

# The Acceleration of Birth Weight and Birth Length of Hypotrophic and Hypertrophic Newborns from Tuzla Canton from 1976 to 2007

Amela Begić<sup>1</sup> and Jasminka H. Halilović<sup>2</sup>

<sup>1</sup> University of Tuzla, Faculty of Science and Mathematics, Biology Department, and Meša Selimović' High school,

<sup>2</sup> University of Tuzla Faculty of Science and Mathematics, Biology Department, Tuzla, Bosnia and Herzegovina

## ABSTRACT

*The acceleration or secular changes are long-term systematic changes across a broad spectrum of anthropological variables in successive generations of the population living in the same territory. The phenomenon can be seen in the size of newborns in the period of childhood and early youth, but also at the population level. The research used the data from the book of protocols, from the Department of Gynecology and Obstetrics, University Clinical Centre in Tuzla. The sample taken from 19312 newborns (10037 boys, or 51.97%, and, 9275 girls, or 48.03%) was composed of four sub-samples of newborns of both sexes, as follows: sub-samples of infants between 01 January and 31 December of the following calendar years: 1976, 1987, 1997 and 2007. The aim of this research paper is to determine the acceleration of birth weight and birth length of hypotrophic (birth weight less than 2500g) and hypertrophic infants (birth weight greater than 4000g) of both sexes in Tuzla Canton, in four time points. On the basis of mathematical-statistical methods, the acceleration of the birth weight of the total sample of hypotrophic neonates with negative values, ranged from  $-21.39$  g / decade and  $-2.48$  g / dec in hypertrophic newborns. The acceleration of birth length of hypotrophic infants in the total sample was  $0.14$  cm / decade, and in hypertrophic  $0.62$  cm / decade. Conclusion: it is presumed that this secular change was caused by massive and violent population migrations during the 1992–1996 war in Bosnia and Herzegovina, when there was a change in the genetic composition of the local population.*

**Key words:** *acceleration, hypotrophic newborns, hypertrophic newborns, Tuzla Canton, Bosnia and Herzegovina.*

## Introduction

The general tendency of acceleration of somatic growth and development and physiological maturation of children and youth, called acceleration (or secular change), was observed in the last one hundred and fifty years in populations all around the world. Acceleration of growth and development is also evident in the tested area of Tuzla Canton. Secular changes in birth weight and birth length of newborns were monitored in many countries of the world.

According to the latest available literature, the largest secular changes ( $\approx 5$  g / year) were recorded by Schack-Nielsen and colleagues in Denmark<sup>1</sup>.

The acceleration of body measures of newborns in Sweden was concluded by Odland et al.<sup>2</sup>, in Norway, by Skjaerven et al.<sup>3</sup>, in Canada, by Wen et al.<sup>4</sup>. In these countries, the secular change in birth weight was  $\approx 3$  g / year.

In the U.S., Ananth and Wen<sup>5</sup> observed an increase in body weight of Caucasian newborns in the amount of  $\approx 0.7$  g / year, and, an increase in body weight of African-American newborns in the amount of  $\approx 2.1$  g / year. In Russia, this phenomenon was studied by Dubrova et al.<sup>6</sup>, and Tretyakova et al.<sup>7</sup>. In Hungary, in the Baranya, the secular change was studied by Dober et al. (from 1979 to 1981), and compared with the results obtained by Fekete et al. (1968 to 1974), it was concluded that in the twelve-year period, there was a small increase in birth weight<sup>8</sup>.

In Croatia, the secular changes of newborns before, during and after the war were studied by Bralić et al.<sup>9</sup>. In the former Yugoslavia, the problem of acceleration in infants was followed by Sarvan and colleagues<sup>10</sup> in Novi Sad, for the period from 1904 to 1970. Tutkuviene and colleagues followed the secular change in Lithuania for the

period 1974–2004 and found that infants have become longer, but not much heavier over the past 30 years<sup>11</sup>.

The causes of acceleration are still being investigated, and there are several hypotheses about the causes of acceleration that are often questionable and contradictory to each other. These are: halogenation theory, constitutional choice, borne theory, influence of the nervous system, racial theory, nutrition theory and radiowave theory.

None of the hypotheses on acceleration can completely explain the phenomenon of acceleration. In any case, the totality of endogenous and exogenous factors has the effect on the early maturation of the body of young generations, to subsequent aging of the elderly people and the greater length of time<sup>12</sup>.

Testing on the acceleration of birth weight and birth length in infants has been conducted in Tuzla Canton. Tuzla Canton (TC) is the administrative-territorial unit of the Federation created by an internal reorganization of government by the Washington Agreement of 1994. It was formed on the parts of the former area of northeast Bosnia in Tuzla district. Territorially, it rounds a whole, or parts of, thirteen municipalities. Bosnia and Herzegovina (BiH) is a country in Southeastern Europe located on the Balkan Peninsula.

The aim of this research paper is to:

- determine the acceleration of birth weight and birth length of hypotrophic (birth weight less than 2500g) and hypertrophic infants (birth weight greater than 4000g) of both sexes in Tuzla Canton, in four time points.
- determine the number of male infants in relation to female infants and the number of stillborn children.

- determine the percentage prevalence of infants with low birth weight and birth length, as well as the presence of hypertrophic newborns.

### Subjects and Methods

The study is a retrospective study, in which data from the book of protocols from the Department of Gynecology and Obstetrics, University Clinical Centre in Tuzla, has been used (OGC UCC Tuzla). The sample was composed of four subsamples of newborns of both sexes, as follows: sub-samples of newborns from 1976, 1987, 1997 and 2007. The research excluded stillborns. In order to examine the secular change within each tested year, further divisions of the sample were designed according to birth weight of infants. In relation to birth weight, each year, three sub-samples were made:

- Subsample of low birth weight infants – hypotrophic newborns (up to and including 2499 grams);
- Subsample of infants of normal birth weight – eutrophic infants (from 2 500g to and including 3999 grams);
- Subsample of high birth weight infants – hypertrophic infants (from 4000 grams).

The newborns were measured according to the instructions of the World Health Organization (WHO, 2000). For each individual birth, the following data were collected: the data of general and social history (place of residence, mother’s year of birth, father’s occupation, occupation of the mother, marital status), newborn (date of birth, sex, birth weight, birth length, live birth (APGAR score), gestational age, malformation), pregnancy (fertility, multiple fertility), delivery (birth order – mother’s parity).

**TABLE 1**  
THE NUMBER OF EXAMINEES PER YEAR BORN IN OGC UCC – TUZLA

Year	No. of deliveries	No. of newborns	Stillborn			Liveborn		
			Total	Male	Female	Total	Male	Female
1976	4 034	4 080	61 (1.5%)	34	27	4 019	2 100	1 919
1987	5 528	5 603	67 (1.2%)	38	29	5 534	2 839	2 695
1997	5 653	5 739	76 (1.3%)	41	35	5 663	2 975	2 688
2007	4 057	4 125	29 (0.7%)	16	13	4 096	2 123	1 973

**TABLE 2**  
THE TOTAL NUMBER AND PERCENTAGES OF MALE AND FEMALE HYPOTROPHIC, EUTROPHIC AND HYPERTROPHIC INFANTS IN THE OBSERVED PERIOD

Year	Hypotrophic newborns				Eutrophic infants				Hypertrophic infants			
	♂♂		♀♀		♂♂		♀♀		♂♂		♀♀	
	N	%	N	%	N	%	N	%	N	%	N	%
1976	123	5.86	102	5.32	1673	79.67	1666	86.82	304	14.48	151	7.87
1987	168	5.92	190	7.05	2267	79.96	2306	85.59	402	14.20	198	7.35
1997	163	5.48	194	7.22	2419	81.34	2295	85.38	392	13.18	199	7.40
2007	98	4.62	123	6.24	1725	81.29	1659	84.22	299	14.09	188	9.54

The mathematical-statistical data processing was done using the computer program STATA – 4.5 for Windows Copyright Stat Soft, Inc. 1993. Statistical significance of differences between means was determined using the t-test.

According to the data from the Protocol Book of OGC UCC – Tuzla during 1976, 1987, 1997 and 2007, there were 19,272 deliveries. There were N=19,312 liveborn, out of which 10037 were male, and 9,275 were female newborns. The number of examinees per year is shown in Table 1.

In the observed period, a total of 1,161 hypotrophic infants were born, 16,010 eutrophic newborns, and 2,133 of hypertrophic infants. The total number and percentages of male and female hypotrophic, eutrophic and hypertrophic infants in the observation period are shown in Table 2.

**Results**

**Secular change in birth weight of hypotrophic infants from Tuzla Canton**

The average value of birth weight in male, female, and the total sample of hypotrophic infants was highest in 1976 (2076.76 g). Since 1976, the observed parameter in the total sample of hypotrophic infants has gradually been declining, and, in 2007, it was 2012.60 g (Table 3 and

Fig.1). Comparing the average values of birth weight by years, results of the t-test show that: the total sample showed statistical significance in comparison between 1976–2007, and 1987–2007 (Table 3). In the female infants (Table 4), and male infants (Table 5), the result of the t-test did not show statistical significance in the mutual comparison between calendar years.

The secular change in birth weight of hypotrophic infants: in the total sample, female and male infants from 1976 to 2007 showed a negative value. In the total sample of hypotrophic infants for the past thirty years it was –64.16 g, ie –21.39 g / decade or –2.14 g / year. In female newborns, secular change in 1976 and 2007 was –87.22 ie

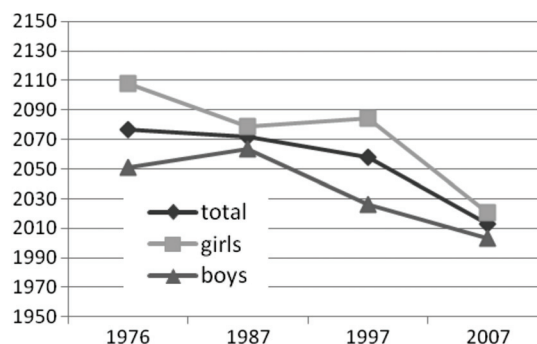


Fig. 1. Birth weight of hypotrophic infants in the period 1976–2007 in Tuzla Canton.

**TABLE 3**

STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH WEIGHT PER CALENDAR YEAR IN THE TOTAL SAMPLE OF HYPOTROPHIC INFANTS IN TUZLA CANTON

♀♂+	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth weight	1976–1987	2076.76	2071.65	0.16	581	0.87	225	358	365.00	368.59
	1976–1997	2076.76	2057.84	0.62	580	0.53	225	357	365.00	351.32
	1976–2007	2076.76	2012.60	1.78	444	0.08*	225	221	365.00	394.16
	1987–1997	2071.65	2057.84	0.51	713	0.61	358	357	368.59	351.32
	1987–2007	2071.65	2012.60	1.82	577	0.07*	358	221	368.59	394.16
	1997–2007	2057.84	2012.60	1.44	576	0.15	357	221	351.32	394.16

\*p<0.05

**TABLE 4**

STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH WEIGHT PER CALENDAR YEAR IN FEMALE HYPOTROPHIC INFANTS IN TUZLA CANTON

♀♀	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth weight	1976–1987	2107.55	2079.05	0.65	290	0.52	102	190	346.45	363.04
	1976–1997	2107.55	2084.54	0.56	294	0.58	102	194	346.45	331.96
	1976–2007	2107.55	2020.33	1.66	223	0.10	102	123	346.45	427.24
	1987–1997	2079.05	2084.54	–0.15	382	0.88	190	194	363.04	331.96
	1987–2007	2079.05	2020.33	1.30	311	0.19	190	123	363.04	427.24
	1997–2007	2084.54	2020.33	1.50	315	0.14	194	123	331.96	427.24

**TABLE 5**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH WEIGHT PER CALENDAR YEAR OF MALE HYPOTROPHIC INFANTS IN TUZLA CANTON

♂♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth weight	1976–1987	2051.22	2063.27	-0.27	289	0.79	123	168	379.20	375.69
	1976–1997	2051.22	2026.07	0.56	284	0.57	123	163	379.20	371.59
	1976–2007	2051.22	2002.91	0.97	219	0.33	123	98	379.20	350.16
	1987–1997	2063.27	2026.07	0.91	329	0.37	168	163	375.69	371.59
	1987–2007	2063.27	2002.91	1.30	264	0.20	168	98	375.69	350.16
	1997–2007	2026.07	2002.91	0.50	259	0.62	163	98	371.59	350.16

-29.07 g / decade or -2.91 g / year. The values of the secular change in male infants for the past thirty years were -48.31 g ie -16.1 g / decade or -1.61 g / year.

**The secular change in birth weight of hypertrophic infants in Tuzla Canton**

The average birth weight in the percentages of hypertrophic female newborns from 1976 ( $\bar{X}$ =4103.51 g) to 2007 ( $\bar{X}$ =4215.27 g) was slightly increased (Table 7). Unlike in female, in male hypertrophic infants the observed parameter is declining. Thus, its value in 1976 amounted to 4259.31 g, and in 2007, it amounted to 4211.04 g (Table

8). For this reason, in the total sample of male and female hypertrophic infants in all the observed counts, this parameter had pretty constant values, and from 1976 to 2007, it showed a slight decline (Table 6, Figure 2).

The secular change in birth weight of hypertrophic infants in the total sample is slightly sloping and has negative values. In the observed counts of 1976 and 2007, its value was -28.12 g, i.e. -9.37 g / decade, or -0.94 g / year.

Registered secular change in girls in the period of thirty years is positive, and its value is 11.76 g or 3.92 g / decade, or 0.39 g / year. Unlike girls, secular change in boys is negative with a value measured over thirty years, -48.27 grams, or -16.09 g / decade, or -1.61 g / year.

**TABLE 6**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH WEIGHT PER CALENDAR YEARS IN THE TOTAL SAMPLE OF HYPERTROPHIC INFANTS IN TUZLA CANTON

♀♀+ ♂♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth weight	1976–1987	4240.79	4224.33	1.10	1053	0.27	455	600	263.52	221.31
	1976–1997	4240.79	4207.48	2.17	1044	0.03*	455	591	263.52	231.20
	1976–2007	4240.79	4212.67	1.76	940	0.08	455	487	263.52	226.17
	1987–1997	4224.33	4207.48	1.29	1189	0.20	600	591	221.31	231.20
	1987–2007	4224.33	4212.67	0.86	1085	0.39	600	487	221.31	226.17
	1997–2007	4207.48	4212.67	-0.37	1076	0.71	591	487	231.20	226.17

\*p<0.05

**TABLE 7**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH WEIGHT PER CALENDAR YEARS OF FEMALE HYPERTROPHIC INFANTS IN TUZLA CANTON

♀♀	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth weight	1976–1987	4203.51	4187.47	0.70	347	0.486	151	198	236.97	192.04
	1976–1997	4203.51	4173.87	1.27	348	0.204	151	199	236.97	198.15
	1976–2007	4203.51	4215.27	0.46	337	0.644	151	188	236.97	228.93
	1987–1997	4187.47	4173.87	0.69	395	0.488	198	199	192.04	198.15
	1987–2007	4187.47	4215.27	-1.29	384	0.196	198	188	192.04	228.93
	1997–2007	4173.87	4215.27	-1.91	385	0.058	199	188	198.15	228.93

**TABLE 8**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH WEIGHT PER CALENDAR YEARS OF MALE HYPERTROPHIC INFANTS IN TUZLA CANTON

♂♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth weight	1976–1987	4259.31	4242.49	0.88	704	0.38	304	402	274.25	232.47
	1976–1997	4259.31	4224.54	1.76	694	0.08	304	392	274.25	244.76
	1976–2007	4259.31	4211.04	2.36	601	0.02*	304	299	274.25	224.78
	1987–1997	4242.49	4224.54	1.06	792	0.29	402	392	232.47	244.76
	1987–2007	4242.49	4211.04	1.80	699	0.07	402	299	232.47	224.78
	1997–2007	4224.54	4211.04	0.74	689	0.46	392	299	244.76	224.78

\*p<0.05

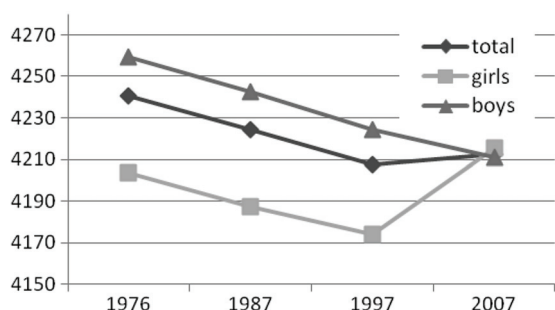


Fig. 2. Birth weight of hypertrophic infants in period 1976–2007 in Tuzla Canton.

**The secular change in birth length of hypotrophic infants from Tuzla Canton**

The average value of birth length, as well as birth weight, of hypotrophic female newborns is higher in all the observed counts than in male. From 1976, birth length has had an abrupt jump in 1987, after which this parameter has been in decline until 2007.

The result of the t-test in the total sample of hypotrophic female infants showed statistical significance in comparison between 1976–1987 and 1976–1997 on the one side, and 1987–2007 and 1997–2007 on the other side.

In male hypertrophic infants, statistical significance was found compared to 1976–1987 and 1976–1997. In other years that were compared, the results of the t-test were higher than 0.05 (Tables 9, 10, 11 and Figure 3).

The secular change in birth length in the total sample of hypotrophic infants in 1976 and 2007 has a value that is 0.43 cm, 0.14 cm / decade, or 0.014 cm / year. In female newborns, registered secular change in the period of thirty years was 0.29 g or 0.1 cm / decade, i.e. 0.01 cm / year. The secular change in male infants in a thirty year period was 0.53 cm or 0.18 cm / decade, i.e. 0.02 cm / year.

**The secular change in birth length of hypertrophic infants from Tuzla Canton**

The average value in birth length of hypertrophic, as in eutrophic, male infants was higher in all the observed counts than in hypertrophic female. The birth length from 1976 has had an abrupt jump in 1987, after which this parameter has been in decline until 2007. In 1976, it was  $\bar{X}$ =54.28 cm in girls, while in boys it was  $\bar{X}$ =54.56 cm. In 2007, this parameter was  $\bar{X}$ =56.00 cm in girls, while in boys  $\bar{X}$ =56.45 cm (Tables 12, 13, 14 and Figure 4).

The results of the t-test in all tested categories showed statistical significance in comparison between all the observed years except for 1997–2007.

**TABLE 9**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH LENGTH PER CALENDAR YEARS IN THE TOTAL SAMPLE OF HYPERTROPHIC INFANTS IN TUZLA CANTON

♀♀+ ♂♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth length	1976–1987	45.33	46.62	-4.34	580	2E-05*	225	357	3.38	3.56
	1976–1997	45.33	46.42	-3.63	579	3E-04*	225	356	3.38	3.62
	1976–2007	45.33	45.76	-1.25	441	2E-01	225	218	3.38	3.81
	1987–1997	46.62	46.42	0.72	711	5E-01	357	356	3.56	3.62
	1987–2007	46.62	45.76	2.74	573	6E-03*	357	218	3.56	3.81
	1997–2007	46.42	45.76	2.09	572	4E-02*	356	218	3.62	3.81

\*p<0.05

**TABLE 10**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH LENGTH PER CALENDAR YEARS OF HYPERTROPHIC FEMALE INFANTS IN TUZLA CANTON

♀	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth length	1976–1987	45.50	46.76	-2.84	289	0.005*	102	189	3.57	3.61
	1976–1997	45.50	46.72	-2.83	293	0.005*	102	193	3.57	3.48
	1976–2007	45.50	45.79	-0.55	222	0.585	102	122	3.57	4.18
	1987–1997	46.76	46.72	0.11	380	0.909	189	193	3.61	3.48
	1987–2007	46.76	45.79	2.17	309	0.031*	189	122	3.61	4.18
	1997–2007	46.72	45.79	2.13	313	0.034*	193	122	3.48	4.18

\*p<0.05

**TABLE 11**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH LENGTH PER CALENDAR YEARS OF HYPERTROPHIC MALE INFANTS IN TUZLA CANTON

♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth length	1976–1987	45.19	46.46	-3.17	289	0.002*	123	168	3.22	3.49
	1976–1997	45.19	46.07	-2.10	284	0.037*	123	163	3.22	3.77
	1976–2007	45.19	45.72	-1.20	217	0.232	123	96	3.22	3.31
	1987–1997	46.46	46.07	0.96	329	0.336	168	163	3.49	3.77
	1987–2007	46.46	45.72	1.69	262	0.093	168	96	3.49	3.31
	1997–2007	46.07	45.72	0.77	257	0.445	163	96	3.77	3.31

\*p<0.05

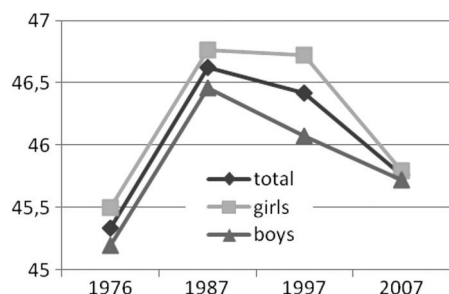


Fig. 3. Birth length of hypertrophic infants in the period 1976–2007 in Tuzla Canton.

In the observed counts in 1976 and 2007, the secular change in birth length had the following values: in boys 1.89 cm, or 0.63 cm / dec, girls 1.72 cm, or 0.57 cm / decade, and the total sample was 1.82 cm and 0.60 cm / dec.

### Discussion

Birth weight of hypo- and hypertrophic infants of the total sample has had a negative trend in the period 1976–2007. This means that the average birth weight of these two categories of infants today (2007) is less than it was thirty years ago (1976). We assume that this decrease in

**TABLE 12**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH LENGTH PER CALENDAR YEARS IN THE TOTAL SAMPLE OF HYPERTROPHIC INFANTS IN TUZLA CANTON

♀♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth length	1976–1987	54.46	57.40	-21.77	1051	0*	455	598	2.27	2.09
	1976–1997	54.46	56.43	-13.96	1044	0*	455	591	2.27	2.25
	1976–2007	54.46	56.28	-12.93	940	0*	455	487	2.27	2.04
	1987–1997	57.40	56.43	7.69	1187	2.97E-14*	598	591	2.09	2.25
	1987–2007	57.40	56.28	8.87	1083	2.85E-18*	598	487	2.09	2.04
	1997–2007	56.43	56.28	1.14	1076	0.254664	591	487	2.25	2.04

\*p<0.05

**TABLE 13**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH LENGTH PER CALENDAR YEARS OF HYPERTROPHIC FEMALE INFANTS IN TUZLA CANTON

♀	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth length	1976–1987	54.28	56.98	-12.52	347	0*	151	198	1.83	2.11
	1976–1997	54.28	56.17	-9.06	348	9.31E-18*	151	199	1.83	2.00
	1976–2007	54.28	56.00	-8.23	337	4.25E-15*	151	188	1.83	1.98
	1987–1997	56.98	56.17	3.94	395	9.55E-05*	198	199	2.11	2.00
	1987–2007	56.98	56.00	4.70	384	3.7E-06*	198	188	2.11	1.98
	1997–2007	56.17	56.00	0.82	385	0.412936	199	188	2.00	1.98

\*p<0.05

**TABLE 14**  
STATISTICAL SIGNIFICANCE OF DIFFERENCES OF THE COMPARED BIRTH LENGTH PER CALENDAR YEARS OF HYPERTROPHIC MALE INFANTS IN TUZLA CANTON

♂	Compared year	$\bar{X}$ 1	$\bar{X}$ 2	t-test	df	p value	N1	N2	SD1	SD2
Birth length	1976–1987	54.56	57.61	-17.98*	702	0	304	400	2.45	2.04
	1976–1997	54.56	56.56	-10.94*	694	7.94E-26	304	392	2.45	2.36
	1976–2007	54.56	56.45	-10.28*	601	5.87E-23	304	299	2.45	2.06
	1987–1997	57.61	56.56	6.64*	790	5.71E-11	400	392	2.04	2.36
	1987–2007	57.61	56.45	7.34*	697	6.15E-13	400	299	2.04	2.06
	1997–2007	56.56	56.45	0.63	689	0.525861	392	299	2.36	2.06

\*p<0.05

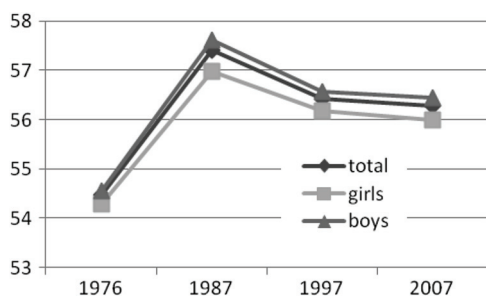


Fig. 4. Birth length in hypertrophic infants in period in 1976–2007 in Tuzla Canton.

birth weight occurred under the influence of socioeconomic factors, while the same could not influence the birth length since that parameter is under greater control of genetic factors.

There is a change in genetic composition of the local population due to massive and violent population migrations during the war (1992–1995). We assume that they also contributed to such a secular change. Therefore, migration changed the genetic structure of the population of Tuzla Canton, so we can say that the population up until 1992, and after 1992, in terms of genetics, completely differ.

### Hypotrophic newborns

The total social environment has a great impact on birth weight of infants, as many studies have proven. Extreme reproductive age, poor education, low maternal weight, smoking after the fourth month of pregnancy, previous cesarean sections, the period between the deliveries of less than 24, and greater than 37 months, maternal hypertension, cardiac disease and previous premature births, fewer than five prenatal visits during pregnancy, a later care about pregnancy (after the third month), infectious diseases, bleeding during pregnancy, etc., are all risks that lead to the birth of infants of low birth weight<sup>13</sup>. Quitting smoking and reducing stress can have a short term effect, but bad social influence has long-term consequences and requires a lot of attention in the nutrition and health status of the child<sup>14</sup>. An explicit part of the American public-health policy prevention of birth of low birth weight infants and increase of birth weight is a strategy to combat neonatal mortality<sup>15</sup>.

In our sample, with the exception of 1976, the researched years had higher share of female hypotrophic infants than male.

If these results are compared with the values that are established by the UNICEF and WHO [16], it can be concluded that our findings fit the results set out for Europe in 2000.

According to »The Institute of Medicine Report on Preventing Low Birth Weight«, taken from Prpic et al.<sup>17</sup>, 6.8% of newborns has weighed less than 2500 grams. In Europe, the incidence of birth of low birth weight infants was 6.5%, U.S. 7.0%, and in Asia as a whole, 19.7%<sup>18</sup>.

Misir Galić<sup>19</sup> has found that in 2000 the share of low birth weight infants in five Croatian counties (Čaklovec, Sisak, Šibenik, Varaždin, Koprivnica) was 3.9 %, which is 1.5 % less than the percentage of infants in Tuzla Canton in 2007.

Examining the factors associated with low birth weight in the period from January 1986 to December 2004 in the city of Campinas in the state of São Paulo, Brazil, Ribeiro et al.<sup>13</sup>, determined that the percentage of live-born infants with birth weight less than 2.500 g 12.8%. Such a large difference in the percentages could be explained by the authors' elimination of the sample of hypertrophic newborns in their research. In relation to Tuzla Canton, a large percentage of hypotrophic neonates were identified in Nepal Medical College (Nepal) in 2005 and 2006 for which the incidence was 11.9%<sup>18</sup>.

The increase in the number of newborns of hypotrophic was registered in Addis Ababa (Ethiopia). This

increase ranged from 5.8 % in the seventies and eighties, and 7.0% and 11.2% in the nineties<sup>20</sup>.

Reduction of frequency of low birth weight was noted in infants whose parents emigrated from Southeast Asia to the State of Washington. This increase was reduced from 7.2% in 1980–1981 to 5.4% in 1986<sup>21</sup>.

### *Hypertrophic newborns*

Neonatal hypertrophy, as well as hypotrophy, has lasting effects on a person's health. People who have had a large birth weight have a higher mortality rate from prostate cancer<sup>22</sup>. Power and colleagues, taken from Law et al.<sup>23</sup>, also assume that large birth weight may have an impact on the occurrence of breast cancer in later life. There was also evidence that higher birth weight affects the increased blood pressure in infants<sup>24</sup>. Examining the impact of the increase of the amount of adipose tissue and water during pregnancy in New York, Lederman and colleagues<sup>25</sup> have concluded that the increase in adipose tissue during pregnancy has no effect on weight gain, but that the increase in the amount of water in the body of the mother significantly increases birth overweight of the child.

**TABLE 15**  
THE SHARE OF HYPERTROPHIC NEWBORNS IN SOME CITIES AND COUNTRIES AROUND THE WORLD

Place (state) and year of research	% of hypertrophic newborns	Source
Montreal (Canada) 1978–1980	10 %	Boyd, 1983 <sup>26</sup>
Dakar (Dakar) 1995–1996	1.57%	Badji et al.1999 <sup>27</sup>
Magdeburg (Germany) 1990–1997	9.1%	Wollschlaeger et al. 1999 <sup>28</sup>
Kuopio (Finland) 1989–2001	>4500g 3.4%	Heiskanen et al. 2006 <sup>29</sup>
Šibenik (Croatia) 1995	16.3%	Jakšić, 1998 <sup>30</sup>
Šibenik (Croatia) 1996	18.6%	Jakšić, 1998 <sup>30</sup>
Šibenik (Croatia) 1984–1992	20.3%	Mikulandra et al. 1993 <sup>31</sup>
Šibenik (Croatia) 2000	17.7%	Misir-Galić, 2006 <sup>19</sup>
Varaždin (Croatia) 2000	7.7%	Misir-Galić, 2006 <sup>19</sup>
Sisak (Croatia) 2000	11.4%	Misir-Galić, 2006 <sup>19</sup>
Koprivnica (Croatia) 2000	10.6%	Misir-Galić, 2006 <sup>19</sup>
Čaklovec (Croatia) 2000	8.3%	Misir-Galić, 2006 <sup>19</sup>
Podgorica (Montenegro) 1974	16.12%	Stefanović, 2008 <sup>32</sup>
Podgorica (Montenegro) 1984	15.02%	Stefanović, 2008 <sup>32</sup>
Podgorica (Montenegro) 1990	14.10%	Stefanović, 2008 <sup>32</sup>
Podgorica (Montenegro) 2004	14.40%	Stefanović, 2008 <sup>32</sup>
Kotar (Montenegro) 1974	10.35%	Stefanović, 2008 <sup>32</sup>
Kotar (Montenegro) 1993	10.50%	Stefanović, 2008 <sup>32</sup>
Kotar (Montenegro) 2004	11.68%	Stefanović, 2008 <sup>32</sup>
Pljevlje (Montenegro) 1998	11.76%	Stefanović, 2008 <sup>32</sup>
Pljevlje (Montenegro) 2004	11.31%	Stefanović, 2008 <sup>32</sup>
Tuzla Canton (B&H) 1976	11.32 %	this research
Tuzla Canton (B&H) 1987	10.85%	this research
Tuzla Canton (B&H) 1997	10.44%	this research
Tuzla Canton (B&H) 2007	11.9%	this research



The percentage of hypertrophic newborns in 1976 was 11.32%, after which, in the next two examined years, this ratio decreased by about 1%, so, in 1987, it amounted to 10.85%, and 10.44% in 1997. In 2007, an increase in the number of hypertrophic newborns to 11.9% of all live-born infants was recorded.

Analyzing birth parameters at birth in the pre-war, wartime and post-war period in Tuzla Canton (from 1988 to 2003), Skokić et al. have also noted an increase in the number of hypertrophic newborns in the postwar period compared to war and pre-war period<sup>33</sup>.

Proportion of macrosomic newborns (whose weight is greater than 4000g) in the total sample of five Croatian counties was 10.7% in 2000, and the number was significantly different in five counties<sup>19</sup>.

The identified share of hypertrophic newborns in Tuzla Canton compared with the share of macrosomic newborns from five Croatian counties has had an approximate value for the total sample, Varaždin and Sisak – Moslava County, while in Šibenik – Knin this share was much larger and much lower in Međumurska County.

By comparing the share of hypertrophic infants from Tuzla Canton with the share of hypertrophic infants from

Montenegro, determined by Stefanović<sup>32</sup>, it can be concluded that Pljevlje and Kotar have approximate values as Tuzla Canton, while in Podgorica this share is much greater (Table 15).

## Conclusion

Average values of birth weight observed in both categories of (hypotrophic and hypertrophic) infants are in slight decline, and the secular change has a negative value.

Birth length of hypotrophic newborns is insignificantly increased. Unlike them, hypertrophic infants had a statistically significant increase in birth length.

Number of stillborn infants in the last thirty years has been halved as a result of improvement of socio-economic conditions and greater prenatal care of the offspring.

In the last thirty years, in Tuzla Canton, different socio-economic living conditions of the observed period, as well as the altered genetic structure of the population, which was the result of mass migration during the war in Bosnia and Herzegovina (1992–1995), have contributed to such values in birth weight and in birth length of newborns.

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A. Begić

University of Tuzla, Faculty of Science and Mathematics, Biology Department, Univerzitetska, 75000 Tuzla,  
Bosnia and Herzegovina  
e-mail: amelabegicgms@gmail.com

## **AKCELERACIJA POROĐAJNE MASE I DUŽINE TIJELA HIPOTROFIČNE I HIPERTROFIČNE NOVOROĐENČADI S PODRUČJA TUZLANSKOG KANTONA U PERIOD OD 1976. DO 2007. GODINE**

### **SAŽETAK**

Akceleracija ili sekularni trend predstavlja dugoročne sistematične promjene u širokom spektru antropoloških varijabli u uzastopnim generacijama populacije koji živi na istom području. Fenomen može biti sagledan u veličini novorođenčadi, u periodu djetinjstva i rane mladosti, ali također i na nivou populacije. U istraživanju sekularnog trenda porođajne mase i dužine tijela novorođenčadi su korišteni podaci iz knjige protokola Ginekološko akušerske klinike Univerzitetsko-kliničkog centra Tuzla (GAK UKC-Tuzla). Uzorak od 19.312 novorođenčadi (10.037 dječaka ili 51,97% i 9.275 djevojčica ili 48,03%) sastavljen je od četiri poduzorka i to: poduzorcima novorođenčadi rođenih u periodu od 01.01. do 31.12. kalendarskih: 1976., 1987., 1997. i 2007. godine. Cilj istraživanja u ovom radu je utvrditi akceleraciju porođajne mase i dužine tijela hipotrofične (porođajna masa manja od 2500g) i hipertrofične (porođajna masa veća od 4000g) novorođenčadi oba spola na području TK u četiri vremenske tačke. Na osnovu matematičko-statističkih metoda akceleracija porođajne mase u ukupnom uzorku imala je negativne vrijednosti koje su iznosile  $-21,39$  g / dekadno kod hipotrofične novorođenčadi, i  $-2,48$  g / dekadno kod hipertrofične novorođenčadi. Akceleracija dužine tijela hipotrofične novorođenčadi u ukupnom uzorku iznosila je  $0,14$  cm / dekadno, a kod hipertrofične  $0,62$  cm / dekadno. Predpostavljamo da je ovakav sekularni trend uzrokovan masovnim, nasilnim, migracijama stanovništva u toku rata (1992.–1995. godine) u Bosni i Hercegovini pri čemu je došlo do izmjene genetičkog sastava lokalne populacije.