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## Where Are the Polish Sunday Babies? Declining Weekend Births in the Years 1967-2017

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Submitted 26/10/21, 1st revision 10/11/21, 2nd revision 30/11/21, accepted 20/12/21

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**Abstract:**

**Purpose:** The main objective of the paper was to analyze the weekly seasonality of childbirths in 1967-2017 nationwide, divided by voivodeships and types of gminas (local communities). The relationship between the intensity of births on Sundays and the proportion of childbirths performed by caesarean section was also investigated

**Design/Methodology/Approach:** The analysis covered 26,060,540 records containing the dates of births in Poland from the PESEL database for 1967-2017. The seasonality of births was presented by means of heat maps, while the Pearson correlation coefficient was used in the analysis of relationships.

**Findings:** Research confirms the increasing proportion of deliveries carried out by the cesarean section in the majority of countries worldwide. However, Poland is one of the countries where the prevalence of cesarean sections is the highest in the world. According to WHO, the percentage of cesarean sections should be about 10-15 % of all births, while in 2017 in Poland it amounted to 45%. The empirical study confirmed a marked decline in births on Saturdays and Sundays in Poland.

**Practical Implications:** The described trends may adversely affect demographic processes, e.g., they may exacerbate the low fertility rate in Poland.

**Originality/value:** The study fills the gap in the international research on the phenomenon by adding results from Poland.

**Keywords:** Demographic changes, weekly seasonality of births, PESEL database, caesarean section, Poland.

**JEL classification:** J11, H51.

**Paper Type:** Research study.

**Acknowledgement:** The project is co-financed within the framework of the program of the Minister of Science and Higher Education under the name „Regional Excellence Initiative” in the years 2019 – 2022; project number 001/RID/2018/19; the amount of financing PLN 10,684,000.00

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## **1. Introduction**

In the case of healthy women giving birth through normal delivery, childbirths are evenly distributed and therefore weekly seasonality does not occur (Mancuso *et al.*, 2004). However, for several decades, a marked decline in births on Saturdays and Sundays can be seen in many countries around the world, for example in the UK (Macfarlane, 1978), Germany (Lerchl, 2007), France (Régnier-Loilier, 2010), Switzerland (Lerchl and Reinhard, 2007), Australia (Mathers, 1983), and Japan (Morikawa *et al.*, 2016). The reason for this is the increasing popularity of cesarean sections and labor inductions, which, due to the nature of hospital operations, are not scheduled on weekends (MacFarlane, 1978).

In Poland, the excessive medicalization of childbirth is a particularly serious problem. Nearly half of births here occur by cesarean section (43% in 2015). While WHO recommends the births by cesarean section to range between 10-15 %. Simultaneously with the decrease in births, there is an increase in infant mortality on weekends. However, there are other studies that do not confirm the concurrence of these trends.

As for the non-medical reasons for the seasonality of births, one of them is the higher costs of doctors' work on weekends and public holidays. In Germany, doctors' rates on Sundays are on average 25% higher than their rates on weekdays. Another, economic aspect of this situation is the reduced demand for midwives' services on weekends, as their assistance is needed far less in cesarean sections.

Cesarean section births are not without consequences for the health of mother and child. They result in a reduced number of vaginal births in subsequent deliveries, increase the risk of infection, and may weaken the relationship between the mother and her child. They also amplify the odds of allergies, asthma and many other diseases in children. It is believed that the above trends and a decline in weekend births may affect demographic processes, for example, reduce fertility in the population.

This paper is a continuation of research into the seasonality of births in Poland. The main purpose of the paper is to analyze the weekly seasonality of births in Poland over five decades between 1967 and 2017. Also, the authors examined the variation in the intensity of births by voivodships and types of gminas (local community, municipality) and they measured the correlation between births by cesarean section with the intensity of Sunday births.

## **2. Data and Methods**

The study was performed using data on 26,060,540 records containing the dates of births in Poland from the PESEL database for 1967-2017. The PESEL (General Electronic System for Registration of the Population) database contains detailed

personal information about Polish citizens and foreign residents in Poland who have been assigned a PESEL number which serves as the main national identification number. The system has been in operation since 1979 and is currently maintained by the Ministry of Digitalization (previously by the Ministry of Internal Affairs and Administration). The system is the only digital source of individual data covering the previous century, i.e. data from about 1900 to the present.

The study examined the general data, broken down by gmina type, voivodship and gender. The classification of gminas proposed by Śleszyński and Komornicki (Śleszyński and Komornicki, 2016) was used and gminas were divided into the following types: A - Functional Urban Areas (FUA) of voivodship capital cities, B – their external zones, C – Functional Urban Areas of sub-regional centers, D - their external zones, E - multifunctional urban centers, F - gminas with developed transport functions, G - gminas with other developed non-agricultural functions (tourism and large-scale functions, including mining), H - gminas with intensively developed agricultural functions, I - gminas with moderately developed agricultural functions, J - extensively developed gminas (with forests and nature protection areas). The analysis by voivodships covered all the 16 Polish voivodships.

Statistical data on cesarean sections were obtained from the National Consultant in Obstetrics and Gynecology, Professor Krzysztof Czajkowski. They present the general situation in Poland from 2002 to 2017 and by voivodships.

In order to identify daily regularities, birth dates from the PESEL database were transformed into time series of daily number of births and detrended by dividing them by the daily average in a given month. Daily deviations from yearly average obtained this way for each day of the week were presented graphically in the form of heat maps. A three-color scheme was used in the process of creation of the maps. Selected regularities were also presented by means of line graphs made in Excel.

The correlation between birth rates and the number of cesarean sections was evaluated using a simple measure of correlation, i.e., Pearson's  $r$ . Statistical significance was expressed with a  $p$ -value (Weinbach and Grinnell, 2007).

### **3. Research Results**

Between 1968 and 2017 Poland saw a decrease in weekend childbirths, particularly in the Sunday ones (Figure 1). The number of births declined also on public holidays. Simultaneously, there was an increase in births on weekdays, most noticeably on Tuesdays, Wednesdays and Thursdays.

The decline in births on Sundays began in 1972, when births first stood at a yearly average of 0.98, while the decline in Saturday births became apparent a few years later, in 1976 (0.99). Although initially the deviations from the average were minor, they steadily grew over the period under study.

**Figure 1.** Heat map of deviations from the yearly mean of births by days of week in Poland 1968-2017

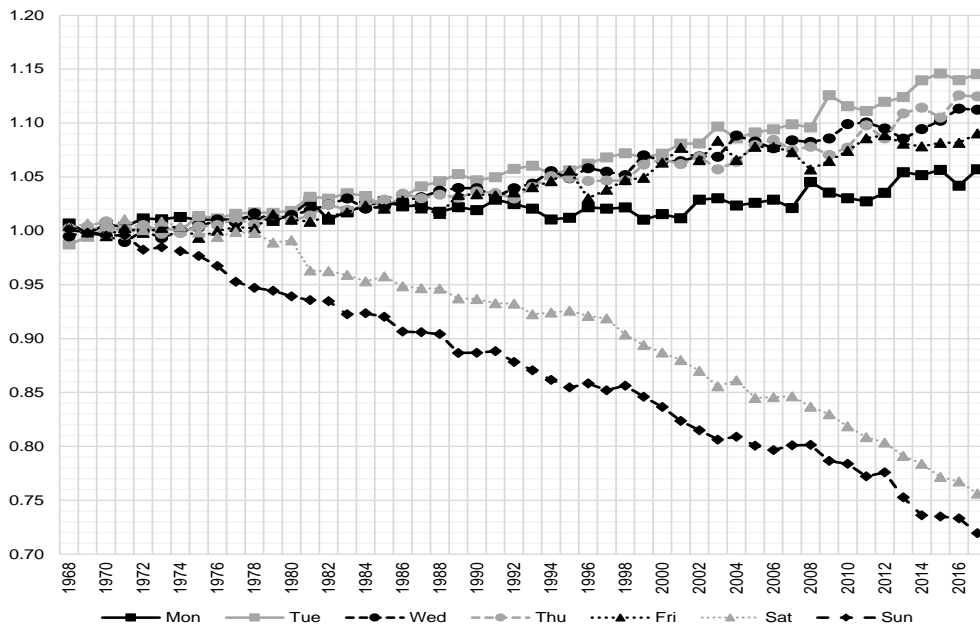
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
1968	1.01	0.99	0.99	1.00	1.00	1.00	1.00
1969	1.00	0.99	1.00	1.00	1.00	1.01	1.00
1970	1.01	1.00	1.00	1.01	1.00	1.00	1.00
1971	1.00	1.00	0.99	1.00	1.00	1.01	1.00
1972	1.01	1.00	1.00	1.01	1.00	1.00	0.98
1973	1.01	1.00	0.99	1.00	1.00	1.01	0.98
1974	1.01	1.00	1.00	1.00	1.00	1.00	0.98
1975	1.01	1.01	1.00	1.00	0.99	1.00	0.98
1976	1.01	1.01	1.01	1.01	1.00	0.99	0.97
1977	1.01	1.02	1.01	1.01	1.00	1.00	0.95
1978	1.01	1.02	1.02	1.01	1.00	1.00	0.95
1979	1.01	1.02	1.01	1.02	1.02	0.99	0.94
1980	1.02	1.02	1.01	1.01	1.01	0.99	0.94
1981	1.03	1.03	1.02	1.01	1.01	0.96	0.94
1982	1.01	1.03	1.02	1.02	1.01	0.96	0.93
1983	1.02	1.03	1.03	1.02	1.02	0.96	0.92
1984	1.02	1.03	1.02	1.02	1.02	0.95	0.92
1985	1.03	1.02	1.02	1.03	1.02	0.96	0.92
1986	1.02	1.03	1.03	1.03	1.03	0.95	0.91
1987	1.02	1.04	1.03	1.03	1.02	0.95	0.91
1988	1.02	1.05	1.04	1.03	1.02	0.95	0.90
1989	1.02	1.05	1.04	1.03	1.03	0.94	0.89
1990	1.02	1.05	1.04	1.04	1.03	0.94	0.89
1991	1.03	1.05	1.03	1.03	1.03	0.93	0.89
1992	1.02	1.06	1.04	1.03	1.04	0.93	0.88
1993	1.02	1.06	1.04	1.04	1.04	0.92	0.87
1994	1.01	1.05	1.06	1.05	1.05	0.92	0.86
1995	1.01	1.06	1.05	1.05	1.06	0.93	0.85
1996	1.02	1.06	1.06	1.05	1.03	0.92	0.86
1997	1.02	1.07	1.05	1.05	1.04	0.92	0.85
1998	1.02	1.07	1.05	1.05	1.05	0.90	0.86
1999	1.01	1.07	1.07	1.06	1.05	0.89	0.85
2000	1.02	1.07	1.06	1.07	1.06	0.89	0.84
2001	1.01	1.08	1.06	1.06	1.08	0.88	0.82
2002	1.03	1.08	1.07	1.07	1.07	0.87	0.81
2003	1.03	1.10	1.07	1.06	1.08	0.86	0.81
2004	1.02	1.09	1.09	1.06	1.07	0.86	0.81
2005	1.03	1.09	1.08	1.08	1.08	0.84	0.80
2006	1.03	1.09	1.08	1.08	1.08	0.85	0.80
2007	1.02	1.10	1.08	1.08	1.07	0.85	0.80
2008	1.05	1.10	1.08	1.08	1.06	0.84	0.80
2009	1.04	1.13	1.09	1.07	1.06	0.83	0.79
2010	1.03	1.12	1.10	1.08	1.07	0.82	0.78
2011	1.03	1.11	1.10	1.10	1.09	0.81	0.77
2012	1.04	1.12	1.09	1.09	1.09	0.80	0.78
2013	1.05	1.12	1.09	1.11	1.08	0.79	0.75
2014	1.05	1.14	1.09	1.11	1.08	0.78	0.74
2015	1.06	1.15	1.10	1.11	1.08	0.77	0.73
2016	1.04	1.14	1.11	1.13	1.08	0.77	0.73
2017	1.06	1.15	1.11	1.12	1.09	0.76	0.72

**Source:** Own calculation on the basis of PESEL database.

In 2017, births on Sundays and Saturdays fell to 0.72 and 0.76 of the yearly average, respectively. The decline in births on public holidays was first seen in 1971 and, similarly to weekend births, the numbers kept falling until the end of the observation period (2017). Since the onset of the downward trend in weekend births, the rate of decline averaged 0.01 percentage point from year to year. The rise in weekday births began slightly later than the weekend declines and intensified to a lesser degree over the study timeframe. The rise in births on Mondays began in 1972 (1.01 of the average). The intensity of the variable remained stable for the following decades to reach 1.06 in 2017. As regards Monday births, their number grew at the slowest rate compared to other weekdays. The largest increases were seen on Tuesdays, Wednesdays, and Thursdays.

The number of Tuesday births began rising in 1975 (1.01), to be followed by the growth in the Wednesday and Thursday births from 1976 on (1.01). The trend continued until 2017 when there were births on Tuesdays exceeded the yearly average by 15% (1.15), on Wednesdays by 11% (1.11), and by 12 percent on Thursdays (1.12). The rate of increase in Monday, Tuesday, and Wednesday births was similar. Since its inception, the variable kept rising by an average of 0.003 percentage points annually. The increase in births on Fridays was slower than that on Tuesdays, Wednesdays and Thursdays, but faster than on Mondays. The onset of the Friday growth dates back to 1979 (1.02), while in 2017 the ratio of Fridays births to the average reached 1.09.

**Figure 2.** Deviations from yearly average of births by days of week in Poland 1968-2017



Source: Own calculation on the basis of PESEL database.

A summary of the birth intensity deviations from the average is shown in Figure 2. At the beginning of the study period, i.e., 1968-72, the weekly seasonality of births did not appear. The distribution of births by days of the week was stable. A progressive increase in births on weekdays (Tuesdays, Wednesdays, and Thursdays) and their falling number at weekends resulted in strong weekly seasonality at the end of the period under study.

**Figure 3.** Heat map of deviations of Sunday birth rates from the annual average by gmina types in Poland 1968-2017

	H	I	J	G	D	B	E	F	C	A
1968	1.04	1.03	1.03	1.01	0.99	1.01	0.99	1.05	1.00	0.98
1969	1.01	1.02	1.02	1.00	1.01	1.03	1.00	0.98	1.00	0.98
1970	1.03	1.03	1.05	1.02	1.03	0.99	0.99	1.04	0.99	0.96
1971	1.01	1.05	1.00	1.00	1.02	0.99	1.00	1.00	1.00	0.96
1972	1.02	1.00	1.02	1.00	0.99	0.98	0.99	1.02	0.97	0.96
1973	1.01	1.01	1.01	1.03	1.00	0.99	1.00	0.98	0.98	0.96
1974	1.00	1.02	0.99	1.02	1.03	0.99	0.99	0.99	0.97	0.95
1975	1.00	1.00	1.00	0.99	1.01	0.99	1.00	0.99	0.97	0.94
1976	1.01	1.03	1.01	0.99	1.01	0.96	0.98	0.96	0.97	0.93
1977	1.01	0.99	1.02	0.96	1.00	0.97	0.97	0.92	0.94	0.91
1978	0.95	1.00	1.02	0.95	1.01	0.95	0.96	0.97	0.93	0.92
1979	0.96	0.99	0.98	0.95	0.96	0.95	0.95	0.93	0.94	0.92
1980	0.93	0.98	0.93	0.94	0.98	0.96	0.95	0.97	0.94	0.91
1981	0.97	0.97	0.96	0.95	0.94	0.96	0.95	0.93	0.92	0.91
1982	0.95	0.95	0.95	0.93	0.98	0.96	0.95	0.93	0.93	0.91
1983	0.97	0.97	0.97	0.92	0.97	0.95	0.94	0.93	0.90	0.89
1984	0.96	0.94	0.95	0.94	0.96	0.94	0.94	0.96	0.90	0.90
1985	0.96	0.96	0.98	0.93	0.94	0.93	0.93	0.93	0.91	0.90
1986	0.93	0.92	0.94	0.91	0.94	0.92	0.93	0.91	0.90	0.88
1987	0.91	0.93	0.93	0.91	0.97	0.93	0.92	0.92	0.88	0.89
1988	0.95	0.94	0.91	0.94	0.93	0.92	0.91	0.90	0.89	0.88
1989	0.89	0.92	0.94	0.93	0.93	0.88	0.91	0.85	0.87	0.86
1990	0.92	0.90	0.90	0.91	0.93	0.91	0.89	0.89	0.87	0.87
1991	0.91	0.92	0.92	0.92	0.93	0.90	0.90	0.87	0.87	0.86
1992	0.92	0.92	0.85	0.90	0.89	0.89	0.90	0.84	0.87	0.85
1993	0.90	0.90	0.90	0.91	0.85	0.90	0.89	0.86	0.85	0.85
1994	0.91	0.87	0.90	0.90	0.83	0.89	0.87	0.85	0.85	0.84
1995	0.89	0.87	0.89	0.89	0.81	0.90	0.86	0.79	0.85	0.85
1996	0.88	0.89	0.91	0.88	0.81	0.87	0.88	0.84	0.84	0.84
1997	0.86	0.85	0.87	0.88	0.79	0.86	0.87	0.84	0.84	0.83
1998	0.90	0.86	0.90	0.90	0.83	0.85	0.88	0.79	0.85	0.83
1999	0.90	0.84	0.90	0.84	0.80	0.88	0.87	0.88	0.83	0.83
2000	0.87	0.83	0.90	0.88	0.83	0.85	0.85	0.88	0.82	0.82
2001	0.87	0.84	0.81	0.90	0.83	0.84	0.83	0.79	0.82	0.81
2002	0.82	0.80	0.81	0.83	0.80	0.82	0.83	0.82	0.82	0.80
2003	0.84	0.81	0.89	0.87	0.77	0.79	0.82	0.80	0.81	0.79
2004	0.84	0.85	0.86	0.88	0.76	0.81	0.82	0.78	0.81	0.79
2005	0.86	0.76	0.84	0.84	0.82	0.83	0.82	0.81	0.79	0.79
2006	0.86	0.75	0.75	0.83	0.83	0.81	0.81	0.81	0.78	0.79
2007	0.83	0.83	0.92	0.81	0.80	0.80	0.81	0.80	0.79	0.80
2008	0.81	0.83	0.84	0.84	0.79	0.81	0.81	0.80	0.80	0.79
2009	0.83	0.82	0.84	0.84	0.81	0.79	0.79	0.77	0.80	0.76
2010	0.81	0.80	0.88	0.77	0.79	0.81	0.79	0.77	0.78	0.77
2011	0.89	0.80	0.76	0.79	0.85	0.80	0.78	0.75	0.76	0.76
2012	0.82	0.79	0.80	0.81	0.76	0.81	0.78	0.76	0.77	0.76
2013	0.80	0.77	0.76	0.79	0.82	0.77	0.76	0.72	0.75	0.74
2014	0.76	0.75	0.71	0.72	0.78	0.74	0.75	0.71	0.75	0.72
2015	0.77	0.75	0.68	0.75	0.82	0.76	0.74	0.73	0.75	0.72
2016	0.83	0.77	0.68	0.73	0.73	0.72	0.74	0.69	0.73	0.73
2017	0.80	0.71	0.65	0.78	0.74	0.74	0.71	0.66	0.71	0.72

Source: Own calculation on the basis of PESEL database.

Figure 3 shows the deviation from the annual average of Sunday births by gmina type. Similar differences were reported for Saturdays, but on Sundays the trend was the most noticeable. At the beginning of the study period, the intensity of births on Sundays was close to or higher than the annual average of births (e.g., at 1.04). Around 1978, declines in births on Sundays began to be clear, and continued successively in all types of gminas until the end of the period under study. A specific situation occurred in the core areas of the Urban Functional Areas (FUAs), where the declines were the reported the soonest (in 1968).

The number of Sunday births was also falling relatively fast in gminas classified as core areas of FUAs and in gminas with a developed transport function. The least significant declines in Sunday births were seen in gminas with an intensively developed agricultural function (0.8 in 2017). The reason for abandoning the standard classification of gminas by Central Statistical Office (CSO) was the fact that the classification proposed by Śleszyński and Komornicki (Śleszyński and Komornicki, 2016) better reflected the specificity of rural gminas. For example, the gminas located far from cities and the rural gminas adjacent to cities are considered differently.

The variation in the intensity of births on Sundays by gmina type was increasing. At the beginning of the observation, i.e., in 1968, the gap, i.e., the difference between the maximum and minimum value of the birth rate, accounted for 0.07 percentage points, while in 2017 it reached 0.15. When looking at the final years of the study period, it can be clearly seen that the most significant "losses" of Sunday births occurred in the ecological (0.65 in 2017) and transportation (0.66 in 2017) gminas. This means that births in ecological gminas were 35% lower than the annual average of births, and 34% lower in transportation gminas. Transportation gminas are those with highway and expressway interchanges, airports, and border crossings. Ecological communes are either the ones that are extensively developed, with more than 50% of forest cover, or those where over 80% of land is covered by nature protection areas or nature reserves and national parks (Śleszyński and Komornicki, 2016).

Changes in the rate of births on Sundays by voivodship followed a similar pattern as for the gmina types (Figure 4). The Sunday births declined from 1968 to 2017 in all voivodships, with the variation of the variable increasing. From the beginning of the study period until about 1974, the deviations of Sunday birth rates from the average did not occur. From that year onwards, a downward trend in births on Sundays emerged in all voivodships (the graph shows only the situation on Sundays, but analyses were also performed for all days of the week broken down to weekdays and holidays). The trend was strongest in the Łódzkie, Śląskie, Zachodniopomorskie, Opolskie and Małopolskie voivodships. In 2017 in Łódzkie the birth rate stood at 0.64, and 0.69 for the remaining four voivodships. The smallest decreases in the Sunday birth rate were recorded in Pomorskie (0.80 in 2017), Kujawsko-Pomorskie (0.78) and Wielkopolskie (0.75).

**Figure 4.** Heat map of deviations of Sunday birth rate from the annual average by voivodships in Poland 1968-2017

	Podlaskie	Pomorskie	Podkarpackie	Opolskie	Lubelskie	Świętokrzyskie	Kujawsko-Pomorskie	Warmińsko-Mazurskie	Małopolskie	Dolnośląskie	Zachodniopomorskie	Wielkopolskie	Lubuskie	Mazowieckie	Śląskie	Łódzkie
1968	1.00	1.00	1.01	0.99	1.04	0.98	1.00	0.98	1.01	1.00	1.03	1.00	0.96	0.98	1.01	1.01
1969	1.00	1.01	1.02	1.01	1.00	1.00	1.01	1.00	1.02	1.00	1.01	0.99	0.97	0.97	1.01	0.99
1970	1.04	0.99	1.02	0.98	1.00	1.04	0.97	0.99	1.01	0.99	0.98	1.00	0.95	0.99	0.99	1.01
1971	1.02	0.98	1.03	0.98	1.00	1.01	1.00	0.98	1.01	0.99	0.99	0.99	0.97	0.99	1.00	0.99
1972	1.01	1.00	0.99	1.00	1.02	0.98	0.99	0.95	1.01	0.96	0.99	0.97	0.96	0.96	0.98	1.00
1973	1.02	0.99	0.95	0.99	1.00	1.02	0.99	0.99	0.99	1.00	0.99	0.98	0.96	0.97	0.98	0.98
1974	0.97	0.99	1.01	0.99	0.98	0.99	0.99	0.98	1.01	0.99	0.96	0.97	0.95	0.96	0.97	0.98
1975	1.02	0.98	1.00	1.00	0.99	0.99	0.99	0.99	1.00	0.97	0.95	0.97	0.96	0.96	0.97	0.95
1976	1.01	0.97	1.00	0.96	0.99	1.00	0.96	0.94	1.00	0.98	0.96	0.95	0.96	0.95	0.97	0.96
1977	0.97	0.97	0.96	0.94	0.98	0.99	0.95	0.97	0.97	0.96	0.92	0.94	0.92	0.93	0.94	0.94
1978	0.99	0.95	0.95	0.98	0.97	0.95	0.95	0.95	0.96	0.95	0.95	0.93	0.93	0.93	0.94	0.93
1979	0.97	0.94	0.97	0.98	0.97	0.95	0.94	0.95	0.96	0.96	0.93	0.92	0.92	0.93	0.94	0.94
1980	0.99	0.94	0.96	0.95	0.95	1.01	0.92	0.91	0.95	0.94	0.92	0.91	0.91	0.94	0.92	0.95
1981	0.95	0.96	0.95	0.93	0.96	0.94	0.93	0.94	0.95	0.95	0.91	0.91	0.91	0.92	0.93	0.92
1982	0.97	0.95	0.96	0.93	0.96	0.94	0.94	0.93	0.96	0.95	0.91	0.92	0.93	0.91	0.93	0.90
1983	0.92	0.95	0.95	0.96	0.96	0.97	0.90	0.90	0.94	0.90	0.91	0.91	0.92	0.92	0.89	0.92
1984	0.94	0.92	0.93	0.94	0.94	0.94	0.92	0.92	0.95	0.93	0.91	0.90	0.92	0.90	0.92	0.90
1985	0.92	0.93	0.95	0.95	0.96	0.94	0.91	0.92	0.93	0.93	0.91	0.90	0.90	0.90	0.91	0.90
1986	0.95	0.93	0.93	0.94	0.92	0.89	0.89	0.88	0.92	0.89	0.88	0.89	0.88	0.89	0.91	0.89
1987	0.93	0.92	0.93	0.92	0.91	0.93	0.90	0.89	0.94	0.92	0.87	0.89	0.89	0.88	0.90	0.87
1988	0.93	0.91	0.96	0.95	0.92	0.92	0.90	0.91	0.91	0.91	0.89	0.88	0.86	0.90	0.88	0.87
1989	0.93	0.91	0.93	0.89	0.90	0.88	0.88	0.88	0.89	0.89	0.87	0.87	0.84	0.88	0.87	0.88
1990	0.93	0.89	0.89	0.92	0.93	0.88	0.91	0.90	0.90	0.91	0.87	0.86	0.88	0.87	0.87	0.86
1991	0.92	0.89	0.92	0.92	0.89	0.89	0.87	0.90	0.90	0.90	0.90	0.88	0.85	0.87	0.88	0.85
1992	0.92	0.88	0.91	0.92	0.88	0.86	0.90	0.89	0.88	0.90	0.88	0.85	0.87	0.85	0.87	0.85
1993	0.92	0.88	0.88	0.90	0.89	0.88	0.88	0.86	0.88	0.87	0.85	0.85	0.88	0.87	0.85	0.82
1994	0.90	0.89	0.89	0.90	0.88	0.85	0.88	0.87	0.87	0.86	0.89	0.80	0.85	0.87	0.83	0.81
1995	0.88	0.88	0.88	0.92	0.86	0.86	0.88	0.85	0.85	0.86	0.88	0.83	0.87	0.83	0.83	0.82
1996	0.87	0.88	0.89	0.91	0.87	0.92	0.84	0.87	0.86	0.86	0.84	0.83	0.86	0.86	0.83	0.80
1997	0.89	0.86	0.86	0.88	0.88	0.88	0.85	0.83	0.87	0.85	0.87	0.84	0.84	0.85	0.82	0.79
1998	0.89	0.89	0.83	0.86	0.86	0.87	0.90	0.86	0.88	0.86	0.85	0.83	0.84	0.85	0.83	0.81
1999	0.87	0.86	0.84	0.88	0.84	0.92	0.85	0.89	0.87	0.85	0.88	0.82	0.86	0.82	0.81	0.79
2000	0.91	0.87	0.86	0.85	0.87	0.88	0.83	0.83	0.85	0.84	0.85	0.81	0.88	0.82	0.81	0.76
2001	0.83	0.84	0.87	0.74	0.83	0.85	0.87	0.86	0.85	0.83	0.80	0.82	0.83	0.81	0.79	0.78
2002	0.86	0.85	0.80	0.80	0.81	0.86	0.85	0.88	0.83	0.81	0.79	0.81	0.78	0.80	0.80	0.77
2003	0.87	0.82	0.81	0.76	0.82	0.80	0.83	0.87	0.83	0.81	0.78	0.82	0.78	0.79	0.78	0.75
2004	0.82	0.83	0.81	0.82	0.82	0.79	0.84	0.86	0.83	0.77	0.80	0.81	0.82	0.81	0.79	0.75
2005	0.81	0.85	0.79	0.83	0.79	0.76	0.81	0.85	0.81	0.78	0.80	0.80	0.80	0.82	0.78	0.74
2006	0.82	0.84	0.79	0.78	0.81	0.78	0.85	0.83	0.77	0.78	0.78	0.81	0.81	0.79	0.77	0.76
2007	0.78	0.83	0.79	0.83	0.76	0.78	0.85	0.84	0.82	0.80	0.78	0.83	0.80	0.80	0.76	0.76
2008	0.83	0.82	0.84	0.77	0.78	0.77	0.83	0.86	0.81	0.79	0.80	0.82	0.82	0.79	0.76	0.79
2009	0.80	0.82	0.79	0.77	0.74	0.76	0.85	0.82	0.79	0.77	0.78	0.79	0.77	0.80	0.76	0.75
2010	0.79	0.83	0.82	0.77	0.77	0.71	0.83	0.80	0.77	0.77	0.76	0.80	0.76	0.79	0.76	0.75
2011	0.79	0.83	0.79	0.77	0.73	0.70	0.76	0.80	0.75	0.77	0.74	0.80	0.74	0.79	0.75	0.74
2012	0.80	0.84	0.78	0.79	0.77	0.72	0.81	0.82	0.74	0.76	0.77	0.81	0.76	0.78	0.76	0.72
2013	0.78	0.79	0.74	0.73	0.73	0.73	0.83	0.76	0.72	0.74	0.74	0.76	0.73	0.77	0.74	0.70
2014	0.73	0.81	0.71	0.74	0.73	0.70	0.76	0.76	0.69	0.75	0.74	0.76	0.70	0.75	0.71	0.70
2015	0.75	0.81	0.73	0.78	0.72	0.70	0.76	0.75	0.68	0.73	0.70	0.77	0.70	0.75	0.72	0.67
2016	0.75	0.79	0.70	0.71	0.71	0.75	0.77	0.73	0.70	0.75	0.72	0.78	0.71	0.74	0.70	0.67
2017	0.75	0.80	0.73	0.69	0.70	0.71	0.78	0.72	0.69	0.72	0.69	0.75	0.71	0.73	0.69	0.64

Source: Own calculation on the basis of PESEL database.



As mentioned before, the variability of birth rate grew in the period under examination. At the beginning in 1968 the variable range was 0.08, whereas in 2017 it amounted to 0.16.

Finally, the authors examined deviations from the Polish yearly average of Sunday births by gender over the period from 1968 to 2017. Gender did not affect changes in the intensity of births on Sundays. For both women and men, births decreased with the same intensity in the period of study. The difference between the values of the variable for women and men averaged 0.01 percentage point both at the initial, middle, and final stage of the study.

#### **4. Discussion and Conclusion**

The study confirmed a marked decline in Saturday and Sunday births in Poland, which was similar to many other countries of the world, e.g., USA, UK, Australia, Germany, Switzerland and Japan. The main reason for this trend is the increasing number of cesarean sections and induced births, which determine the date of birth resulting specifically in the decreased number of weekend births. This is particularly evident in the case of Sundays. Cesarean sections are mostly scheduled as for time when the hospital is fully staffed, i.e., from Mondays to Fridays.

The analysis conducted for Poland between 1967 and 2017 showed a very strong correlation between the proportion of cesarean sections in total number of births and the intensity of births on Sundays. For five decades under observation, Pearson's correlation coefficient was at (-0.97,  $P < 0.001$ ). This means that in Poland the above phenomena are significantly correlated.

Cesarean sections and induced deliveries are not without effect on the health of mother and child. Several problems can be identified being a result of the growing trend of first births delivered by cesarean sections. First, it results in a reduced number of vaginal births in subsequent deliveries. Secondly, it increases the likelihood of allergies, asthma and gastric problems in children. The likelihood of serious maternal infection after the procedure and failure in developing perinatal bonding between mother and child are also mentioned. The question arises what actions should be taken by decision-makers in health care and medical organizations in order to reverse these trends?

The present empirical study, like the majority of studies on weekly birth seasonality, focused on the quantitative description of trends. When analyzing the seasonality of births in the USA in 1910-1999, Goodman, Nelson and Maciosek observed (Goodman et al., 2005,) similar trends, namely a decline in births on weekends and public holidays. Throughout the period of observation, the changes became more apparent. Goodman, however, did not analyze the causes or consequences of this process, only its duration over time. Unlike the Polish study, he did not examine significant differences in the intensity of births on Saturdays and Sundays.

In England and Wales, similar patterns were recognized by MacFarlane (1978) in 1970-76 and by Macfarlane *et al.* in 2005-2014 (2019). They confirmed the seasonality of births throughout a week with the lowest birth rates on Sundays. That pattern intensified over the both observed periods. The above works also reported a marked decline in births holidays such as Christmas and Boxing Day. In addition to weekly seasonality, monthly seasonality was noted as well, with a marked high in September, as well as diurnal seasonality, predominantly at night from midnight to 7.00 p.m., with a particular increase from 4.00 a.m. to 6.00 a.m. Scheduled births by cesarean section were most likely to be performed on weekdays in the morning.

In addition to the decline in births by cesarean section the weekends are marked with increased infant mortality rate. This is part of a broader pattern: an increased mortality in the total of patients hospitalized on weekends. This seems inevitable given how hospitals operate. Fewer staff on weekends translates to lower quality of medical services on those days. Decreases in weekend births along with increased infant mortality have been reported in England, the USA (Gould *et al.*, 2003) and Australia (Mathers, 1983). Some argue maliciously that the weekend is a dangerous time to be born (Hendry, 1981).

Opposite findings were published for Japan by Morikawa *et al.* (2016). In their study covering the period between 2005 and 2009, they did not find any difference in neonatal mortality on weekends compared to weekdays. In contrast, Morikawa reported a higher number of cesarean section deliveries on weekdays compared to weekends.

Note that in the group of low-risk women who give birth naturally, weekly seasonality does not occur. In her American study, Mancuso *et al.* (2004) observed that the intensity of births on weekends in Texas in 2000 was not lower than on weekdays.

Other important reasons for the reduced number of weekend births are of financial nature. In Switzerland, cesarean section costs twice as much as natural childbirth. The mechanism is as follows: due to declining birth rates, the medical community tries to boost hospital profits by recommending cesarean sections (Lerchl and Reinhard, 2007). In Germany, it is estimated that doctors' rates on Sundays are on average 25% higher than their rates on weekdays. Attention is also drawn to the reduced demand for midwives' services on weekends, also due to financial issues (Lerchl, 2005).

A problem related to perinatal care in Poland is its excessive and aggravating medicalization. The reasons for it are complex and include an excessive rate of induced births much too many births with stimulated contraction and an alarmingly high rate of cesarean sections. In 2018, the proportion of births by cesarean section amounted to 45%, while according to the WHO estimates, medically justified cesarean deliveries vary between 10-15%.

In most European countries, the proportion of births performed by caesarian section is decreasing. However, the trend in countries such as Poland, Romania, Bulgaria, Italy and Hungary is rising. The lowest percentage of births by cesarean delivery takes place in Scandinavian countries: Finland, Norway, Sweden, Iceland and the Netherlands. In response to this situation, the Polish Minister of Health announced efforts to reduce the percentage of births by cesarean delivery in Poland by 2 percentage points annually. According to Euro-Persistat Project. "European Perinatal Health Report. Core indicators of the health and care of pregnant women and babies in Europe in 2015" the doctors point to older age and obesity of mothers as the reasons for frequent caesarian births. Outside Europe, an extreme number of caesarian sections is performed in Brazil and Greece, where an average of 67% of privately insured women give birth in this way (Lerchl, 2007).

The above considerations provide arguments for debate about medical and non-medical consequences of the decline in Sunday births attributable to the increase in cesarean sections and induced deliveries. There are predictions that in the future, babies born by cesarean sections will be weaker, more susceptible to a variety of serious illnesses. This will increase the cost of perinatal care and subsequent treatment. This trend may also affect demographic processes, e.g., lower childbirth rates in the countries under study.

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