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Biological and Cultural Causes of Seasonality of Deaths in Historical Populations From Poland

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ABSTRACT

Seasonal fluctuations in mortality and their causes in the nineteenth century Polish rural populations: wealthy, agriculturally and economically advanced populations from Wielkopolska, and poor populations from Silesia and Galicia (southern Poland) were described. Data sources included parish death registers from the Roman Catholic parish of Dziekanowice in the region of Wielkopolska, Prussian statistical yearbooks for the Poznań Province as well as information from previous publications regarding Silesia and Galicia. The 19th century patterns were compared with those in present–day Poland. The occurrence of seasonality of deaths was assessed with: the Chi–squared test, the Kolmogorov – Smirnov test, and the Autoregressive Integrated Moving Average Models (ARIMA). In all populations there was a winter maximum of the number of deaths, while the minimum occurred in early summer. In the poor populations of Silesia and Galicia another statistically significant increase in the incidence of deaths was observed in the early spring. In the rich and modern villages of Wielkopolska there was no spring increase in the number of deaths, however, in all populations of Wielkopolska, irrespective of a particular pattern, a secondary mortality peak occurred in the late summer and autumn. Statistical tests used in this study did not show any clear differences in the distribution of the seasonality of deaths between the populations of Wielkopolska on the one hand, and the populations from Galicia and Silesia, on the other hand. The statistical significance of differences was, however, evident between populations representing the two distinguished by secondary peaks death seasonality patterns. Seasonal death increase split the populations under study into two groups according to the criterion of wealth.

Key words: *causes of deaths, historical Poland, parish registers, Prussian statistics, socio-economics difference*

Introduction

Many biological phenomena show seasonal changes throughout the year. Seasonality of deaths has been investigated for age, sex, and causes of death in many countries for both historical and present-day populations[1–28]. Such studies may provide valuable information on the biocultural status of human populations. The seasonality of death is a very dynamic phenomenon. It is conditioned by a great number of interacting factors, such as, for instance diseases occurring in a given area, health care level, nutritional habits, climatic conditions, etc. By and large, each cultural change affecting mortality conditions and the structure of age at death determines also the type of seasonality of death.

It is obvious that during periods of peace people try to do their best to minimize human mortality as much as possible. Excess deaths, which despite these attempts, occur in seasonal cycles during the year show the limits of human efforts in this area. Seasonality of deaths, as opposed to seasonality of marriages and, to a certain degree of seasonality of births, is a phenomenon independent from the human will.

The purpose of this study is to assess the magnitude and causes of the seasonality of deaths in historical populations from Poland.

Material and Methods

Materials used in the study were obtained from two sources.

One source was parish death registers – *Libri mortuorum* – from the Roman Catholic parish of Dziekanowice in the region of Wielkopolska. The parish consisted of the individuals of the Polish nationality.

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The typically agricultural parish of Dziekanowice is situated in the Ostrów Lednicki microregion – an important centre of the formation of Polish statehood in the early Middle Ages (Figure 1)[29–31]. The earliest mentions of the village of Dziekanowice date to 1357. It is, however, most likely, that it had been in existence much earlier – an early medieval burial ground dated to the period between mid-eleventh century and the end of the twelfth century was excavated within its boundaries[29,32–34]. Other villages of the parish of Dziekanowice are mentioned in written sources dating back to the mid-thirteenth century[35]. In the nineteenth century and at the beginning of the twentieth century the parish comprised 9 villages: Dziekanowice, Lednogóra, Siemianowo, Jeziorzany, Komorowo, Moraczewo, Piaski, Waliszewo and Żydówko.

The parish registers from the years 1818 –1899 are currently deposited in the Archdiocesan Archive in Gniezno and in the State Archive in Poznań. The registers had been kept in a highly reliable manner. Apart from names of the deceased, the date of death and the age at death, they contain also rare information on the cause of each individual's death. Since in other historical materials at the authors' disposal causes of death were treated in aggregate, the Dziekanowice registers provide a unique opportunity to assess seasonality of deaths by cause. Data were collected on the total of 2347 deceased individuals aged from 0 to 107 years.

Causes of death were registered in the parish registers for 88 % of deceased in accordance with the medical knowledge of persons registering death. In the remaining 12 % of cases the parish registers did not contain any information on causes of death.

The other source of data used in the study were original Prussian statistical yearbooks (Preussische Statistik) published in the second half of the nineteenth century and at the beginning of the twentieth century by the Royal Statistical Bureau in Berlin (Königliche Statistische Bureau in Berlin). They were annual, summative reports on, among other things, natural population movements[36] and medical reports[37–41]. They offered data on very large populations, presented – by necessity – in a rather general form, and thus were less informative from the point of view of this study's objectives than the discussed earlier parish registers. In the yearbooks, the causes of death were treated jointly for the whole population of a given region and for a given time interval. Groups of causes of death were classified pursuant to the Prussian state act of March 1874[38].

The yearbooks were used as a source of data on the Poznań Province (Provinz Posen) at that time. The territory of this Province (with two smaller territories: Regierungsbezirk Posen and Regierungsbezirk Bromberg – Bydgoszcz) corresponded to the present day Polish province of Wielkopolska. The parish of Dziekanowice was situated within its boundaries. Two kinds of data were drawn from the source: 1 – aggregate data, on causes of death in all villages treated together (N=357,745 individuals who died in the years 1875 – 1899; Regierungsbezirk Posen)[37–41]; 2 – data on the numbers of the deceased in particular months of the year from 1865 to 1899 in the villages of the Province (N=877,400 deceased individuals)[36]. As mentioned before, this information was given by the Prussian authors in aggregate. Such form of data precluded more refined analysis of seasonality based on this part of the material. Data on mortality drawn from the Prussian Yearbooks comprised followers of all denominations (mainly Roman Catholics and Lutherans) and members of both Polish and German nationalities.

Further, the data on seasonality of deaths in selected Polish villages in the comparable period of time were drawn from the literature. In data from this source Wielkopolska was represented additionally by the parish of Czacz[2], Silesia – by the parish of Płużnica Wielka[24], Galicia – by the parish of Wielkie Drogi[24]. All of them were of the Roman Catholic denomination and their inhabitants were of Polish nationality. Additionally, for comparison, the authors used also the data on present day Polish villages[42]. Most of the inhabitants of present day Polish villages are declared to be the followers of Roman Catholic religion.

The material under study was analyzed in terms of the qualitative and quantitative assessment of the causes of death. Interpopulational differences in the percentages of these causes were estimated using the u-test[43].

Several independent methods were used to assess seasonality of deaths.

For each month the total number of deaths was calculated for the Dziekanowice Parish (1818–1899, parochial death records) and for all Wielkopolska parishes for 1875–1899[36]. In order to eliminate the effect of unequal number of days in particular months, the numbers of deaths recorded in these months were converted according to the following formula:

$$N_i^x = 30 \cdot N_i \cdot D_i^{-1}$$

where: N_i^x is a standardized number of deaths in the i-th month, N_i – the observed number of deaths in the i-th month, D_i – the number of days in the i-th month[44–45].

Furthermore, relative numbers of deaths (RND) were calculated as ratios of the number of deaths in a given month to the twelve-month mean. The RND distributions were smoothed using three-month running averages with doubled central value.

Periods of life immediately after birth and during senility are especially vulnerable to causes of mortality since individual immunity in those periods is lower. Hence, seasonality of deaths and its causes were analyzed for the material as a whole and for the following vulnerable periods of individual life: 1 – infants (0–1 year) and 2 – elderly individuals (50–x years of age).

Subsequently, the seasonality of occurrence of the selected causes of death was analyzed. For each month of the year a share of deaths due to a given cause in all causes of death in this month was estimated.

The occurrence of seasonality of deaths was assessed with the χ^2 test. The null hypothesis assumed that the

expected number of deaths in each month is equal to the twelve-month mean. Differences between distributions of deaths were assessed with the Kolmogorov – Smirnov test[46]. Due to the lack of statistically significant differences between sexes, all analyses used combined data for both sexes.

Apart from abovementioned standard methods of seasonality of death estimation, the seasonality was assessed with the Autoregressive Integrated Moving Average Models (ARIMA; STATISTICA 7.1). Standard techniques of the assessment of the seasonality of deaths discussed before produce an averaged picture of the phenomenon. ARIMA tests whether such averaged pattern has been regularly repeated in each year of the period studied. In the instance of our particular study, the time series is constituted by numbers of deaths in consecutive months of the year. In each time series there is a systematic component and a random component. The latter one obscures identification of the structure of the systematic phenomenon. ARIMA filters out the random noise. The non-seasonal component of the time series can be described by two parameters: p – an autoregressive parameter and q – a parameter of the moving average reflecting linear correlations between random errors. The seasonal component is described by two parameters: P – autoregressive parameter, which shows linear correlations between the components of time series, and Q – the so called moving average parameter that reflects correlations between cyclic errors.

According to the Box – Jenkins notation system ARIMA models are conventionally described by values of following parameters: (p, d, q) $(P, D, Q)_s$. Function of (p, d, q) describes the non-seasonal part of the model, and the $(P, D, Q)_s$ describes the seasonal component of the model. The symbol s is the length of the seasonal period (in our case, it is 12 months). The d and D symbols describe so called order of differencing, that is, simplifying, the number of permutations of the time series that need to be performed in order to meet requirements of the ARIMA method.

In our case, irregularly occurring epidemics were one of the disturbing factors (which can be called random noise in ARIMA's terminology). Their occurrence could disturb the annual pattern of deaths and thus impact on the results of ARIMA. There were several epidemics: cholera, smallpox, typhoid fever and, to a much smaller extent, diphtheria. For the ARIMA purposes only, a few months with abnormal, extremely high numbers of deaths, which were related to epidemics, were replaced with the average of the following values: the observed value, the previous and subsequent months' values as well as the values of the same months in the both previous and subsequent years[22].

Results

Causes of death

General information on the causes of deaths is shown in Table 1. As is evident from the data, in the parish of Dziekanowice, like in other villages of Wielkopolska, the largest number of deaths was due to infectious diseases such as whooping cough, diphtheria, scarlet fever, typhoid, smallpox and measles. Another disease responsible for high frequency of deaths was tuberculosis. Statistically significant differences between populations under study were also related to stillbirths, frailty at birth, perinatal mortality and dysentery and diarrhoea (Table 1).

TABLE 1.
CAUSES OF DEATH IN THE PARISH OF DZIEKANOWICE (PARISH DEATH REGISTERS) AND RURAL AREAS OF WIELKOPOLSKA (MEDICAL REPORTS – PREUSSISCHE STATISTIK. MEDIZINLSTATISTIK) IN THE NINETENTH CENTURY

	Rural areas of Wielkopolska 1875–1899	Parish of Dziekanowice 1818–1899
Stillbirths	4.0	3.0*
Frailty at birth	10.6	3.3*
Senility	9.9	9.2
Perinatal death	0.9	0.5*
Infectious diseases (with cholera)	19.2	15.8*
Tuberculosis	6.3	8.5*
Cholera	lack of data**	1.4
Dysentery and diarrhoea	3.1	4.3*
Accidents	1.5	2.0
Suicides and murders	0.2	0.2

* statistically significantly different between rural areas of Wielkopolska and Dziekanowice, p = 0.05

** cholera was included in the original Prussian statistics into category »infectious diseases«

Patterns of seasonality of deaths

General patterns of seasonality of deaths in historical populations

The seasonality of deaths throughout the year in the parish of Dziekanowice and in other historical populations from the area of Poland is shown in Figure 2. In all populations the maximum number of deaths occurred in winter months, while the minimum in early summer (Figure 2).

Additional death increase split the populations under study into two groups. In the populations of Silesia and Galicia of that time a statistically significant increase in incidence of deaths was observed in the early spring[24]. In the parish of Dziekanowice and, in general, in the villages of Wielkopolska there was no spring increase in the number of deaths, but the mortality peak occurred in the late summer and autumn. The seasonality of deaths throughout the year in these populations was very clear (χ^2=56.3, χ^2=7558.6, respectively, p<0.001).

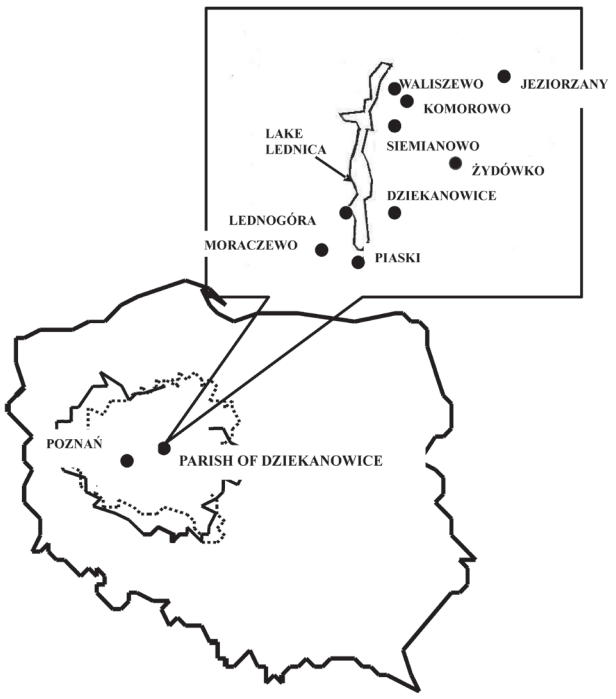

Fig. 1. Parish of Dziekanowice in the nineteenth century Poznań Province (___) and present day Wielkopolska (.....) on the map of Poland.

The seasonality of deaths in both Dziekanowice parish and Wielkopolska villages was confirmed with the use of ARIMA modelling techniques. For both data series an autoregressive, moving average model for the non-seasonal component and a moving average model for the seasonal component were successfully fitted: $(1,1,1)(0,1,1)_{12}$. This means that the number of deaths during a month is correlated to the number of deaths in a previous month (p) and the random error (disturbance, q). The moving average seasonal parameter (Q) indicates that the number of deaths in a specific month is related to the previous year's month. It is suggested that the factors affecting the number of deaths during a specific month of a year influence the number of deaths during the same month in subsequent years in the period under study. The p, q, and Q parameters are statistically significant ($p<0.05$, Table 2).

A similar pattern of seasonality of deaths was observed in the other Wielkopolska village – Czacz[2]. The Kolmogorov – Smirnov test did not show any clear differences in the distribution of the seasonality of deaths within populations representing a given pattern of seasonality of deaths: there were no statistically significant differences between the populations of Wielkopolska on the one hand, and Wielkie Drogi from Galicia and Płużnica from Silesia, on the other hand. The statistical significance of differences was, however, evident between populations representing the two distinguished death seasonality patterns ($p\leq0.05$).

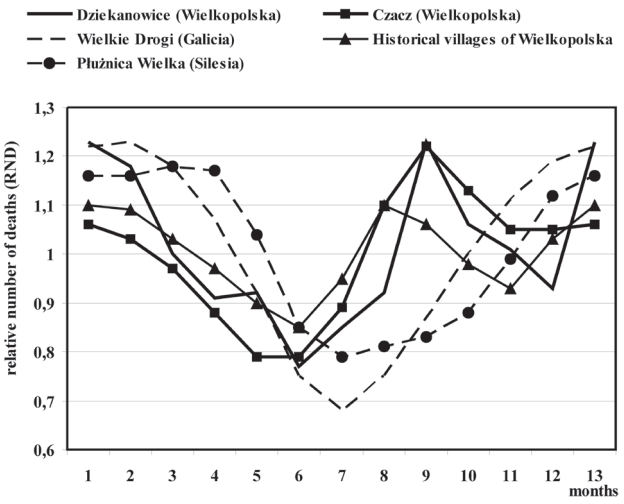

Fig. 2. Relative numbers of deaths (RND) in succeeding months of the year in the parish of Dziekanowice, in the villages of Wielkopolska and in selected historical parishes from the area of Poland.

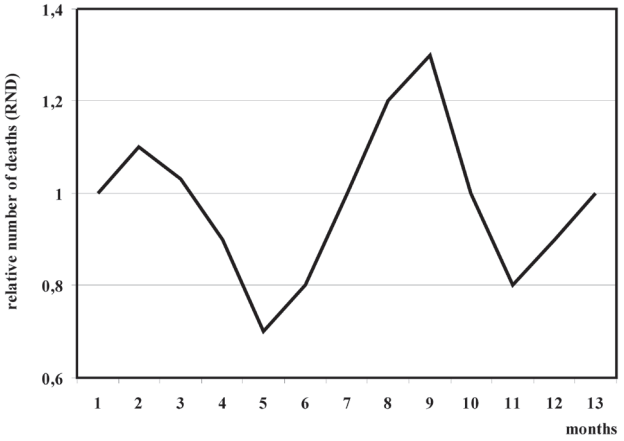

Fig. 3. Relative numbers of infantile deaths in successive months of the year in the historical parish of Dziekanowice.

Seasonality of deaths in selected age categories in historical populations

Figure 3 represents significant ($\chi^2=43.3$, $p<0.001$) seasonality of deaths of children up to one year of age. As is evident, two mortality maxima were noted in this group – in the winter and in the late summer and early autumn. The seasonality of infant mortality was also confirmed with use of ARIMA modelling techniques. For this data series an autoregressive, moving average model for the non-seasonal component and a moving average model for the seasonal component were successfully fitted: $(1,1,1)(0,1,1)_{12}$. The p, q, and Q parameters are statistically significant ($p<0.05$, Table 2 and Figure 3).

Figure 4 shows the seasonality of deaths in people aged 50 and over (50-x) years. The distribution indicates a very

TABLE 2.
ESTIMATED PARAMETERS OF ARIMA MODELS FOR POPULATIONS UNDER STUDY*

Populations	p	q	Q
Historical Dziekanowice	0.088	0.835	0.816
Historical Dziekanowice: 0–1 years	0.384	0.979	0.898
Historical Dziekanowice: 50–x years	–	0.931	0.653
Historical Wielkopolska villages	0.564	0.835	0.705
Contemporary Polish villages	–	0.441	–

*parameters statistically significant, p<0.05; p-autoregressive non-seasonal parameter, q-moving average non-seasonal parameter, Q-moving average seasonal parameter using the Box-Jenkins notation system

clear autumn and winter peak in the number of deaths in this group and the minimum in summer months. The seasonality of deaths among age category 50-x was statistically significant (χ^2= 53.5, p<0.001). The seasonality of »elderly people« mortality was confirmed with use of ARIMA model: $(0,1,1)\ (0,1,1)_{12}$. In this model the autoregressive parameter in both non-seasonal and seasonal parts of the model disappeared. The q and Q parameters are statistically significant (p<0.05, Table 2 and Figure 4).

Seasonality of deaths in the present day Polish rural populations

In the present day Polish rural areas a significantly greater number of deaths in winter months is still the case (Figure 5, χ^2 =1876.2, p<0.001). However, this annual rhythm is not confirmed by ARIMA analysis. The modern series are successfully described by a (0,1,1) ARIMA model. This shows that the seasonal component disappears (Table 2).

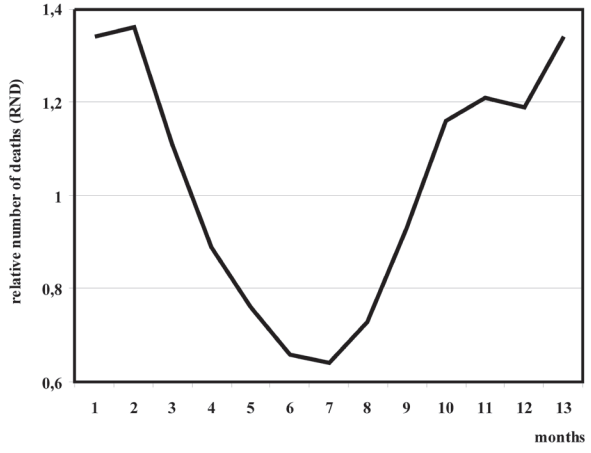

Fig. 4. Relative numbers of deaths of individuals aged 50-x years in successive months of the year in the historical parish of Dziekanowice.

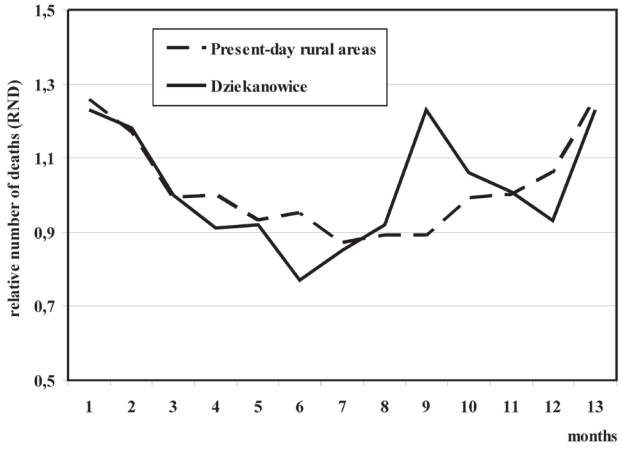

Fig. 5. Relative numbers of deaths in successive months of the year in the historical parish of Dziekanowice and in present-day Polish villages.

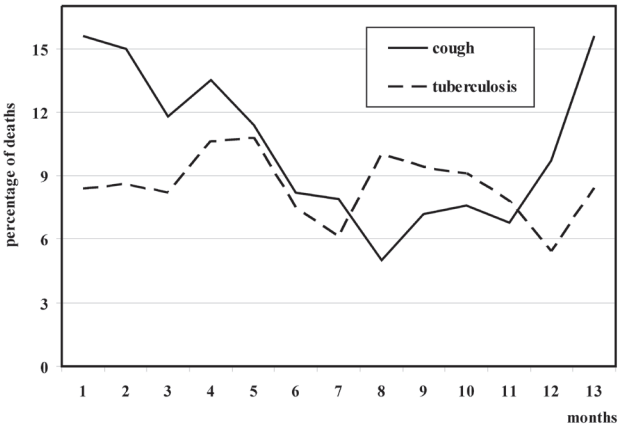

Fig. 6. Share of deaths due to cough and tuberculosis (in %) in the total number of deaths in a given month in the parish of Dziekanowice.

Seasonality of deaths due to selected causes of deaths

Figures 6–8 show the share of selected causes of deaths in the total number of deaths in a given month of a year. Figure 6 shows a significant excess of deaths (χ^2=44.8, p<0.001) due to »cough« in the winter months. The highest number of deaths due to this cause was noticed in January and February. In the parish of Dziekanowice they constituted 15.6 % of all causes of deaths in January and 15 % in February. Deaths due to tuberculosis did not show seasonal fluctuations. They were on the same level during a year, about 8 % of all deaths on average (Figure 6, Figure 7 and Figure 8).

Figure 7 shows the share of deaths described as due to »old age«in the number of deaths due to different causes in successive months of the year in the parish of Dziekano-

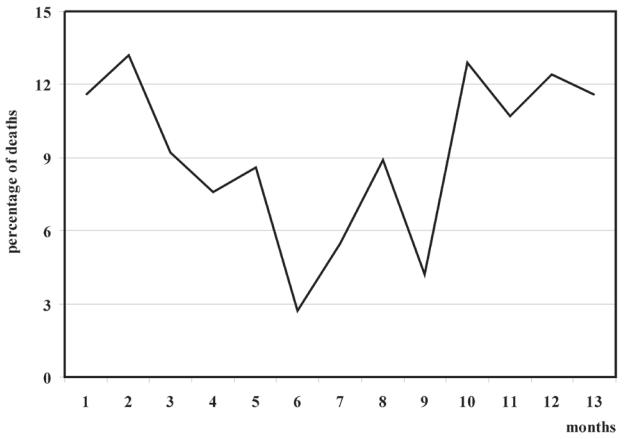

Fig. 7. Share of deaths due to old age (in %) in the total number of deaths in a given month in the parish of Dziekanowice.

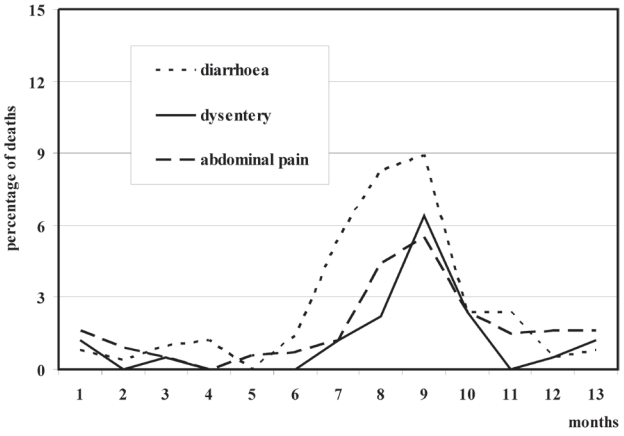

Fig. 8. Share of deaths due to dysentery, diarrhoea and abdominal pain (in %) in the total number of deaths in a given month in the parish of Dziekanowice.

wice. It is evident that mortality due to old age was considerably higher between October and February (60.8 % of all deaths in these months). All differences were statistically significant (χ^2=43.1, p<0.001).

The frequency of deaths in particular months of the year due to dysentery, diarrhoea and abdominal pain is shown in Figure 8 (χ^2 relatively: 80.6, 85.3, 41.7, p<0.001). They were commonly a cause of 21 % of deaths in the month of September.

Discussion

The largest number of deaths in the nineteenth century was due to infectious diseases. This was typical of the period under study. Striking is significantly lower number of deaths due to infectious diseases in the parish of Dziekanowice. It was a result of the fact that the parish was situated close to two big cities at that time: Gniezno and Poznań. Moreover, the villages of the parish were favoured in the early Middle Ages because of the presence of the prince and royal courts there, what gave the impulse for acceleration of the development of this region in the following centuries[29]. There was cholera among infectious diseases. There were several epidemics of cholera that occurred irregularly in the 19th-century Province of Posen: 1831, 1837–1838, 1848–1849, 1852, 1855–1856 and 1866[47–48], only those of 1849, 1852 and 1866 reached the parish of Dziekanowice[49]. Those epidemics were brought mainly from the port cities. For example, the 1866 cholera epidemic was brought from the port of Szczecin by the raftsmen to the city of Poznań and then to the parish where it left its mark on the statistics[50–52].

Certain statistical differences between the parish of Dziekanowice and other villages of Wielkopolska (Table 1) could have in part resulted from the ambiguity of the terms used to describe individual diseases as well as inaccuracy of the nineteenth century sources. Here we retained the original terminology used in the Prussian statistical yearbooks[37,41] and in historical parish registers. It seems that Prussian yearbooks could be more accurate than parish records. Official Prussian statistics were compiled by medical practitioners following the state act of March 1874[5,38]. Parish death records were compiled by various local priests. This could result in uneven accuracy of death records and variations in the names of causes of deaths. Such differences were dramatically noticed in cause of death called in historical sources »frailty at birth« (Table 1). It seems that this difference could have resulted from the lack of recognition of a cause of death by a priest or by a person reporting death of a child (a physician was never mentioned in the parish registers under study, rarely was it a midwife). Registration and reporting of stillbirths is also of different nature. In Western Europe at the beginning of the 19th century any child born without vital signs or dying within 24 hours of delivery was considered a stillbirth. At the end of the 1830s only children born without vital signs were considered as stillborn[53]. In 19th century parish records from Poland under Prussian rule, including Dziekanowice Parish a stillbirth was defined as a birth of a child without vital signs only. Stillbirths were recorded only in death records, without mention in birth registers. Children born with vital signs, even if they lived for just a few minutes were recorded in birth registers as well as in death records. Additionally, observed in Table 1 interpopulation differences in frequency of stillbirths could reflect differences in definitions of stillbirths by various religious groups. Dziekanowice parish records include exclusively Roman Catholics. Prussian statistical yearbooks include all denominations. Catholics could registered fewer stillbirths due to their belief that a stillborn cannot be baptized and thus cannot seek entry into the heaven[53–55].

The general pattern of seasonality of deaths throughout the year (Figure 2) could have had its source in climatic conditions prevailing in Poland. It was occurred in the studied population as a whole as well as in the two

distinguished age categories: small children and elderly individuals. In particular, severe winters were conducive to overall weakening, decreased immunity and development of certain diseases. Modern medicine notes a clear increase in the incidence of bronchitis during the two first and the two last months of the year, and of influenza – in February[23]. In the parish death registers the following causes of winter deaths were mentioned: influenza, cold and diseases of respiratory system (mainly: bronchitis, pneumonia) among the children, and pneumonia among elderly people. Despite this, in the sources from the nineteenth century the causes of death were described in a rather imprecise way and frequently simply main symptoms of a disease were given instead of its medical name. Hence the presence in historical records of such »illnesses units« as »cough«, »senility« and »dropsy«.

Cough could, of course, stand for many different diseases, it is, however, most likely that the »cough deaths« were caused by the respiratory diseases. Although in the past correct diagnosing of many diseases posed a serious problem, it did not mean the lack of medical knowledge. Although the modern medical knowledge was already available at the end of the 19th century, its benefits reached rural areas with difficulty. Despite this it seems that the cough accompanying tuberculosis was correctly identified as different from cough resulting from other causes. Tuberculosis was diagnosed based on such symptoms as: cough, chronicity, fever, weakness and bleeding[56–57]. Tuberculosis related mortality showed no seasonal rhythm while cough was also accompanying, for instance, cold, influenza, bronchitis and pneumonia (Figure 6).

The term »elderly people« is used in this study to refer to all persons over 50 years of age. For this age group causes of death were often unknown – in the parish registers they were referred as to »senilis«. Interestingly, this cause occurs much earlier in women than in men. A woman aged 50 was considered old, while a man was regarded as such only some ten years later. »Senility« certainly is not a specific nosological unit. Deaths due to »senility« are in principle deaths of elderly people of unspecified causes. However, they are a valuable source of information on how these individuals, as weaker and less immune to various infectious diseases, reacted to climatic changes.

Another cause of death closely related to seasonal change was also death due to »dropsy«. Dropsy may relate for many causes of death, for instance: liver cirrhosis, kidney inflammation, or cancer. Chronic insufficiency of cardiovascular system is mentioned as a frequent cause of dropsy[58–60]. In this study »dropsy« occurred frequently especially among elderly people (12 % among total number of deaths from October to February). It seems that the most frequent cause of dropsy in this age category could be a circulatory failure. The same pattern of seasonality of deaths due to circulatory system was obtained, for instance, for present-day populations of the USA[8].

As was mentioned in the Results section, secondary death increase split the populations under study into two groups according to the criterion of wealth (Figure 2). In the populations of Silesia and Galicia of that time a statistically significant increase in the incidence of deaths was observed in the early spring[24], reflecting food scarcity after the winter, before the main harvest. In a common opinion of Polish historians[61–62] food scarcity after the winter affected the majority of Polish rural populations very often. Agriculture in Austrian-ruled Galicia had always been at a low level of development[61]. The term »Galician poverty« popular in the nineteenth century, is occasionally used in Poland up to this day. Upper Silesia was another poverty stricken region afflicted with great natural disasters such as floods and potato blight outbreaks as well as inflation, high taxes and high food prices[63].

In the rich and modern parish of Dziekanowice and, in general, in the villages of Wielkopolska there was no spring increase in the number of deaths. A similar pattern of seasonality of deaths was observed in the other Wielkopolska village – Czacz[2]**.** Interpopulational differences were confirmed by the index of agricultural production. For instance, in the second half of the 19th century and at the beginning of 20th century four-corn-harvest (rye, wheat, barley and oats) per 1 person per year was as follows: in Wielkopolska 653 kg, in Silesia 412 kg, and in Galicia 280 kg only; potatoes harvest was respectively: 1529 kg, 733 kg and 580 kg[64]. The cattle production per 100 persons per year was: in Wielkopolska 47.2 animals, in Silesia 31.9 animals, other livestock production was respectively: 50.3 animals and 23.1 animals[65].

In all populations of Wielkopolska, irrespective of a particular pattern, mortality peak occurred in the late summer and autumn. It seems that problems related to the alimentary system had been the most serious cause of the late summer and autumn mortality represented by dysentery, diarrhoea and abdominal pain.

The late summer and autumn peak in total mortality can be ascribed mainly to high infant mortality (Figure 3). This maximum covers the months from July to September and overlaps with a very strongly marked increase in postneonatal deaths caused mainly by diseases of digestive tract (dysentery, diarrhoea and »abdominal pain«) and by infectious diseases (diphtheria, smallpox, and scarlet fever). Among all deaths in a whole year due to dysentery, diarrhoea and »abdominal pain« as much as 81 % of infants died in July, August and September. In turn, among all deaths in a whole year from infectious diseases as much as 33 % deaths fell from July to September. Summer mortality increase caused by diseases of digestive tract was probably due to change of diet as a result of weaning, lack of knowledge of the hygienic needs and principles of healthy nutrition. Historical sources report frequent and varied alimentary tract disorders particularly in warm weather months. Infantile diarrhoea had taken the highest toll of them all[66]. There was also a summer-autumn peak observed in other European countries[67–68].

Among older children as well as among infants, increased mortality was also observed in late summer and autumn, although it did not reach the level of statistical significance. It seems likely that children in rural areas were frequent victims of food-borne diseases. Kuchowicz[69]

writes that children were unable to distinguish toxic plants from edible ones. There were cases of deadly nightshade (*Atropa belladonna*) ingestion, or mistaking the roots of water hemlock (*Cicuta virosa*) for parsnip or parsley roots. Other important cause of an increase of infant deaths stressed many a time in literature was premature weaning[67,70–73].

The parish records used in the study enabled insight into the seasonality of causes of death. Based on their contents the information on correlation of the causes of death with individual types of seasonality of deaths was obtained. This seems to be of particular importance considering the scarcity of sources containing both data on the dates of death and on the causes of death of individuals in a population. Majority of available sources provide only information on the age and date of death or simply on the numbers of deceased in a given age group and in a given month of the year. Our research makes it possible to move from these limited data to seeing the causes of death. In this way, it is possible to obtain a more complete picture of the conditions and biological dynamics of the population.

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BIOLOŠKE I KULTURNE UZROCI SEZONALNOSTI SMRTI KOD POVIJESNIH POPULACIJA POLJSKE

S A Ž E T A K

Sezonalne fluktuacije u mortalitetu i njegovim uzrocima u poljskoj populaciji devetnaestog stoljeća: opisane su bogate i agrikulturno i ekonomski napredne populacije iz Wielkopolske te siromašne populacije iz Sleške i Galicije (južna Poljska). Izvori podataka uključuju župne registre umrlih iz rimokatoličke župe iz mjesta Dziekanowice u području Wielkopolske, pruske statističke godišnjake iz provincije Poznań kao i prijašnje publikacije o Sleški i Galiciji. Uzorci iz 19. stoljeća su uspoređeni s današnjom Poljskom. Pojavnost sezonalnosti smrti je mjerena pomoću: Chi-squared testa, Kolmogorov – Smirnovog testa i Autoregresivnih integriranih pomičnih prosječnih modela (ARIMA). Kod svih populacija maksimum smrtnosti bio je u zimskom periodu, dok je minimum bio u ljetnom periodu. U bogatim i razvijenim selima Wielkopolske za vrijeme proljetnog perioda nije došlo do rasta smrtnosti, no kod svih populacija Wielkopolske, bez značajnog uzorka, kasnom ljetu i jeseni se pojavljuje sekundarni šiljak u mortalitetu. Statistički testovi korišteni u ovoj studiji nisu pokazali jasnu razliku između distribucije sezonalnosti smrti između populacija Wielkopolske i populacija Galicije i Šleske. Statistički značajne razlike su bile očite između populacija koje su se razlikovale kod uzoraka sezonalnosti mortaliteta sa sekundarnim šiljcima. Porast sezonalnih smrti dijeli populacije unutar studije na dvije grupe nastale na kriteriju bogatstva.