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Seasonality of Births in Croatia

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A B S T R A C T

The aim of this paper was to investigate seasonal fluctuations of the number of births in Croatia. Vital registration data from the years 1970–2002 was used for analysis of the quarterly data (from the years 1970–1997), and monthly data (from the years 1998–2002). Both data sets were smoothed, using seasonal variation removal for quarterly data, and T4253H smoothing for monthly data. Edwards test and Ratchet circular scan tests were used in analysis. The results showed an increase in the summer birth proportion and decrease in the spring birth proportion, distorted during the wartime period (1991–1995). Monthly analysis reveals highest birth proportion in Croatia during July–September period, with peak date moving towards the end of summer, and reaching stability in the beginning of September during the years 2000–2002. This presumes highest conception rate during the beginning of the Christmas holiday season. Secondary peak in January was found in some years, which presumably sets second period of increased conception rate into the Easter holiday season, supporting the observation of the holiday-related birth peaks. Both quarterly and monthly data indicate a birth pattern that does not resemble either »European« or »American« seasonal pattern. Regional analysis showed lack of seasonality in the capital city of Zagreb and either intermittent or stable seasonality pattern in the rest of the country.

Keywords*: seasonality, seasonal pattern, birth, proportion, conception rate, war, Croatia*

Introduction

One of the aspects exhibiting seasonal pattern in humans is birth seasonality. Although it was described virtually in all populations, there is no general pattern of seasonality[1]. In an attempt to understand seasonal patterns in different societies, researchers have described numerous potential factors, such as level of urbanization, photoperiod, seasonality of marriages or relatedness to holidays[1–7]. Two general birth patterns were identified; the »European« pattern, with an excess of births during spring and summer, and a secondary peak in September; and the »American« pattern, with a trough in April–May, and a peak in September[8]. However, not all studies identified presence of the seasonal pattern of births. Lack of seasonality was described for Tierra del Fuego, the extreme Chilean South, mainly colonized by the Chilean, British and Croatian immigrants[9]. It has been described in some historic agricultural societies in the less extreme environments[10,11]. Additionally, seasonal birth pattern sometimes shows variation in time, as seen in the case of the Inuit population from the Canadian arctic. They exhibited birth seasonality during 1970's, followed by the obvious lack of seasonality in the 1980's[12].

In this paper seasonal pattern of births in Croatia is investigated, with special attention to the long-term trend and contemporary seasonal pattern after the war in Croatia (1991–1995).

Material and Methods

Materials

Vital registration data on number of births published by the Central Bureau of Statistics in the Republic of Croatia was used in this study. Quarterly data for the number of births was available from the years 1970–1997[13], while monthly data was available from the years 1998–2002[14]. Two demographic parameters were correlated to the seasonal pattern, percent of Christians and urbanization level[16]. Also, the number of marriages from the years 1998–2002 was obtained and compared to the seasonal birth pattern[17].

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For purposes of establishing monthly birth pattern and analyzing regional differences in Croatia, the records from the years 1998–2002 were utilized. The Republic of Croatia was divided into five regions, in an attempt to unify similar geo-climatic and cultural determinants. Zagreb was chosen as the control, comprising highly mixed urban population. Data on the regions involved, number of births during the years 1998–2002, percent of Christians and percent of urban population is given in Table 1.

Sample size

Obtaining statistical significance for seasonal data at $p<0.05$ level requires at least 1500 subjects in quarterly distribution, or at least 4500 subjects for monthly data distribution[18]. These conditions were met in quarterly and monthly analyses, as well as regional monthly analysis.

Statistical analysis

Success of statistical analysis of seasonal variation depends on how well the theoretical assumptions correspond to empirical data, and statistical method applied should be chosen with due consideration[19]. Having this in mind, for purposes of the present study analyses were divided in two parts; first dealing with quarterly data from the years 1970–2002, and second dealing with monthly data from the years 1998–2002. For quarterly data both absolute numbers and quarterly proportions during one year were calculated and plotted, aiming to examine a long-term trend. A commonly used moving average[7] is not recommended for measuring trend, so a method of seasonal variation removal was applied, given as[20]:

$$Sm_{(qt)} = \frac{\left(\frac{1}{2}\right)x_{t-2} + x_{t-1} + x + x_{t+1} + \left(\frac{1}{2}\right)x_{t+2}}{4}$$

Although the results of this transformation are similar to the moving average, this method does not include time lag, which appears in moving averages analysis, and is better for measuring the trend. After plotting both raw and transformed data on a single diagram, special attention was assigned to showing long-term trend for each of the four quarters, approximately corresponding to winter, spring, summer and autumn. Following, a quadratic regression model was fitted to the data to determine time trend in the birth proportion for each quarter.

In monthly data analysis, due to small number of consecutive years involved, time series analysis methods were not utilized. Instead, T4253H smoothing of absolute number of births was used, to remove noise and obtain appropriate pattern for further analysis. Edwards's seasonal test and Ratchet circular scan test were used to determine presence of seasonality and 2-month and 3-month seasonal peaks, respectively. Spearman rank test was used for correlation of seasonal pattern with demographic descriptors. For both tests probability of nil-hypothesis was set at 0.05. Transformations and analysis of quarterly data was performed with SPSS version 10.0.1 (SPSS Inc., Chicago, IL), while Edwards test and Ratchet test were performed using PEPI 4.04x[21].

Results

A total of 1.923,803 live births were recorded in Croatia during the years 1970–2002. Analyses in the present study were split in two parts, first based on the quarterly data for the years 1970–2002, and second based on the monthly data for the years 1998–2002.

Quarterly data

Analysis of the quarterly data aimed at examining long-term trend, without establishing seasonal pattern.

TABLE 1
NUMBER OF BIRTHS, PERCENTAGE OF CHRISTIANS AND URBAN POPULATION PERCENTAGE RECORDED IN THE FIVE REGIONS FROM CROATIA INVESTIGATED IN THE MONTHLY SEASONAL PATTERN ANALYSIS

Region	Counties involved	No. of births*	Christians (%)**	Urban population (%)***
1	Zagreb	37,921	89.20	94.54
2	Zagrebacka, Krapinsko-zagorska, Varazdinska, Medjimurska, Korpivnicko-krizevacka, Bjelovarsko-bilogorska and Sisacko-moslavacka county	58,716	95.22	32.00
3	Osjecko-baranjska, Vukovarsko-srijemska, Brodsko-posavska county, Viroviticko-podravska and Pozesko-slavonska county	46,408	94.64	44.07
4	Primorsko-goranska, Istarska, Karlovacka, and Licko-senjska county	28,050	86.78	58.41
5	Splitsko-dalmatinska, Dubrovacko-neretvanska, Zadarska and Sibensko-kninska county	45,985	93.62	63.29
Total		217,080	92.39	48.89

* During the years 1998–2002, ** Data from 2001 Census[15], *** unpublished data from Central Bureau of Statistics[16]

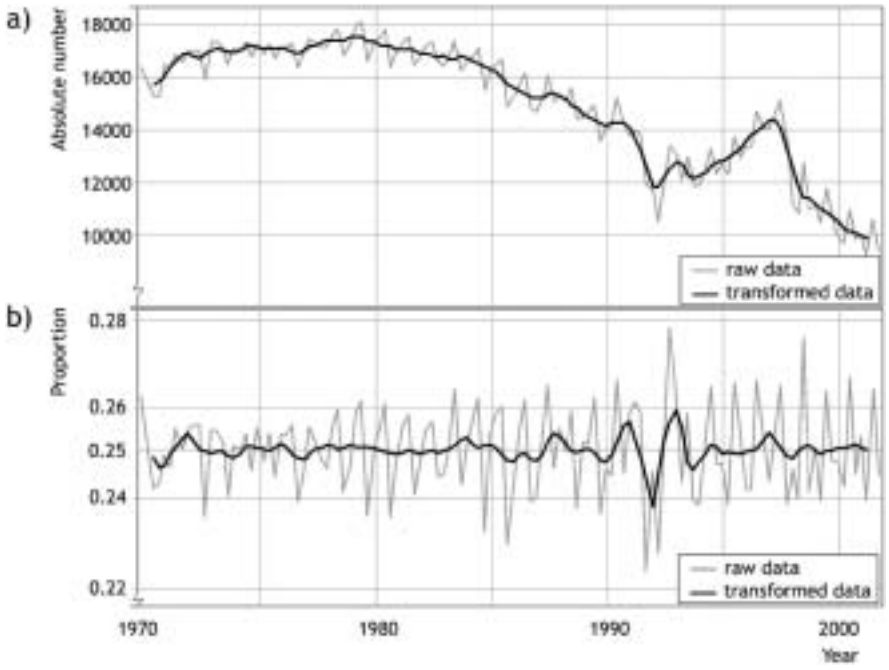

Fig. 1. Quarterly data on birth pattern in Croatia: 1a) absolute number of births, 1b) quarterly proportions.

Both absolute number of births and result of the seasonal variation removal indicate a slight decrease in the number of births during the years 1970–1990. The war years (1991–1995) exhibit a large decrease in the absolute number of births, which is followed by the post-war increase. Since the year 1997, a substantial decrease in the number of births is observed (Figure 1a). When the data was arranged in the consecutive series of quarterly proportion of births per each studied year, results yield relatively constant birth pattern in both pre-war and post-war period, with substantial variations during the wartime (Figure 1b).

When the quarterly proportion of births in each year (1970–2002) was transformed and regressed with quadratic curve, long term trend in the form of gradual increase of the birth proportion in the 3rd quarter was observed (from 25.37% to 26.65%, or 1.28% increase). Parallel to this, a decrease of the birth proportion in the 2nd quarter (from 25.16% to 24.12%, or 1.04% decrease) was observed (Figure 2). Proportions of the remaining two quarters remained similar during the studied period.

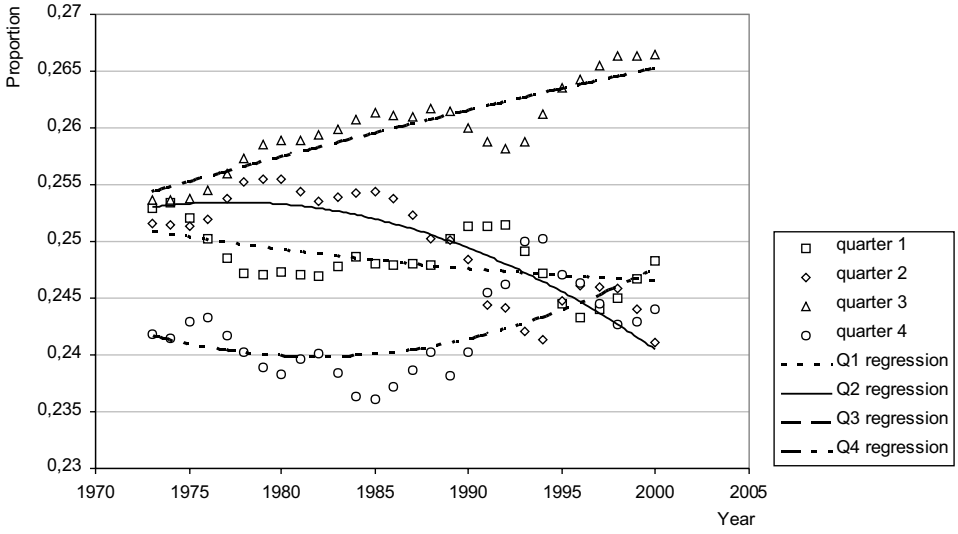

Fig. 2. Seasonal variation of the transformed birth proportion in Croatia for the years 1970–2002, with quadratic regression curves.

Monthly data

Monthly data for the years 1998–2002 showed high level of variation with overall trend indicating a decrease in the absolute number of births during the studied period. Smoothed data showed peaks that approximately fall into summer period of each studied year (Figure 3a). When marriages seasonal pattern is examined, results yield a bi-modal pattern, which does not resemble seasonal birth pattern (Figure 3a and b).

Results of transformed birth data analysis for entire Croatia for each examined year (1998–2002) yield presence of seasonal birth pattern for all studied years, with peak birth date on August 23rd and 3-month birth peak during July–September period. Changing seasonal pattern was confirmed with occurrence of a day-peak, 2-month and 3-month peaks moving towards the end of summer (Table 2).

Regional analysis revealed interesting results, with region 1 (Zagreb) not exhibiting seasonal birth pattern in either pooled or yearly data. Two regions exhibited overall seasonal pattern, with yearly variations; in region 2 (Central Croatia) seasonal pattern was present during the years 1998, 1999 and 2001; in region 4 (Northern Dalmatia) seasonal pattern was present during the years 1998 and 1999. Finally, two regions (Southern Dalmatia and Eastern Croatia) exhibited stable seasonal birth pattern (Table 2). Analysis of peak birth date revealed high variation in cases where seasonality was not confirmed, and relatively stable summer pattern of birth peak where seasonality was confirmed (Table 2). Overall pattern of regional seasonality exhibits lack or intermittent occurrence of seasonality in Northern parts of Croatia, and presence of the seasonality pattern in eastern and southern part of the country (Figure 4).

Fig. 4. Monthly birth pattern in the five regions in Croatia, during the years 1998–2002. Gray color – statistically significant findings, white – insignificant.

Secondary birth peak was recorded for entire Croatia for the years 1998 (March–May) and 2000 (January), region 2 for the year 2001 (January), region 3 for the year 1998 (April–May) and region 5 for the year 2001 (January).

Seasonal pattern was correlated to the demographic data; both Christian percent (Spearman r=0.369, p= 0.541) and urbanization level (Spearman r=–0.316, p= 0.604) did not correlate significantly to the seasonal pattern within the five studied regions.

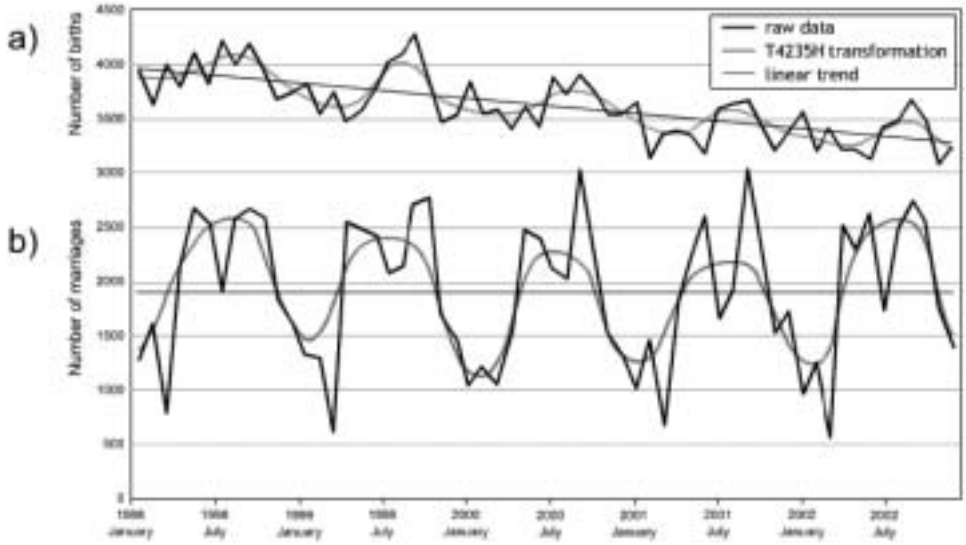

Fig. 3. Monthly number of births and marriages during the years 1998–2002 in Croatia; 3a) number of births, 3b) number of marriages.

TABLE 2
SEASONAL BIRTH PATTERN IN THE FIVE REGIONS AND ENTIRE CROATIA DURING THE YEARS 1998–2002

Region	Parameter	1998	1999	2000	2001	2002	Total
Croatia	Edwards test p level	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
	Peak date	July 22nd	August 25th	September 2nd	September 1st	September 8th	August 23rd
	2-month peak	Jul-Aug	Aug-Sep	Aug–Sep	Aug–Sep	Aug–Sep	Aug–Sep
	3-month peak	Jul-Sep	Jul–Sep	Jul–Sep	Jul–Sep	Aug–Oct	Jul–Sep
1	Edwards test p level	0.145	0.058	0.911	0.517	0.548	0.148
	Peak date	June 9th	September 13th	August 23rd	June 28th	April 18th	July 12th
2	Edwards test p level	0.004*	<0.001*	0.415	0.049*	0.418	<0.001*
	Peak date	June 24th	August 10th	September 12th	August 7th	August 8th	August 1st
3	Edwards test p level	0.131*	<0.001*	<0.001*	<0.001*	0.046*	<0.001*
	Peak date	July 18th	August 24th	August 23rd	August 22nd	September 23rd	August 23rd
4	Edwards test p level	0.035*	0.019*	0.647	0.885	0.144	0.014*
	Peak date	July 18th	September 10th	June 14th	January 11th	September 19th	August 20th
5	Edwards test p level	0.045*	0.020*	<0.001*	0.004*	0.025*	<0.001*
	Peak date	August 16th	September 11th	September 22nd	October 24th	September 20th	September 20th

* Statistically significant

Discussion

In contrast to some papers exhibiting stable trend of seasonality with little or no change, this study indicates a changing seasonal pattern of births in Croatia. As the analysis of the long-term trend was based on the quarterly data, only simple descriptive methods were used, as pooling the data into quarters or longer time periods may mask individual months with exceptional birth rates[19].

Long-term quarterly data analysis reveals relatively constant birth pattern for both pre-war and post-war time, and substantial disturbance during the wartime (Figure 1). Hypothetical reasons underlying wartime changes are numerous, and are difficult to explain with certainty. First possible reason is the real change in the seasonality pattern, produced by the socio-economic change induced by the war. Secondly, changing birth seasonality could have hypothetically been induced by a substantial number of refugees, fleeing from the war regions into safer parts of the country and changing regional seasonal pattern. Thirdly, there might have been a short but abrupt change in the coital frequency, inducing changed conception rate, which resulted in the disturbed seasonal birth pattern. Finally, these changes might have been induced by an interruption and hypothetical lower quality of the civil service registry data collecting during the wartime. Multitude of the possible factors underlying this change and the fact that parts of Croatia were occupied during the war and the vital statistics data was irretrievable requires treating of the results for the seasonal birth pattern during the wartime uncertain.

When quarterly proportions were examined and compared to each other for all studied years, results yielded a steady increase in the 3rd quarter and comparable decrease in the 2nd quarter. Interestingly, this change begins before the wartime, as the 3rd quarter proportion increase can be observed in the 1970s, and 2nd quarter decrease can be observed in the 1980s (Figure 2).

The second part of the present analysis was based on the monthly data. Both five-year pooled and most of the yearly data on monthly birth pattern in Croatia indicate the presence of July–September peak with trough during the spring. This seasonal pattern does not resemble either the »American« or the »European« pattern[8,22] completely, and can be considered as an »intermediate« one, having the characteristics of both »European« and »American«. However, seasonal pattern in Croatia is not constant, and the present paper indicates a changing nature of it. If the 3rd quarter birth proportion increase and 2nd quarter decrease (Figure 2) are combined with observed peak date and both 2-month and 3-month peaks shifting towards the end of summer (Table 2), it seems that seasonal birth pattern in Croatia changes in the fashion of summer birth peak with decrease in the spring birth proportions. Such change might indicate shifting towards »American« seasonal pattern with September peak. Similar findings of changing seasonal pattern from the »European« to »American« have been reported for the several European countries[1,22,23].

Seasonal pattern from the years 2000–2002, with primary September peak, presumes highest conception rate 9 months earlier, which falls into the beginning of the Christmas holiday season. Phenomenon of holiday related birth peaks was described before, mainly for the most important holidays, such as Christmas and Thanksgiving[22,23]. Having this in mind, it seems as a reasonable explanation to secondary January peaks, which would presume increased conception rate during the Easter

holiday season, and further support the hypothesis of the holiday-related birth peaks.

Besides birth, marriages sometimes exhibit seasonal pattern, mainly determined by religious practice[24], which also influences birth pattern[25]. While overall birth seasonality pattern exhibits one major peak during July-September period, seasonality of marriages exhibits bimodal pattern, with one peak during April-June and second one during August-October (Figure 3). This pattern can be related to the seasonal weather pattern, with highly desirable periods for weddings during meteorologically suitable period for the wedding ceremony (spring and autumn). Having in mind apparent differences in the birth and marriages seasonal pattern, hypothesis that marriages seasonality defines birth seasonality[6] couldn't be confirmed for Croatia.

Results of the regional analyses raise more doubt. While complete lack of seasonality in the region 1 is easily explained with highly heterogeneous and mixed urban population, intermittent pattern are more difficult to explain. With the religious practice and urbanization level having no direct correlation to seasonal pattern in the five examined regions such as in some previously published papers[26–34], it remains for the future analyses to attempt to describe the most proximate factors influencing birth seasonality pattern in Croatia.

A central issue in assessing long-term seasonal pattern in Croatia is occurrence of three war periods in the 20th century (1914–1918, 1941–1945, and 1991–1995). During these periods, demographic changes during the fiercest wartime periods could easily be expected. The most recent war period in Croatia, marked with change in numerous aspects of human biology[35–39], determined that the post-war period was used as the starting point of the present analysis. Consequently, statistical analysis couldn't have been replaced by the more complex time series analysis, which require longer time span for obtaining reliable results. Changing trend in the birth seasonality during post-war transition in Croatia will have to be re-evaluated in the following years, relying primarily on longer time span and more sophisticated statistical methods.

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SEZONALNOST PORODA U HRVATSKOJ

S A Ž E T A K

Cilj ovog rada bio je istražiti sezonalne varijacije broja poroda u Hrvatskoj. Korišteni su podaci vitalne statistike iz perioda 1970–2002, i to podaci o broju poroda po tromjesečjima (1970–1997), te podaci o mjesečnom broju poroda (1998–2002). Oba seta podataka su zaravnjivana, korištenjem metode uklanjanja sezonalne varijacije za podatke o tromjesečjima, te T4253H metode za mjesečne podatke. U analizi su korišteni Edwardsov i Ratchet test. Rezultati ukazuju na porast proporcije poroda u ljetu i pad proporcije poroda u jesen, koji se potpuno poremete u vrijeme rata (1991–1995). Analiza mjesečnih podataka ukazuje na najveći broj poroda u Hrvatskoj tijekom perioda srpanj- rujan, s najvećim brojem poroda na kraju ljeta, i dostiže stabilnost na početku rujna za godine 2000–2002. Ovaj datum pretpostavlja najveći broj začeća tijekom početka blagdana u periodu Božića. Sekundarni vrhunac broja poroda pojavljuje se tijekom siječnja u nekoliko godina, i ukazuje na povećani broj začeća tijekom uskršnjih blagdana, te govori u prilog poroda vezanih uz blagdane. I podaci tromjesečnih i mjesečnih analiza ukazuju da trenutni uzorak sezonalnosti poroda u Hrvatskoj ne odgovara ni europskom ni američkom uzorku. Regionalna analiza pokazala je nepostojanje sezonalnog uzorka u glavnom gradu Zagrebu, i pojavu izmjenične ili stalne sezonalnosti poroda u ostatku zemlje.