23	25	27	27	27.50	28.63	30.75	32	33.75	35.50	36
33	77	26.34	27.45	29	30	31	33	34	34	34.66	68	26.01	27	27.50	30	31.75	33	34.65	35.65	37.98
34	105	28	29	29.25	31	33	34	35	35	35.92	86	29	29	29.30	31	33	34	35	36	36
35	169	28	29	30	32	33	34	35	35.35	36	160	28.74	29.45	30	32	33	34	35	36	36
36	277	30	30	31	32	33	34	35	36	36	263	29	30	31	32	33	34	35	35.50	36
37	502	31	31	32	33	33.50	34.50	35.50	36	36.53	584	31	31	31.50	32.50	34	34.50	35.50	36	36
38	1187	31	31	32	33	34	35	36	36	37	1154	31	31	32	33	34	35	36	36	36.50
39	1871	31.50	32	32.50	33.50	34	35	36	37	37	1841	31	32	32.46	33	34	35	36	36.50	37
40	1964	32	32	33	34	35	35.50	36	37	37.50	1834	32	32	33	34	34	35	36	37	37
41	1044	32	33	33	34	35	36	37	37	37.50	956	32	32.50	33	34	35	36	36.50	37	37.50
42	332	33	33	33	34	35	36	37	37	37.58	342	32	33	33	34	35	36	36.55	37	38
43	35	32.03	32.38	33	34	35	35.13	36	37.50	38.90	27	33	33	33	34	35	36	37	37	37
44	2	32	32	32	32	33.50	35	35	35	35	3	34	34	34	34	36	36	36	36	36

Lubchenco unisex percentiles, the results were 5.8% (n=870) for SGA, 83.9% (n=12.627) for AGA, and 10.3% (n=1.548) for LGA singleton neonates. The distribution of SGA, LGA and AGA neonates on both weight for age percentiles were compared. Sixtyseven neonates born at 43 and 44 WG were excluded from this comparison due to the absent data for these weeks of gestation in Lubchenco growth curves. New weight for age unisex percentiles were close to Lubchenco percentiles. There was a strong correlation between these two weight for age unisex percentiles (Kappa=0.74, P<0.001). When neonates were classified as SGA, LGA and AGA using both growth percentiles separately, 91.8% of the newborns was classified in the same BW percentiles. According to both curves, 843 newborns were SGA, 11.726 were AGA, and 1.255 were LGA. However, when SGA, LGA, and AGA neonates were separately evaluated, there were significant differences (Mc Nemar test, P<0.001). According to the Lubchenco percentiles, 27 newborns were SGA whereas according to new curve, these were between 10th-90th centiles and therefore labeled as AGA (P<0.001). According to the Lubchenco percentiles, 754 newborns were AGA whereas according to new curve, these were <10th centile and therefore labeled as SGA (P<0.001). According to the Lubchenco percentiles, 147 newborns were AGA whereas according to new percentiles, these were >90th centiles and therefore labeled as LGA (P<0.001). According to Lubchenco percentiles, 293 newborns were LGA whereas according to new percentiles, these were between 10th-90th centiles and therefore labeled as AGA (P<0.001).

Discussion

Our moderately large data base of 15.112 neonates provides current, stable, gender and gestation specific, cross-sectional intrauterine growth percentiles for classifying neonatal population at sea level as small, appropriate or large for gestational age. Birth weight data were compared with the Lubchenco unisex intrauterine birth weight data.[9] Number of subjects, the standardization of parameters, comparison of SGA and LGA neonates between the new weight for age unisex percentiles and Lubchenco unisex weight for age percentiles, analysis of the maternal factors' effect on the BW, L, and HC are the strongest aspects of this study. The main limitation of this study is the absence of the growth percentiles for the ≤27 WG preterm neonates. This is due to the insufficient number of subjects for each WG to provide percentiles for these premature neonates. The observation of the small difference from the most widely used Lubchenco percentiles shows the necessity of constructing and renovating population based intrauterine growth percentiles. SGA and LGA are commonly used to define high-risk groups of infants who receive extra attention in the neonatal intensive care unit (NICU). SGA infants are at risk for adverse outcomes such as growth and neurodevelopmental delays, and LGA infants are at risk for early hypoglycaemia and later metabolic syndrome.[13-15] The misclassification by using the Lubchenco unisex percentiles may lead to some SGA infants not receiving the care that they need because they are misclassified as AGA, LGA infants may be overlooked because they are misclassified as AGA, and AGA infants may be mistargeted for extra NICU attention because they are misclassified as LGA. This may lead to misuse of NICU resources.

There are previous reports comparing their newly constructed intrauterine growth percentiles with the commonly used Lubchenco growth percentiles.[5,16] Thomas et al.[5] found significant differences between their growths percentiles and those reported by Lubchenco et al, especially for neonates greater than 36 WG. Olsen et al.[16] reported growth percentiles for 22-42 WG neonates born in 33 states of United States of America. They compared their growth curves with the Lubchenco percentiles. SGA and LGA classification using the Lubchenco percentiles differed significantly from their new percentiles for each gestational age. In our study, similar to the above mentioned reports, when the Lubchenco percentiles were used, the percentage of SGA neonates was underestimated and percentage of LGA were overestimated. Secular trends for BW by gestational age occured due to general improvements in health and changes in obstetric practice.[4] On the other hand, the 81.8% compatibility of our results with the Lubchenco percentiles explains why the Lubchenco percentiles are still used worldwide.[9]

There are reports about cross-sectional birth data who do not represent intrauterine growth[7] however, they represent intrauterine growth of fetuses up to time of birth.[16] Despite the limitations, cross-sectional birth data from neonates of varying ages remain the generally accepted best sources for creating growth percentiles for the assessment of neonate at birth.[17,18]

Several new standards for BW by gestational age have been suggested after the initial work of Lubchenco et al.[6,8,19-23] The first cross-sectional intrauterine growth percentiles for Turkish infants born between 25 and 42 WG is reported in 2003 by Ovali.[24] Singleton liveborn 2,481 neonates of the middle class women included in this study. Recently, the second cross-sectional birth data from Turkey is published by Atici.[25] In this report, data from 33 centers all through the country of 9.734 liveborn singleton 24-42 WG neonates born between 2006-2010 were used to construct gender specific intrauterine growth percentiles for BW, L and HC. At 40th WG, the 50th centile BW, L and HC values for both genders were in accordance with our results.

The mean BW, L and HC values for males were found significantly higher than those for females. Maternal age,

maternal preconceptional weight, smoking history, parity, number of antenatal visits and maternal education were observed as important determinants of BW, L and HC. Our results are in accordance with the literature. All these determinants are well known to influence the anthropometry of a newly born that vary from one society to another.[5,18,25] For this reason, population based intrauterine growth percentiles is needed for each population.

Conclusion

Hospital-based intrauterine BW, L and HC percentiles for preterm and term singleton neonates based on a population born between 2000-2006 have been prepared. Since Istanbul, a metropolis located at sea level, is receiving an intense immigration from other regions of Turkey, we believe that the study population of this current report can represent the neonates born at other regions of the country.

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