

Secular Birth Weight Changes in Liveborn Infants before, during, and after 1991-1995 Homeland War in Croatia

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Aim To assess secular trends in birth weights of liveborn infants in Croatia from 1983 to 2003.

Methods Of a total of 959 591 liveborn infants in the study period, 384 367 were born in the prewar (1983-1989), 226 226 during the war (1991-1995), and 348 998 in the postwar (1996-2003) period. The birth weight of liveborn infants was assessed by 500 g weight groups on the basis of data provided by the Croatian National Institute of Public Health.

Results The gradual and significant increase in the share of infants with birth weight ≥ 3500 g ($P < 0.001$) was paralleled by a reduction in the share of infants with birth weights 2500-3449 g ($P < 0.001$) and < 2500 g ($P < 0.05$) in the study period. There was a positive trend in the proportion of 4000-4499 g, ≥ 4500 g ($P < 0.001$ for both), and 500-999 g ($P = 0.002$) birth weight groups and negative trend in 1000-1499 g, 2500-2999 g, and 3000-3499 g weight groups ($P < 0.001$ for all). During the war period, the proportion of liveborn infants in the 2500-3499 g weight group decreased in comparison with prewar proportion; this trend continued in the postwar period ($P < 0.001$ for both). In the war period, the proportion of liveborn infants with birth weights of 2000-2499 g was significantly larger ($P < 0.001$) and that of ≥ 4500 g significantly smaller in comparison with the prewar and postwar proportions ($P < 0.001$ for both).

Conclusion Positive secular changes in infant birth weights observed in the prewar and postwar period contrasted negative changes during the war period in Croatia. This finding may suggest the association between war suffering and stress and changes in birth weights of newborns.

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Birth weight figures 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. The average birth weight of newborns ranges between 2500 and 3999 g. Newborns with low birth weight of <2500 g are exposed to both higher neonatal and postnatal morbidity and mortality (1). The incidence of premature births and low-birth-weight newborns in Croatia is stable, with an annual level of 5-6%. However, from the public health standpoint, these newborns are among the most serious perinatalogic problems (2,3).

Good socioeconomic conditions are associated with proper diet and good medical care of pregnant women and thus are important for appropriate growth of the fetus and birth weight of liveborn infants. Since the 19th century, secular trends in height increase (1-3 cm in adults) and earlier onset of menarche have been observed in many countries (4). These positive secular changes are considered to have resulted from improved health care, higher quality diet, and better general socioeconomic and living conditions (5). However, in spite of obvious improvement in socioeconomic and health conditions in various countries, there are no clear and uniform secular changes in birth weights of newborns over a longer time period (6-13).

According to the 2001 Census, Croatia has a population of 4 437 460 inhabitants (14). In the 1973-1991 period, a positive secular trend in growth and development of schoolchildren was recorded in Croatia and explained by socioeconomic progress (15). From 1991 to 1995, Croatia suffered the ravages of war, and during that time changes were observed in biological and anthropometrical determinants of population victimized by war, similar to other countries affected by war (16-21).

Our aim was to determine if some identifiable trends existed in birth weights of live newborns in Croatia during the past 20 years, when major socioeconomic changes took place (war,

transition, and socioeconomic development). Given that from 1991 to 1995 Croatian population was exposed to war, the primary objective was to analyze the changes in the birth weight of liveborn infants during the war period in comparison with prewar (1983-1989) and postwar (1996-2003) periods.

Data sources and methods

Data sources

Data on birth weight were obtained from routine health statistics data (individual birth notification) from all 37 Croatian maternity hospitals, from 1983 to 2003. The birth weight used for analysis was the first weight measured in a newborn within the first hour of life (22). Under the National Statistical Research Program, each maternity ward must submit a completed birth notification form for each child delivery to Croatian National Institute of Public Health. The form contains basic information on the course of pregnancy, childbirth, and its outcome together with anthropometric measures of the newborn. The accuracy and completeness of submitted data depend on the quality of form completion at maternity wards.

Methods

The data provided by the Croatian National Institute of Public Health cover only infants born in Croatia by mothers who are permanent residents in the country. The data provided from the Central Institute of Statistics for the 1983-1997 period, on the other hand, cover infants born in Croatia by the mothers with a possibly long foreign residence, who, nevertheless, stated Croatia as their place of permanent residence. Due to this variance in data collection, the data from the Croatian National Institute of Public Health and the Central Institute of Statistics differed for the given period. Upon adopting the reporting methodology of the Statistical Of-

office of the European Communities for the births in 1998, the Central Institute of Statistics started to publish the official data on liveborn infants from mothers who have actually lived in Croatia for at least 1 year before delivery. According to both the Croatian National Institute of Public Health and Central Institute of Statistics, Croatia recorded a decline in the number of liveborn infants during the 1983-2003 period, with the already mentioned differences in recorded child-birth totals until 1998. Apart from this difference in the number of live born between the observed population (Croatian National Institute of Public Health) and the official national figures (Central Institute of Statistics), the study did not cover the infants born outside health institutions because only a birth notification form for these infants is completed and submitted to the Birth Registry. Since only a small number of children (0.5-1.0%) were born outside health facilities, it could not have a significant impact on the results of the present analysis. Also, the children with permanent residence in Bosnia and Herzegovina born in the war period in Croatian health facilities (refugees) were excluded from the study.

Between 1983 and 2003, 959 591 live births were registered via medical childbirth notification forms. The reason that we did not include the data from 1990 in our analysis was the incompleteness of birth weight distribution figures of liveborn infants for that year. Since Croatian population was exposed to war in 1991-1995 period, the birth weights from the war period were compared with those in prewar (1983-1989) and postwar (1996-2003) period. The available data with the known birth weights comprised 384 367 live births over the 7 years of prewar period (54 910 annually), 226 226 live births over the 5-year war-period (45 245 annually), and 348 998 live births over the 8 years of postwar period (43 625 annually).

The proportion of liveborn infants with unknown birth weight in the 1983-2003 period was 0.97% ($n = 9649$) and did not significantly

change over the prewar, war and postwar period ($P = 0.013$). Birth weight by 500 g groups was analyzed for liveborn infants in the study periods, except for 1991-1992 because of the changes in the data processing method. Thus, data on birth weight of infants weighing >4000 g for these two years were grouped.

We analyzed the trends in birth rates for liveborn infants with low birth weight (<2500 g), high birth weight (4000-4449 g), and very high birth weight (≥ 4500 g) for the entire study period from 1983 to 2003 and separately for the prewar, war, and postwar periods. We also investigated if there was an association between war conditions and proportion of liveborn infants with low birth weight (<2500 g) by comparing the proportions of birth weight subgroups of 500-999 g, 1000-1499 g, 1500-1999 g, and 2000-2499 g in the prewar, war, and postwar periods.

Statistical analysis

Statistical analysis included χ^2 test for categorical data per each birth weight subgroup. For 2 by 2 data, rate ratios and 95% confidence intervals (CI) were calculated. Linear trend was calculated with extended Mantel-Haenszel χ^2 analysis for trends by using specific 500-g birth weight subgroup rates per 100 liveborn infants. STATISTICA 6.0 (StatSoft Inc., Tulsa, OK, USA) was used for all statistical analyses. $P < 0.05$ was considered statistically significant.

Results

Analysis of birth weight by 500 g groups showed a gradual and statistically significant increase in the proportion of liveborn infants in 3500-3999 g ($P < 0.001$ for trend), 4000-4499 g ($P < 0.001$ for trend), and ≥ 4500 g ($P < 0.001$ for trend) birth weight groups throughout the 1983-2003 period (Figure 1). The same trend was evident for the infants with birth weight of 500-999 g ($P = 0.002$ for trend). In other birth weight groups, the observed trend was either not significant ($P = 0.063$

for 1500-1999 g and $P=0.162$ for 2000-2499 g birth weight group) or negative (1000-1499 g, 2500-2999 g and 3000-3499 g, $P<0.001$ for all).

A comparison of the prewar, war, and postwar period showed significant differences in infant birth weight distribution (Table 1). The war period showed marked and significantly higher incidence of liveborn infants with birth weight of 2000-2499 g in comparison with the prewar (rate ratio 1.073; 95% CI, 1.046-1.101) or postwar period (rate ratio, 1.126; 95% CI, 1.110-1.156) ($P<0.001$ for both). The lowest incidence

of the liveborn infants with birth weight >4000 g (7.5%) was recorded in 1989; thereafter it gradually and steadily increased from 9.2% in 1983 to 12.2% in 2003 ($P<0.001$ for trend). Furthermore, there were significantly fewer infants with ≥ 4500 g birth weight born during the war period in comparison with the prewar (rate ratio, 0.612; 95% CI, 0.579-0.647) or postwar period (rate ratio, 0.477; 95% CI, 0.451-0.504) ($P<0.001$). During the war period, the proportion of the 2500-3499 g weight groups decreased in comparison with the prewar period; this trend con-

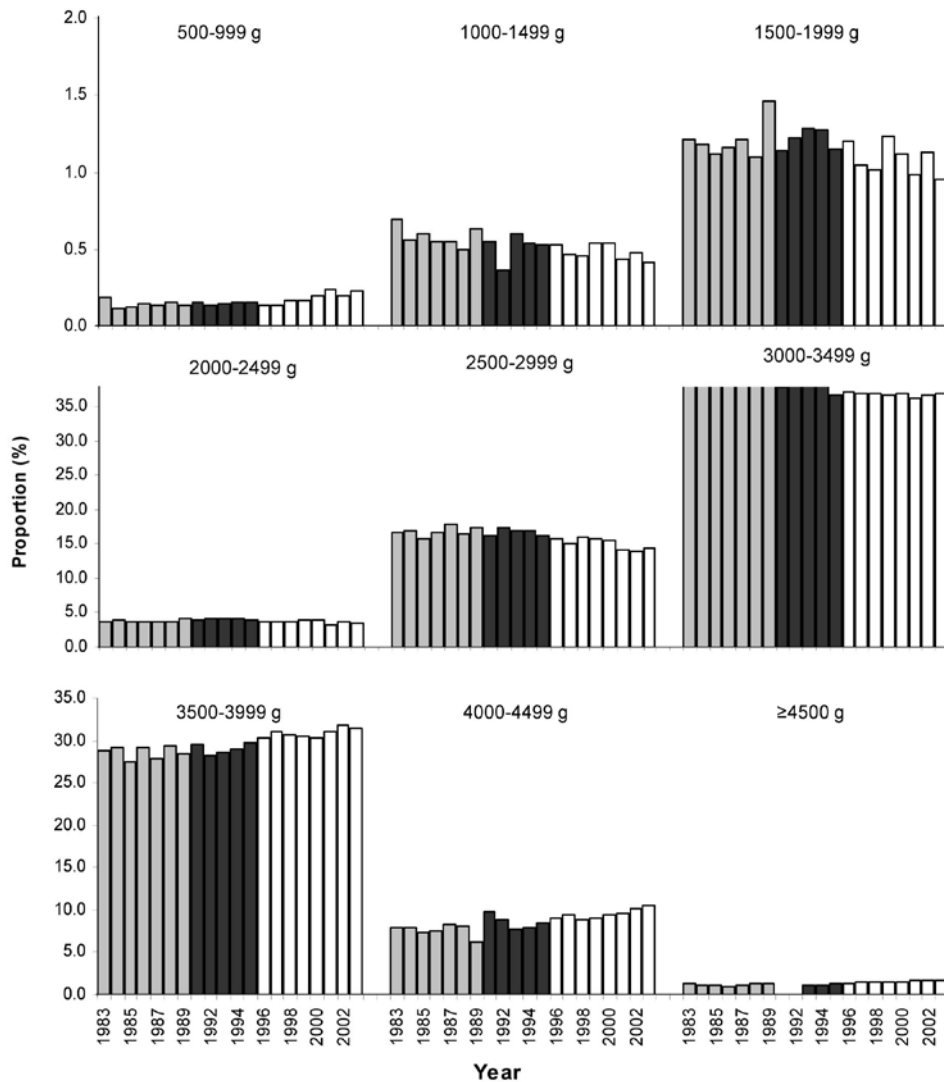


Figure 1. Trends in birth weight per 500 g weight groups during the 1983-1989 prewar (n=384 367; gray bars), 1991-1995 war (n=226 226; closed bars), and 1996-2003 postwar period (n=348 998; open bars) in Croatia.

Table 1. Proportion of 500 g birth weight groups in the prewar (1983-1989), war (1991-1995), and postwar (1996-2003) periods in Croatia and rate ratios in the war period vs pre- and postwar periods*

Birth weight groups (g)	Proportion (%)			Rate ratio (95% confidence interval)			
	prewar (n=384 367)	war (n=226 226)	postwar (n=348 998)	prewar	P	postwar	P
500-999	0.141	0.149	0.179	1.056 (0.922-1.209)	0.423	0.832 (0.729-0.949)	0.006
1000-1499	0.587	0.521	0.485	0.884 (0.824-0.949)	<0.001	1.075 (0.988-1.157)	0.057
1500-1999	1.204	1.213	1.093	1.007 (0.961-1.056)	0.765	1.109 (1.056-1.164)	<0.001
2000-2499	3.817	4.095	3.641	1.073 (1.046-1.101)	<0.001	1.126 (1.097-1.156)	<0.001
2500-2999	16.837	16.709	15.157	0.992 (0.981-1.004)	0.195	1.127 (1.111-1.143)	<0.001
3000-3499	39.013	37.884	36.781	0.971 (0.964-0.977)	<0.001	1.031 (1.024-1.038)	<0.001
3500-3999	28.609	29.074	30.885	1.016 (1.008-1.025)	<0.001	0.942 (0.934-0.949)	<0.001
4000-4499	7.614	8.533	9.427	1.121 (1.101-1.140)	<0.001	0.906 (0.891-0.922)	<0.001
≥4500	1.192	0.729	1.527	0.612 (0.579-0.647)	<0.001	0.477 (0.451-0.504)	<0.001

tinued in the postwar period ($P < 0.001$ for trend for both) (Figure 1).

Over the study period, an absolute decrease by roughly 2% was noted in weight groups 2500-2999 g and 3000-3499 g (Table 1). In contrast, in the >3500 g birth weight groups, and especially >4000 g group, an increase in the proportion was roughly 2%.

A slight but significant declining trend from the 6.5% (highest) in 1989 to 5.0% in 2003 (lowest) was observed in the low birth weight (<2500 g) group ($P = 0.002$ for trend; Figure 1). The comparison of the war-period with the prewar and postwar period for the low birth weight group showed inconsistent changes by weight groups (Table 1).

During the study period, Croatia recorded the highest number of liveborn infants of 58 810 in 1983 and the lowest number of 39 179 in 2003, or 19 531 (33%) fewer liveborn infants than in 1983 (Table 1).

Discussion

We found a positive secular trend in the birth weight of Croatian liveborn infants over the 1983-2003 period, which was particularly evident in the groups of infants with birth weight above 3500 g. There was a gradual increase in the number of newborns weighing >4000 g at birth over the analyzed period, a finding similar to that of Bergmann et al (23) for Berlin, Germany. It is speculated that this increase in the prevalence of infants with high birth weight may contribute to

the secular trend of overweight and obesity under affluent living conditions (23). Increased maternal height probably accounts for the increase in infant birth weight more than any other improvement in the quality of the intrauterine environment (11). In addition, the traditional diet in combination with less common cigarette smoking and alcohol consumption during pregnancy could have a positive effect on the delivery of children with higher birth weight (24). The positive secular trend in the number of infants with high birth weight may be explained not only by the improvement in the medical care of pregnant women and newborns during the study period, but also by generally higher living standard and better socioeconomic conditions.

Secular trends in birth weights of liveborn infants in different societies are contradictory (6-13). A Canadian study that found a significant increase in mean birth weight between 1981 and 1997 also showed a positive trend in the secular changes of fetal growth (6). A Russian study showed that body length and weight at birth increased in Moscow and Saratov, whereas a significant decrease in body length for boys was observed in Khvalynsk (25). However, Rosenberg et al (7) have not confirmed significant secular birth weight changes in Norway during the period 1860-1984. Secular changes in birth weights in Brazil were very slight (8). Studies in Hungarian children have not shown significant secular changes in anthropometric values of the newborns (13).

The recent war in Croatia was associated with increased risk of pregnancy complications among otherwise healthy women and some changes in proportion of low-birth-weight children were noticed. We found significant differences in the birth weight trends between infants born alive during the war period and those born in the pre- and postwar periods. In the war period, the proportion of infants with 2000-2499 g birth weight was significantly greater and that of ≥ 4500 g significantly smaller in comparison with the pre- and postwar periods. During the war period, the ratio of liveborn infants with birth weight >4000 g ranged from 8.8% to 9.9%, which was lower than in the postwar period and not different than in the prewar period. This was even more evident in the group of infants with ≥ 4500 g birth weights, where a clear-cut decrease was evident during the war period; in the postwar period, however, the number of liveborn infants in that weight group almost doubled. Previous study by Kuvačić et al (16) showed a slight increase in preterm delivery rate and a subsequent slight decrease in birth weight from 1990 to 1992 in Croatia. Their results support the possible influence of stress, fear, exile, and inadequate antenatal surveillance on the length of gestation. Improvements in quality of care and access to health care were unlikely during the war period (20). Mothers exposed to a war-induced famine had offspring with birth weights lower than mothers who were not exposed to famine (21).

The proportion of liveborn infants with low birth weight in our study gradually decreased from 1983 to 2003. This finding should be interpreted with caution due to the incompleteness and inaccuracy of statistical data. The medical information on childbirth was often incomplete for this group of newborns, because they were often transferred to neonatal intensive care and treatment units. According to the accessible data from annual aggregate maternity hospital reports submitted to the Croatian National Institute of Public Health since 1996, the proportion of low-

birth-weight children over the 10 past years has been 5.0-5.5% and closely related to the proportion of premature births (2). Within the low-birth-weight group, there was a marked increase in the liveborn infants with extremely low birth weight of 500-999 g, which could be associated with improved antenatal and perinatal care. Depending on the quality of perinatal care, its organization and accessibility, the survival differs from one country to another, moving toward the theoretical limit of 22 weeks and birth weight of 500 g (26).

In 1981-1983 and 1995-1997 periods, Canada's incidence of low-birth-weight newborns was 4.95% and 4.61%, respectively (6). In Sao Paulo, Brasil, the incidence of 8% was stable over 25-year period (8), whereas in the United States the percentage of low-birth-weight children increased from 6.7% in 1984 to 7.8% in 2002 (27). In Sweden, 3.1% of newborns had a birth weight of <2500 g (28).

Since 1991, a depopulation trend has been noticed in Croatia, with the number of deaths exceeding the number of births. In 2004, there were 9449 more deaths than live births (29). Therefore, special attention should be given to the survival and quality of life of every newborn through official prenatal policy and health and socioeconomic measures.

The limitation of our study is insufficient information on the gestational age, sex, parity, and pathological conditions of mothers and children during pregnancy, such as pathology associated with premature childbirths and intrauterine growth retardation with consequential low birth weight and hypertrophy of infants (30).

In conclusion, a positive secular trend in the birth weights of liveborn children between 1983 and 2003 in Croatia was evident. A slight decrease in the number of low-birth-weight newborns and a significant increase in the number of extremely low-birth-weight liveborn infants were recorded during the same period. During the war, there was an increasing trend in live births in

the 2000-2499 g birth weight group and a declining trend in the ≥ 4500 g group, when compared with the pre- and postwar data, which was probably a result of the stress and worsening of socio-economic conditions. Future research in Croatia should relate national standard values for the birth weights to different variables like gestational age, parity, and sex of the live born (31) and aim at discerning the influence of existing transitional changes from the influence of ethnically predetermined parental characteristics on the changes in the birth weights of liveborn children.

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