ACTA MEDICA SALINIANA

ORIGINAL PAPER

Birth Weight, Lenght and Head Circumference Percentiles by Gestational Age and Gender of Term Neonates in Tuzla Canton

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Background. In University Clinical Center Tuzla, Department of Obstetrics and Gynaecology is using reference data from 1974 developed for the infants born in Belgrade (Serbia). It estimates the standards of term infants for neonatal weight, length and head circumference.

Aim. This study was create to develop charts for birth weight, lenght and head circumference specific to gestational age, gender and parity for term singleton infants in Tuzla Canton.

Methods. The study was conducted at University Clinical Center Tuzla, Department of Obstetrics and Gynecology, a primary obstetrical care facility for residents of Tuzla Canton over the one-year period. During the one year study period, 01.01.- 31.12.2009, there were 4106 infants born at 37th to 41th weeks of gestation (GW), 2168 (52.8 %) males and 1938 (47.2%) females. We analysed gestational age, birth weights, body length and head circumference.

Results. Females infants of primiparae, born at 40th gestational week, had the lowest median birth weight, 3500 g, followed by female infants of multiparae, 3640 g, and male infants of primiparae, 3650 g. The greatest median birth weight, 3730 g, had male infants of multiparae. Median birth length value at the 40th gestational week for male infants of primiparae and multiparae, as well as female infants of multiparae is the same, 55 cm, while is lower in female infants of primiparae (54 cm). There is no difference in median head circumference at the 40th gestational week between female infants of primiparae and multiparae, and male infants of primiparae (35 cm). Mean birth weight and length of liveborn infants at 37. to 41. gestational week differed significantly between certain parities (F=8,723, Df=2, p<0,001; F=3,292, Df=2, p=0,037, respectively). No significant difference was found for head circumference (F=0,983, Df=2, p=0,374).

Conclusion. The average birth weight of infants within Tuzla Canton is bigger in comparison with the centile that have been used so far.

Keywords. *Birth weight, length, head circumference, percentile curves, infant*

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Competing interests
The authors declare no competing interests.

INTRODUCTION

The second half of the twentieth century is characterised by the impressive progress in knowledge on human growth, which has been described lately from morphological and physiological aspect. It has been found out that fetus does not have a constant intrauterine growth and it has become clear that many consequent health problems depend on the birth weight of infant, so that studying of intrauterine growth has become of a great clinical importance.[1] Birth weight, like growth, is determined by the complex interplay of genetic and environmental factors. The proportional contribution of these influences is unclear. However, birth weight varies within genetically similar populations, another date [1-3] suggesting that environmental factors play a significant role. Environmental factors with a known association with birth weight are nutrition, smoking, maternal ill health, and genital infection. Good socioeconomic conditions are associated with proper diet and good medical care of pregnant women and thus are important for ap-propriate growth of the fetus and birth weight of live born infants. The association of other factors such as stress and exposure to some types of work during pregnancy remains unproven.[4,5] Birth weight also shows a reverse social gradient such that increasing disadvantage is associated with decreasing birth weight.

Percentile curves of growth are a useful parameter for assessing effectiveness of prenatal medical care and indirect indicators of the share of the at-risk newborns in the newborn population. It is specific for each environment, obtained from measuring of many infants from carefully selected, representative population group. According

Table 1. Birth weight, length and head circumference percentiles by gestational age for male infants of primiparae and multiparae

Variables	Gestational (Weeks)	Number (N)	Percentiles				
			3	10	50	90	97
Birth weight (g)	≤ 36	162	1160.00	1650.00	2665.00	3400.00	3700.00
	37	92	2300.00	2506.00	3000.00	3585.00	3810.00
	38	341	2635.00	2850.00	3300.00	3800.00	4110.00
	39	780	2665.00	3001.00	3550.00	4100.00	4400.00
	40	886	2900.00	3150.00	3700.00	4250.00	4500.00
	41	67	2800.00	3280.00	3700.00	4220.00	4575.00
	≥ 42	5	3080.00	3080.00	3650.00	3900.00	3900.00
Birth length (cm)	≤ 36	162	41.00	42.00	50.00	53.70	55.00
	37	92	47.00	48.00	51.00	55.00	55.00
	38	341	49.00	50.00	53.00	57.00	57.00
	39	780	50.00	51.00	54.00	57.00	58.00
	40	886	51.00	52.00	55.00	58.00	59.00
	41	67	52.00	53.00	55.00	58.20	60.00
	≥ 42	5	53.00	53.00	55.00	.	.
Head circumference (cm)	≤ 36	162	29.00	30.00	33.00	35.00	36.00
	37	92	32.00	32.00	34.00	36.00	36.00
	38	341	32.00	33.00	35.00	36.40	37.00
	39	780	33.00	33.00	35.00	37.00	37.00
	40	886	33.00	34.00	35.50	37.00	37.50
	41	67	34.00	34.00	36.00	37.60	38.60
	≥ 42	5	33.00	33.00	34.00	.	.

to definition, percentile curves of growth compare the neonatal birth weight with gestational age, to determine the success of fetal growth. The basis is data about birth weight for each completed gestational week, from which the longitudinal sample of fetal growth is derived for certain population group. Statistical analysis of neonatal population group, in fact neonatal birth weight and length in relation to gestational age, gender of a child and mother's parity are the basis for calculation of average values with standard deviations.[5] Although the clinical focus of neonatologists is the care for infants, it is necessary to monitor the standards of intrauterine growth to identify the infants with risk factors, which could affect further quality of life and development of diseases in further life.[6,7]

In former Yugoslavia, several attempts have been made to develop intrauterine growth standards: in Croatia Dražančić and Latin in 1972,[8,9] in Serbia Ljiljana Nikolić in 1973 and Zagorka Radojković in 1974,[10,11] in Monte Negro, intrauterine growth standards were developed by Kaluđerović in 1982.[12] Bosnia and Herzegovina did not have its own intrauterine growth standards, so that the intrauterine growth standards of Zagorka Radojković, developed for the infants born in Belgrade in 1974, were used.

In the past years, several definitions have been used for small for gestational age (SGA), ranging from a birth

Table 2. Birth weight, length and head circumference percentiles by gestational age for female infants of primiparae and multiparae

Variables	Gestational (Weeks)	Number (N)	Percentiles				
			3	10	50	90	97
Birth weight (g)	≤ 36	153	1270,00	1800,00	2600,00	3100,00	3360,00
	37	97	2380,00	2490,00	2950,00	3400,00	3655,00
	38	419	2700,00	2800,00	3200,00	3700,00	3850,00
	39	702	2800,00	2900,00	3400,00	3900,00	4050,00
	40	689	2975,00	3100,00	3550,00	4100,00	4285,00
	41	33	2988,00	3050,00	3500,00	4130,00	4289,00
	≥ 42	5	2400,00	2400,00	2530,00	.	.
Birth length (cm)	≤ 36	153	41,70	43,00	49,00	53,00	54,00
	37	97	47,00	48,00	51,00	54,00	55,00
	38	419	49,00	50,00	53,00	55,00	56,00
	39	702	50,00	51,00	54,00	56,00	57,00
	40	689	51,00	52,00	54,00	57,00	58,50
	41	33	51,00	52,40	54,00	57,00	57,30
	≥ 42	5	49,00	49,00	50,00	.	.
Head circumference (cm)	≤ 36	153	27,00	29,00	32,50	34,50	35,00
	37	97	30,00	32,00	33,50	35,00	36,00
	38	419	32,00	32,00	34,00	36,00	36,00
	39	702	32,00	33,00	34,50	36,00	36,50
	40	689	33,00	33,00	35,00	36,00	37,00
	41	33	33,00	33,70	35,00	36,00	36,65
	≥ 42	5	31,00	31,00	32,00	.	.

weight and/or length below the 10th to 3rd percentile or -2 SD for gestational age. In 2001, the International SGA Advisory Board Panel reached consensus on the definition of SGA, by defining SGA as a birth weight and/or length below -2 standard deviations for gestational age. This was confirmed in the consensus statement of 2007. Infants are considered large for gestational age (LGA) if their birth weight is greater than the 90th percentile for gestational age, although some restrict the definition to greater than the 97th percentile (2 standard deviations above the mean).[13]

The objective of this study was to create charts for birth weight, lenght and head circumference specific to gestational age and gender for term singleton infants in Tuzla Canton.

METHODS

The study was conducted at University Clinical Center Tuzla, Department of Obstetrics and Gynecology, a primary obstetrical care facility for residents of Tuzla Canton over the one-year period.

During the one year study period 01.01-31.12.2009, there were 4431 live infants born at 37th to 41th weeks of gestation (GW).

From the live born infants, exclusions were made for missing growth data (N=78; 1.8 % of total sample), un-

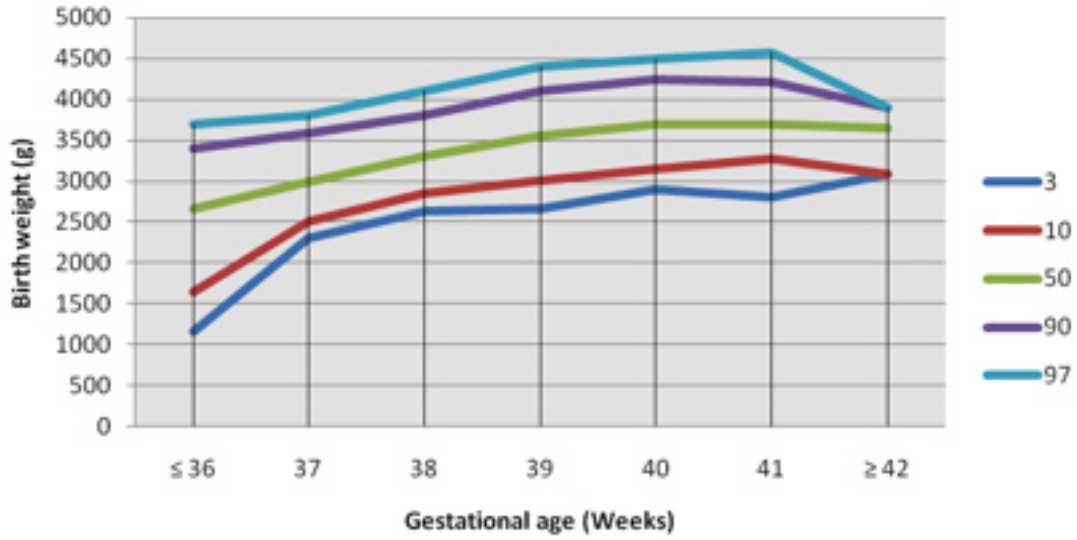

Figure 1. Percentile curves for birth weight for male infants

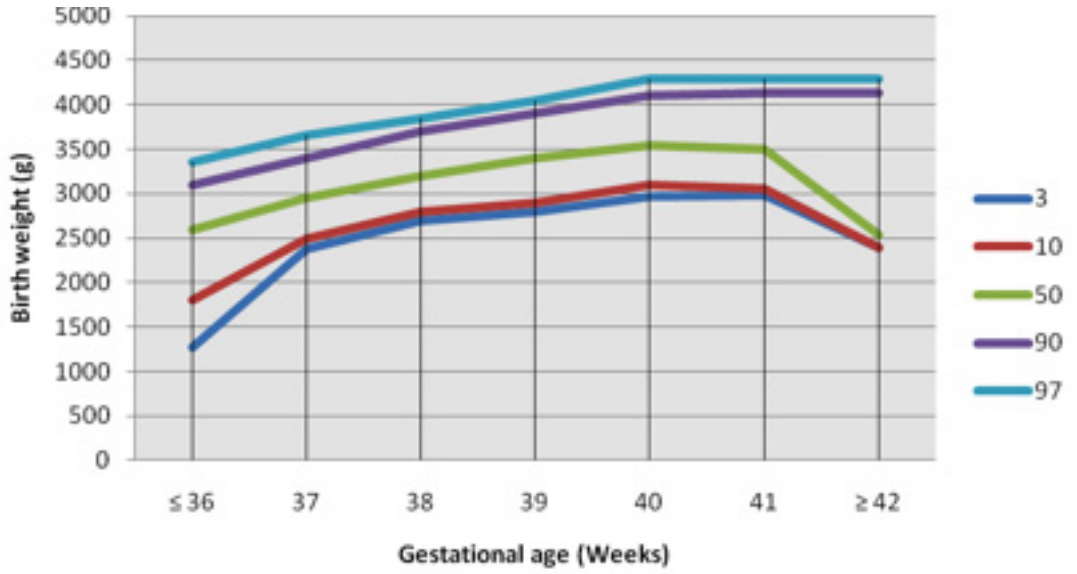

Figure 2. Percentile curves for birth weight for female infants

known gender (N=2; 0.04 %), factors with a known or suspected negative impact on intrauterine growth (eg, multiple births, congenital anomalies, mortality before discharge) (N=190; 4.2 %) and physiologically improbable growth measurements (N=55; 1.2 %).

The final sample included 4106 infants born at 37th to 41th GW, 2166 (52.7 %) males and 1940 (47.3%) females.

We analysed gestational age, birth weight, body length and head circumference (HC). Gestational age at birth was estimated using a combination of date of last menstrual period and ultrasound examination when available. When there was a discrepancy of >14 days between these estimates, the ultrasound estimate was preferred.

In 80% cases early ultrasound is being fair for assessing gestational age. If these data were not available, gestational age was assessed on the basis of external physical characteristics of the newborn.[14]

The birth weight that was measured in our department by trained nurses for analysis was the first weight measured in a newborn within the first hour of life. Birth weight of infants without diapers and with the umbilical cord shorter than 10 cm was measured using spring scales to the nearest 1 g. Birth length (using measuring tape to nearest centimeter) was measured from crown to heal in a newborn with completely extended legs and feet at the angle of 90°. Head circumference (using measuring tape to nearest centimeter) was measured, by a physician, with a non-stretchable measuring tape around the glabellas and the occipital protuberance at the largest occipital-frontal circumference at birth, and again at discharge in cases of caput succedaneum or cephalhematoma.

STATISTICAL ANALYSIS

Gender-specific weight-, length-, and HC-for-age intrauterine curves were created in this study. LmsChartMaker Pro 2.315 was used to create smoothed per-

centile curves for the 3rd, 10th, 50th, 90th, and 97th percentiles from these raw data. Cole's Lambda Mu Sigma (LMS) method estimates 3 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 (in kg), length, or HC; and Centile = M(1 + LSZ)1/L, where Z is the z score that corresponds to a given percentile. The curves were developed so that the resulting z scores follow a normal distribution and then were smoothed and converted to percentiles for clinical use.[15]

The rule of median ± 5 standard deviations was used to exclude neonates with implausible anthropometric measurements for gestational age. In a few cases, expert clinical opinion was used as well. Analysis by the rule of median ± 5 SD or clinical expertise excluded 55 neonates. We have calculated the measures of central tendency and dispersion measures for the observed variables.

Differences in categorical data between the study periods were assessed by ANOVA, Fishers F- test and Tukey test.[16] The programme package SPSS for Windows was used for data processing ($p<0.05$ was considered statistically significant).

RESULTS

The final sample included 4106 infants born at 37th to 41th GW, 2166 (52.7 %) males and 1940 (47.3%) females. Percentiles for each observed feature were calculated and curves were presented, and the results were separately shown for male and female infants (Tables 1 and 2).

Tables 1-2 show 3rd, 10th, 50th (median), 90th, and 97th percentile for birth weight, length and head circumference for male and female infants.

Final weight curves for male and female infants are presented in Figure 1 and 2.

Female infants of primiparae, born at 40th GW, had the lowest median birth weight, 3500 g, followed by female infants of multiparae, 3640 g, and male infants of primiparae, 3650 g. The greatest median birth weight, 3730 g, had male infants of multiparae. Median birth length value at the 40th GW for male infants of primiparae and multiparae, as well as female infants of multiparae is the same (55 cm) while is lower in female infants of primiparae (54 cm). There is no difference in median head circumference at the 40th GW between female infants of primiparae and multiparae, and male infants of primiparae (35 cm). Greater median value of head circumference was observed in male infants of multiparae (35.5 cm).

Mean birth weight and length of liveborn infants differed significantly between certain parities ($F=8.723$, $Df=2$, $p<0.001$; $F=3.292$, $Df=2$, $p=0.037$, respectively). No significant difference was found for head circumference ($F=0.983$, $Df=2$, $p=0.374$), (Table 3).

Mean birth weight and length differed significantly between infants of primiparae and 2. gravida ($p<0.001$, $p=0.037$, respectively), while no significant difference was found between other groups for birth weight, length and head circumference.

DISCUSSION

We developed a new set of weight, length, and head circumference for age intrauterine growth curves for the assessment of term infants in Tuzla, Bosnia and Herzegovina. The advantages of these curves are the inclusion of the 3 routine growth measurements (weight, length, and head circumference) on the same infants at birth; for male and female infants to mother's parity. Our exclusions resulted in a sample of healthy, singleton infants to create standard-type growth curves that represent an estimate of optimal growth. Our results can be considered valid in terms of the two main challenges in formulating reference growth curves for newborns: gestational age assessment and birth weight for gestation.

As greater emphasis is placed on detecting neonatal hazards immediately after birth, additional aids to diagnosis are needed. A useful adjunct to other observations during the early hours after birth is the recording of the baby's weight, length, and head circumference on the intrauterine growth charts.

The position of the infant's measurements on the charts may indicate that he is within the usual boundaries of growth for his gestational age, he may be near to or outside of the extremes of normal growth, or there may be discrepancies between the percentile positions of weight, length, and head circumference.

Median birth weight for male infants born at 40th GW was 3700 g, and for female infants it was 3550 g. Male infants had the greater median birth weight than female infants.

The mean value of birth weight at 40th GW that is so far used by Zagorka Radojković, which relates to children born in Belgrade was 3378 g.[11]

Similar to previous studies, we found that birth size differs by gender. Lubchenco et al[17] noted small but significant differences in weight between boys and girls born at 38th to 41th GW. Thomas et al[18] found that girls on average were 95 g lighter, were 0.6 cm shorter,

Table 2. Mean (and standard deviation) for birth weight, lenght and head circumference by parity

Variable	Primiparae	2. gravida	Multiparae	P
Birth weight (g) X±SD	3485.49 ± 443.42	3521.53± 463.31	3517.89 ± 456.90	p<0,001
Birth lenght (cm) X±SD	53.86 ± 2.59	53.07± 2.60	53.94 ± 2.61	p=0,037
Head circumference (cm) X±SD	34.75 ± 1.43	34.82 ± 1.46	34.79 ± 1.55	p= NS

and had 0.6 cm smaller HC. The average differences in our study were comparable to those of the study by Thomas et al (150 g, 1 cm, and 0.5 cm, respectively).

The results in 2002 from Tuzla shown that the average birth weight was 3520 g. It was higher then in other cities and regions.[19,20] Comparing our results with the results of the others authors, our infants have greater birth weight then the others. The average body weight at birth at the 40th GW in Zagreb was 3231 g, in Belgrade 3378 g, in Novi Sad 3344 g, and in Niksic 3400 g. [8,10,12] Our infants of both gender are heavier and longer than the infants from the Croatian hospital Nova Bila (Bosnia and Herzegowina), as well as the infants from Republic Croatia, and Canada.[21,22,23] The mean value of birth weight of female infants born at the 40th GW in Europe was 3639.5 g, in China 3373.3 g, and in Asia 3376.1 g. According to the available statistics, the median birth weight for U.S. singleton, full-term (40th GW) births is nearly 3500 g.

The average birth weight of a full-term newborn is approximately 3200 g in the developed world, where mothers enjoy the benefits of advanced technology, but is typically in the range of 2700 to 4600 g. In general, according to the studies conducted, male infants weight 100 g more than female at birth.[24]

Gestational age had the largest influence on each growth parameter. The values of birth weight are increasing continuously with higher gestational age. Parity and gender both had effects on birth weight. Results of our assessment have shown statistically important discrepancy in mean birth weight and length by parity, but not in head circumference. The greatest median birth weight, 3730 g, at 40th GW had male infants of multiparae. Females infants of primiparae, born at 40th GW, had the lowest median birth weight, 3500 g, followed by female infants of multiparae, 3640 g, and male infants of primiparae, 3650 g. Primipare had average birth weight for 68.51 g smaller then 2. gravida, and for 62. 58 g smaller then multipare.

Head circumference at birth is an important measure of intrauterine growth, reflecting accurately brain growth and predicting subsequent development. Standards need to reflect the population and the factors that affect intrauterine growth in the population and must be constructed in a manner that is clinically useful and predictive. Many of the present standards used to assess newborn infants are inadequate because of the limitations of sample size and study design. As a result, the current standards are adequate for infants between 37-41 weeks of gestational age. [25]

Centile charts of birth weight for gestational age are a valuable tool in many epidemiological studies. They are providing important information about infants with higher risk of neonatal or postnatal morbidity. It is necessary that the charts used are representative of the population to which they are applied. A number of standards are available based on births occurring in various European countries, mostly using data from the 1980s and the 1990s.[21] There are clear differences between the centiles calculated here from recent data and those in current use in European countries which are based on data from 1975–1989. In recent years a number of centiles charts have been constructed using the method developed by Gardosi. This method aims to give a fetal weight standard and requires only data for term births from the population of interest.[26]

For more than half a century, clinicians and investigators have proposed reference data for assessing birth weight for gestational age. These references have been used by clinicians and researchers to assess fetal growth in individual infants and in populations. It is hard to define normal fetal growth, because growth standards for birth weight and length in certain environments are changed throughout the times due to growth and influence of other external factors, such as climate living conditions, nutrition, and way of life.

Our study is limited by inability to report growth standards for infants of less than 37 weeks of gestation. We described growth curves for weight, length, and head circumference for male and female infants between 37 and 41 weeks' gestation.

CONCLUSION

We present recent growth reference for term singleton neonates in Tuzla Canton. Compared with birth weight from the 1970s, these current norms are heavier for term neonates. Our intrauterine growth curves created and validated in this study, based on a contemporary, provide clinicians with an updated tool for growth assessment.

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