Coll. Antropol. **29** (2005) 1: 257–262
UDC 572.512:618.29
Original scientific paper

Birth Weight of Healthy Newborns in Zagreb Area, Croatia

Ivana Kolčić[1], Ozren Polašek[1], Dina Pfeifer[2], Nina Smolej-Narančić[3], Marcela Ilijić[2], Danko Bljajić[2], Zrinka Biloglav[1], Marina Ivanišević[2] and Josip Đelmiš[2]

[1] Department of Medical Statistics, Epidemiology and Medical Informatics, »Andrija Štampar« School of Public Health, Medical School, University of Zagreb, Zagreb, Croatia

[2] Department of Obstetrics and Gynecology, University Hospital Center »Zagreb«, Medical School, University of Zagreb, Zagreb, Croatia

[3] Institute for Anthropological Research, Zagreb, Croatia

ABSTRACT

The aim of this study was to assess birth weight of healthy newborns from the City of Zagreb and Zagreb County, Croatia. Birth weights of healthy newborns, born at the Department of Obstetrics and Gynecology, University Hospital Center »Zagreb« in the year 2001, were included into analysis. Since there were only few newborns in the 22nd–27th week of gestation, they were excluded from the study. Small number of data points was also noticed in 28th–36th week of gestation, and was supplemented with the data from the years 2000, 2002 and 2003. The method of analysis used in this study was described by Altman and Chitty (Br. J. Obstet. Gynaecol., 101 (1994) 29). After the application of well defined exclusion criteria, the final sample consisted of 4,252 newborns. Percentile values for the four groups of newborns (male gender–primipara, male gender–multipara, female gender–primipara, female gender–multipara) were defined, yielding highest birth weight values in the male gender–multipara group (50th percentile of 40th gestational week was 3551.3 g), while female gender–primipara newborns were the lightest among the four sub-samples studied (50th percentile of 40th gestational week was 3399.9 g). New percentile values for percentile curves plotting are presented here and recommended for use in the clinical practice.

Key words: *newborns, anthropometrics, percentile curve, growth chart, Zagreb, Croatia*

Introduction

The first step in the assessment of neonatal development and health is a comparison of newborn's anthropometrical measures with standard percentile curves, also known as growth charts. This comparison enables clinicians to assess a newborn's growth and development with respect to gestational age. The newborn's weight is considered small for gestational age if it falls bellow 10th percentile. In such cases, clinicians have to use other diagnostic procedures to determine the causes of small birth weight, because it is strongly associated with increased fetal, neonatal, and post-neonatal mortality and infant and child morbidity[1].

The search of biomedical literature revealed that papers with growth charts for newborns are common, but authors used a variety of statistical methods[2,3], which yielded a large variability among results[4]. That variability can be explained by anthropometrical differences between studied populations, but partly also by inadequacy of study design, statistical analysis or both[5].

Since several papers have been published recently about changes in biological and anthropometrical determinants of contemporary Croatian population in relation to the war and post-war periods[6–10], our aim was to describe a growth pattern in newborns.

This paper attempts to provide a methodologically and statistically sound update on the birth weight percentile curves from the year 1982, reported by Drazancic *et al.*[11].

Received for publication November 21, 2004

Subjects and Methods

Study setting

For the purpose of this retrospective study, all newborns from Zagreb area (City of Zagreb and Zagreb County), delivered at the Department of Obstetrics and Gynecology in the year 2001, were included into analysis. Due to small number of data points in the lower gestational weeks (22nd–36th week), sample was additionally modified. There were only few healthy newborns delivered in the 22nd–27th gestational weeks in the year 2001, and this group was not included in the study. In the gestational weeks 28th–36th, additional data from the years 2000, 2002 and 2003 was included to produce growth charts with percentile curves with more reliable correlation between weeks of gestation and birth weight. This kind of procedure was also used in the previous study[11].

To obtain a sample of healthy newborns from Zagreb area, we excluded (i) all newborns from parts of Croatia other than Zagreb and Zagreb County, (ii) stillbirths, neonatal deaths, multiple pregnancies and malformations that could have severely affected intrauterine growth (heart, kidney, brain or alimentary tract malformations, and severe genetic disorders), and (iii) pregnancies of unknown or uncertain gestational age.

The categories of complications during pregnancy that were retained in the sample included newborns with confirmed fetal growth retardation, according to previously accepted standards[11], but without malformations, and the newborns from pregnancies with diabetes mellitus, gestational diabetes or hypertension.

Gestational age was expressed in weeks, counting from the first day of the last menstrual bleeding until the delivery. In line with the previous study[11], the running week method was used (e.g., gestational week 40 meant that pregnancy lasted from 39 weeks and 1 day up to 40 weeks and 0 days, or 274 days up to 280 days). Considering the flaws of this method, we have compared calculated gestational age with the pediatric assessment of newborn's maturation, according to Farr *et al.*[12]. When the difference between the calculated gestational age (based on amenorrhoea) and pediatric assessment was more than 2 weeks, the newborn was excluded from the study.

Delivery room procedures

Measurements of birth weight were performed immediately after the birth, and each newborn was measured only once. Weight was measured on the scale Maxima 10, official trademark M–3.III3, with changeable balance position, manufactured in 1998. The scale had round gamut partitioned by 5 grams, with a weighing range from 100 grams to 10 kilograms.

Statistical analysis

Although different methods are often used in percentile curve plotting[2,3,13], in this paper we followed a method of analysis based on the regression model described by Altman and Chitty[5]. Linear-cubic model was used, in the fashion of:

$$Y = b_0 + b_1X + b_2X^3$$

Residuals of the fitting a linear-cubic model to the raw data are calculated and used for modeling the age-spe-

TABLE 1
PERCENTILE VALUES FOR MALE GENDER – PRIMIPARA CATEGORY

Week	N	Percentile Values					
		5'	10'	50'	90'	95'	SD
28	10	524.7	598.5	861.0	1123.6	1197.4	205.1
29	8	734.2	815.8	1106.0	1396.2	1477.8	226.7
30	11	938.8	1028.2	1345.9	1663.6	1752.9	248.2
31	9	1138.2	1235.3	1580.6	1925.8	2022.9	269.7
32	17	1332.3	1437.1	1809.8	2182.6	2287.4	291.2
33	18	1520.7	1633.3	2033.5	2433.8	2546.4	312.7
34	30	1703.2	1823.6	2251.5	2679.4	2799.7	334.3
35	40	1880.0	2008.1	2463.5	2919.0	3047.0	355.8
36	51	2050.7	2186.5	2669.5	3152.4	3288.3	377.3
37	25	2215.0	2358.6	2869.2	3379.8	3523.4	398.9
38	55	2373.1	2524.4	3062.4	3600.4	3751.7	420.3
39	127	2524.3	2683.4	3249.0	3814.7	3973.8	441.9
40	251	2668.9	2835.7	3428.9	4022.0	4188.9	463.4
41	226	2806.5	2981.1	3601.8	4222.4	4397.0	484.9
42	132	2936.9	3119.2	3767.5	4415.8	4598.2	506.5
43	47	3060.2	3250.2	3925.9	4601.7	4791.7	527.9

cific estimated standard deviation, which is the key element of the method. Standard deviation scores (given as: observed value – fitted mean / fitted standard deviation) are the bases for checks of the assumptions for the model, and should be normally distributed. Finally, if all assumptions are met, percentile values are obtained as fitted mean ± z*SD, where z=–1.88, –1.64, –1.28, 0, 1.28, 1.64, 1.88 for the 3rd, 5th, 10th, 50th, 90th, 95th and 97th percentiles, respectively. The entire sample was divided into four sub-samples (male gender-primipara, male gender-multipara, female gender-primipara, female gender-multipara), which were separately assessed and percentile values were calculated for each of them. The birth weights of the four sub-samples were compared using Kruskal-Wallis test. Accordingly, when comparison of one vs. other sub-samples was performed, Mann-Whit-

TABLE 2
PERCENTILE VALUES FOR MALE GENDER – MULTIPARA CATEGORY

Week	N	Percentile Values					
		5’	10’	50’	90’	95’	SD
28	8	481.6	559.9	838.3	1116.7	1195.0	217.5
29	7	740.5	825.8	1129.3	1432.8	1518.2	237.1
30	12	988.9	1081.3	1409.7	1738.2	1830.6	256.6
31	8	1226.1	1325.5	1679.2	2032.9	2132.3	276.3
32	11	1452.1	1558.6	1937.3	2316.1	2422.6	295.9
33	20	1666.6	1780.1	2183.8	2587.5	2701.1	315.4
34	19	1868.7	1989.3	2418.2	2847.2	2967.8	335.1
35	38	2058.7	2186.3	2640.2	3094.1	3221.8	354.6
36	49	2235.8	2370.5	2849.5	3328.4	3463.2	374.2
37	20	2399.7	2541.5	3045.6	3549.6	3691.4	393.8
38	83	2550.2	2699.0	3228.1	3757.3	3906.1	413.4
39	157	2686.6	2842.5	3396.8	3951.2	4107.1	433.1
40	280	2809.1	2972.0	3551.3	4130.6	4293.6	452.6
41	283	2916.8	3086.8	3691.2	4295.6	4465.6	472.2
42	132	3009.5	3186.6	3816.1	4445.6	4622.6	491.8
43	36	3087.0	3271.1	3925.7	4580.3	4764.4	511.4

TABLE 3
PERCENTILE VALUES FOR FEMALE GENDER – PRIMIPARA CATEGORY

Week	N	Percentile Values					
		5’	10’	50’	90’	95’	SD
28	10	457.9	523.4	756.2	989.0	1054.5	181.9
29	12	692.8	766.8	1030.1	1293.4	1367.5	205.7
30	6	917.7	1000.3	1294.1	1587.8	1670.5	229.5
31	4	1132.0	1223.3	1547.6	1872.0	1963.2	253.4
32	3	1335.9	1435.6	1790.5	2145.3	2245.1	277.2
33	12	1528.6	1636.9	2022.2	2407.5	2515.9	301.0
34	25	1709.9	1826.8	2242.6	2658.3	2775.3	324.8
35	32	1879.5	2005.0	2451.2	2897.4	3022.9	348.6
36	33	2037.0	2171.0	2647.7	3124.4	3258.4	372.4
37	27	2182.0	2324.6	2831.7	3338.9	3481.5	396.2
38	60	2314.2	2465.4	3003.0	3540.6	3691.8	420.0
39	129	2433.3	2593.0	3161.1	3729.2	3888.9	443.8
40	234	2538.9	2707.2	3305.7	3904.3	4072.6	467.6
41	248	2630.5	2807.4	3436.5	4065.7	4242.6	491.5
42	113	2708.1	2893.6	3553.2	4212.7	4398.3	515.3
43	40	2771.1	2965.2	3655.3	4345.3	4539.4	539.1

TABLE 4
PERCENTILE VALUES FOR FEMALE GENDER – MULTIPARA CATEGORY

Week	N	Percentile Values					
		5'	10'	50'	90'	95'	SD
28	8	433.4	509.0	777.6	1046.3	1121.9	209.9
29	7	679.6	762.7	1058.1	1353.5	1436.6	230.8
30	6	915.5	1006.2	1328.5	1650.8	1741.4	251.8
31	8	1141.2	1239.3	1588.4	1937.5	2035.6	272.7
32	11	1356.0	1461.7	1837.5	2213.3	2319.0	293.6
33	13	1559.6	1672.8	2075.5	2478.2	2591.4	314.6
34	23	1751.8	1872.5	2302.0	2731.4	2852.2	335.5
35	22	1931.9	2060.3	2516.6	2972.9	3101.3	356.5
36	40	2100.1	2236.0	2719.0	3202.1	3338.0	377.4
37	22	2255.7	2399.1	2908.9	3418.7	3562.1	398.3
38	51	2398.3	2549.2	3085.9	3622.6	3773.6	419.3
39	134	2527.8	2686.2	3249.7	3813.1	3971.6	440.2
40	265	2643.5	2809.5	3399.9	3990.2	4156.2	461.2
41	263	2745.5	2919.0	3536.1	4153.2	4326.7	482.1
42	132	2833.1	3014.2	3658.0	4301.9	4483.0	503.0
43	39	2906.0	3094.6	3765.4	4436.1	4624.7	524.0

ney test was used, due to non-normally distributed birth weight data across gestational ages. Probability of nil-hypothesis lower than 0.05 was considered statistically significant.

Results

Our final study sample consisted of 4,252 newborns. After the application of exclusion criteria, 3,727 newborns from the year 2001 were included, which represents 83.7% of all births at the Department of Obstetrics and Gynecology, University Hospital Center »Zagreb« (total of 4,452 births was recorded during 2001). Remaining 525 newborns were included from the years 2000 (N=159), 2002 (N=156) and 2003 (N=210), to supplement the small number of data points in the 28th–36th gestational weeks in 2001. Since there were only few newborns in the 22nd–27th gestational weeks, this group was not involved in the analysis. Gestational weeks 42 and 43 didn't require supplementing, and

TABLE 5
REGRESSION FORMULAE AND R^2 VALUES

Sub-sample	b_0	b_1	b_2	R^2
male gender-primipara	–7340.0	315.637	–0.0290	0.640
male gender-multipara	–10123	439.275	–0.0608	0.613
Female gender-primipara	–9582.0	414.403	–0.0576	0.540
Female gender-multipara	–9763.4	421.993	–0.0581	0.573

TABLE 6
COMPARISON OF EACH VS. EACH SUB-SAMPLES USING MANN-WHITNEY TEST

Sub-sample	mp	mm	fp	fm
male gender–primipara (mp)	na			
male gender–multipara (mm)	p<0.001*	na		
female gender–primipara (fp)	p=0.002*	p<0.001*	na	
female gender–multipara (fm)	p=0.401	p<0.001*	p=0.018*	na

* Statistically significant
na – not applicable

were based on the year 2001 data, only. Values for the percentile curve plotting are given in the Tables 1–4, while regression formulae values and R^2 values are given in Table 5.

Comparison of the four sub-samples using Kruskal-Wallis test revealed significant differences among them ($p<0.001$). When sub-samples are compared to one another using Mann-Whitney test, significant differences were obtained in all but male gender–primipara vs. female gender-multipara, therefore confirming necessity of creating the four different sub-samples (Table 6).

Average termed newborn's birth weight comparison renders male gender–multipara newborns the heaviest with 3551.3 grams and female gender–primipara newborns the lightest among the four sub-samples studied, with 3399.9 grams (average being described as birth weight value of the 50th percentile in the 40th gestational week).

Discussion

Percentile curves are usually population based, with very large sample sizes[14–16]. Our study involved slightly less than 10% of all births in the Republic of Croatia in the year 2001[17]. Matter of institutionalized rather than population sample is a shortcoming of the present study. A possible introducing of a cross-country computerized information system for data entry for each newborn in Croatia would provide much larger and more reliable data set. In that case, the correction of the results presented here would be possible, and truly representative for the entire Croatian population.

Large standard deviations in the lowest gestational weeks in our sample have rendered very low and very high values of the 5th and 95th percentile, respectively. Due to this fact, data presented here is considered adequate for gestational weeks 34–43, while the earlier ones should be re-appraised with additional studies, including more institutions or covering longer periods.

Question of comparison of the contemporary and previous data[11] remains open, since direct comparison of the different methods might lead to misleading and wrong conclusions.

Acknowledgements

This paper was supported in part by the Ministry of Education, Science and Sports (Project No. 0108330).

REFERENCES

1. WHO, World Health Organ. Tech. Rep. Ser., 854 (1995) 121. — 2. THOMPSON, M. L., L. P. FATTI, S. Afr. Med. J., 87 (1997) 206. — 3. BONELLIE, S. R., G. M. RAAB, Stat. Med., 15 (1996) 2657. — 4. GASSER, T., L. MOLINARI, M. ROOS, Horm. Res., 45 Suppl. 2 (1996) 2. — 5. ALTMAN, D. G., L. S. CHITTY, Br. J. Obstet. Gynaecol., 101 (1994) 29. — 6. CVJETANOVIC, B., Coll. Antropol., 24 (2000) 11. — 7. JOVANOVIC, H., Z. PREBEG, I. STANIC, G. VULETIC, Coll. Antropol., 27 (2003) 573. — 8. FAJDIC, J., D. BUKOVIC, M. BELICZA, L. PAVELIC, A. BOKIC, D. GURGIC, N. BUKOVIC, G. RADULOVIC, Coll. Antropol., 27 (2003) 685. — 9. FAJDIC, J., D. BUKOVIC, M. BELICZA, M. HABEK, D. GUGIC, I. HOJSAK, H. SILOVSKI, A. BOKIC, Coll. Antropol., 27 (2003) 699. — 10. ZIVICNJAK, M., N. S. NARANCIC, L. SZIROVICZA, D. FRANKE, J. HRENOVIC, V. BISOF, Coll. Antropol., 27 (2003) 321. — 11. DRAŽANČIĆ, A., R. PEVEC-STUPAR, J. KERN, Jugosl. Ginekol. Perinatol., 28 (1988) 13. — 12. FARR, V., D. F. KERRIDGE, R. G. MITCHELL, Dev. Med. Child. Neurol., 8 (1966) 657. — 13. DE STEFANO, G. F., G. HAUSER, J. NEUMULLER, Coll. Antropol., 28 Suppl. 2 (2004) 133. — 14. ANANTH, C. V., S. W. WEN, Semin. Perinatol., 26 (2002) 260. — 15. PARAZZINI, F., I. CORTINOVIS, R. BORTULOS, L. FEDELE, Ann. Ostet. Ginecol. Med. Perinat., 112 (1991) 203. — 16. KRAMER, M. S., R. W. PLATT, S. WU WEN, K. S. JOSEPH, A. ALLEN, M. ABRAHAMOWICZ, et al., Pediatrics, 108 (2001): e35 [cited 12.04.2004]. Available from URL: http://pediatrics.aappublications.org/cgi/reprint/108/2/e35. — 17. CENTRAL BUREAU OF STATISTICS: Statistical Yearbook of the Republic of Croatia (Central Bureau of Statistics, Zagreb, 2002).

I. Kolčić

Department of Medical Statistics, Epidemiology and Medical Informatics, »Andrija Štampar« School of Public Health, Medical School, University of Zagreb, Rockefellerova 4, 10000 Zagreb, Croatia
e-mail: ikolcic@snz.hr

RODNA TEŽINA ZDRAVE NOVOROĐENČADI NA PODRUČJU ZAGREBA

SAŽETAK

Cilj ovog istraživanja bio je analizirati rodnu težinu zdrave novorođenčadi s područja grada Zagreba i Zagrebačke županije. Analizirana je težina zdrave djece rođene u Klinici za ženske bolesti i porode Kliničkog bolničkog centra u Zagrebu, tijekom 2001. godine. Zbog malog broja novorođenčadi gestacijske dobi od 22. do 27. tjedna, ta je novorođenčad isključena iz istraživanja. Podaci za novorođenčad gestacijske dobi od 28. do 36. tjedna nadopunjeni su s podatcima iz 2000., 2002. i 2003. godine. Korištena je metoda analize podataka prema predlošku rada Altmana i

Chittya (Br. J. Obstet. Gynaecol., 101 (1994) 29). Nakon primjene strogih kriterija odabira, konačni uzorak sastojao se od 4.252 novorođenčeta. Percentilne vrijednosti izračunate su za četiri kategorije (muški spol–prvorotkinja, muški spol–višerotkinja, ženski spol–prvorotkinja, ženski spol–višerotkinja). Novorođenčad u kategoriji muški spol–višerotkinja bila su najteža (50. percentila za 40. tjedan gestacije iznosi 3551,3 g), dok su novorođenčad u kategoriji ženski spol–prvorotkinja bila najlakša (50. percentila za 40. tjedan gestacije iznosi 3399,9 g). Izračunate su nove precentilne vrijednosti rodne težine i preporučaju se za upotrebu u kliničkoj praksi.