Industrial Urban Life and Death: Social and Environmental Influences on Mortality in 19th-Century Lodz

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Abstract. The aim of this paper is to analyse mortality in the city of Lodz in the second half of the 19th century and to capture the impact of socio-economic factors, such as profession, and environmental conditions related to the level of hygiene in the place of residence, on the age at death. Due to its industrial character, Lodz was referred to as the "Polish Manchester." Infant mortality was higher in places characterized by poor sanitation than in those with better ecological conditions (329 and 259 per 1000 live births, respectively), and also higher among working class members than in more affluent occupational groups (350 and 259 per 1000 live births, respectively). Life expectancy of a newly born child (e_0) in the group of "workers" ranged 25.7–29.2 years, while in the group of "others" 30.3–33.3 years. There were no differences between e_0 values for females and males among workers. In the case of "others" e_0 for women was 7 years lower than for men. The impact of social status and environmental factors in the urban space on the age at death was confirmed by MANOVA. In 19th-century industrial urban space, living conditions among workers, especially those employed in the textile industry, had a significant impact on their biological status and health.

Keywords: life expectancy, infant mortality, textile industry workers, environmental conditions, industrial city

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1. Introduction

In the 19th and early 20th centuries, the Polish lands were divided among three neighbouring powers: Russia, Austria, and Prussia. This political annexing had significant consequences not only for economic and social development but also for public health and demographic patterns. Most studies in historical demography and biological anthropology of past populations have focused on urban centres located within the Prussian sector or the former Prussian Empire (e.g. Gehrmann 2011; Liczbińska 2009, 2011, 2015, 2017; Spree 1988; Vögele 1998, 2000; Vögele and Woelk 2002). These regions, characterized by better administrative organization and more systematic record-keeping, provide relatively reliable statistical and medical data, which have enabled detailed analyses of mortality trends and their determinants (Liczbińska and Holom, under review).

By contrast, much less is known about cities located in the Russian and Austrian partitions. Research on mortality patterns and their causative factors in these areas has been limited, largely due to the scarcity and poor quality of surviving documentation. The available records are often fragmentary, inconsistent, and regionally uneven, making it difficult to reconstruct accurate demographic profiles. Nevertheless, these neglected regions are crucial for understanding the broader picture of health inequalities and urban living conditions in 19th-century Central Europe.

Lodz, one of the most rapidly industrializing cities in Polish lands under the Russian partition, represents a particularly valuable case study in this regard. Emerging from a small settlement into a major textile centre within a few decades, Lodz experienced the full spectrum of industrial urbanization: demographic explosion, poor housing, and severe sanitary challenges. Investigating mortality in Lodz thus offers an opportunity to explore how social class, occupation, and ecological conditions shaped life expectancy in a city undergoing intense transformation under imperial rule (Janczak 1982).

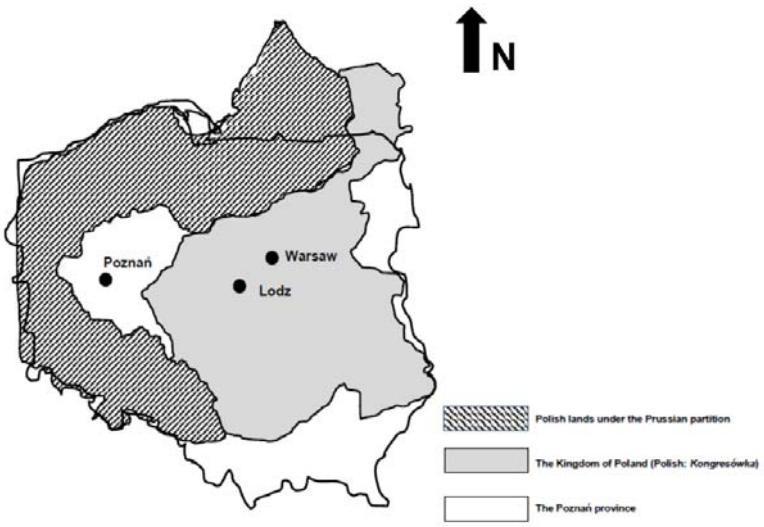
In the light of the above, we have focused in this pilot study on mortality in industrial Lodz in the 1850s, i.e. during its entry into the most intense social and economic transformations. The purpose of this study is twofold: 1) to find a relation between cultural and ecological factors in shaping mortality, 2) to capture the impact of socio-economic factors, expressed by profession, and ecological factors, related to the level of hygiene in the place of residence, on the age at death.

2. Material and Methods

2.1. The city of Lodz in the 19th century

As a result of the decisions of the Congress of Vienna in 1815, Lodz became a part of the Kingdom of Poland, formally united with Russia by the personal union (Figure 1). In 1820 Lodz was included in the group of industrial settlements of drapery and weaving. Then the city had a population of about 800 permanent residents. This date has been considered as the breakthrough in the history of Lodz since the period of "agricultural" Lodz had finished and the new one of "industrial" Lodz began.

Figure 1. Map of 19th century-Polish lands against contemporary Poland



The dynamic development of industry led to a rapid inflow of migrants, causing sudden transformation from the town of over 4,300 permanent inhabitants in 1830 (exactly 4,343 people) into the industrial metropolis, accounting to over 280,000 inhabitants in 1900 (92,286 and 190,920 permanent and temporary residents, respectively) and over 470,000 in 1914 (213,564 and 264,298 permanent and temporary residents, respectively) (Janczak 1982, pp. 38–40). The period of the greatest economic boom started in the 1850s. Some of the factors that contributed to it were as follows: the development of the internal market, the inflow of cheap manpower from villages after the

peasantry enfranchisement, and the re-opening of exports after the abolition of the Russian customs border in 1851 (Baranowski 1988; Fijałek 1979; Janczak, 1988; Szram et al. 1987).

In the 1830s and 1840s the city of Lodz became the most important centre of textile industry in Poland, and due to its dynamic urban and industrial development was known as the "Polish Manchester" (Koter 1988). Migration movements made the nationality structure of the city more dynamic. The agricultural Lodz was a homogeneous town in terms of nationality and religion. In 1831 Lodz was inhabited by the following national groups: Germans who constituted of 74% of the city population, Poles 17.4% and Jews 8.5%. However, it should be emphasized that the ethnic composition quoted here after Kossmann (Janczak 1982 after: Kossmann 1936) was determined on the basis of names from the list of the funds of contributions to the army during the November Uprising. The municipal classification was introduced only in the 1860s. In its light, the percentage of Germans in the urban community ranged from over 40% to more than 60%, whereas the frequency of Polish and Jewish population fluctuated from 21% to 34% and from 16% to 21%, respectively (Janczak 1982). Janczak (1982) quite critically evaluated these classifications, calling them "of dubious quality and origin" as it was not known exactly how they were collected (p. 121). National statistics for 1913 and 1914 indicated a clear predominance of the Polish population (50%), placing the Jewish one on the second position (over 30%). The Germans constituted of 15% of the city population, while the Russians just over 1% (Janczak 1982).

In the years 1850s Lodz was inhabited by the following four denominations: Catholics, Protestants, Jews and Orthodox. The proportion of Catholics and Protestants was then equal: over 40% (Janczak 1982). Jews constituted about 14–15% of the city inhabitants. The number of Orthodox followers in the 1850s was very small. At the beginning of the 20th century, they represented about 3% of the total population (Janczak 1988).

The Roman-Catholic parish of the Assumption of the Blessed Virgin Mary was the only Catholic parish in the city during the period under study. At the end of the 19th century two more Catholic parishes were established: St. Adalbert and the Elevation of the Cross (Budziarek 1995).

In the 19th century Lodz became an industrial centre closely dependent on the pace of the industrial development. The rapid pace of industrialization caused migratory movements, mainly from villages in its vicinity. The population migrated to the city searching for jobs. Consequently, factory districts and working-class residential districts were created in the outskirts of the city.

These suburbs absorbed masses of the poorest (Koter 1988). The acceleration of the migration processes took place especially after 1864, after the act of enfranchisement of peasants had been signed. The rural population "brought" rural traditions with them. They were used to a different rhythm of work and to having a large number of children, unlike in cities, etc. To summarize, the newcomers from the countryside to Lodz were not prepared to live and to work in the city. Moreover, most of them were illiterate. The dynamic industrialization forced the sudden socialization resulting from the transition from the countryside to the city, without a transitional phase. Thus, it generated a powerful stress connected with the need to adjusting to completely new habits. Migrants, who managed to settle down in the city, attracted to Lodz other family members (Sikorska-Kowalska 2001, 2013; Żarnowska 1992).

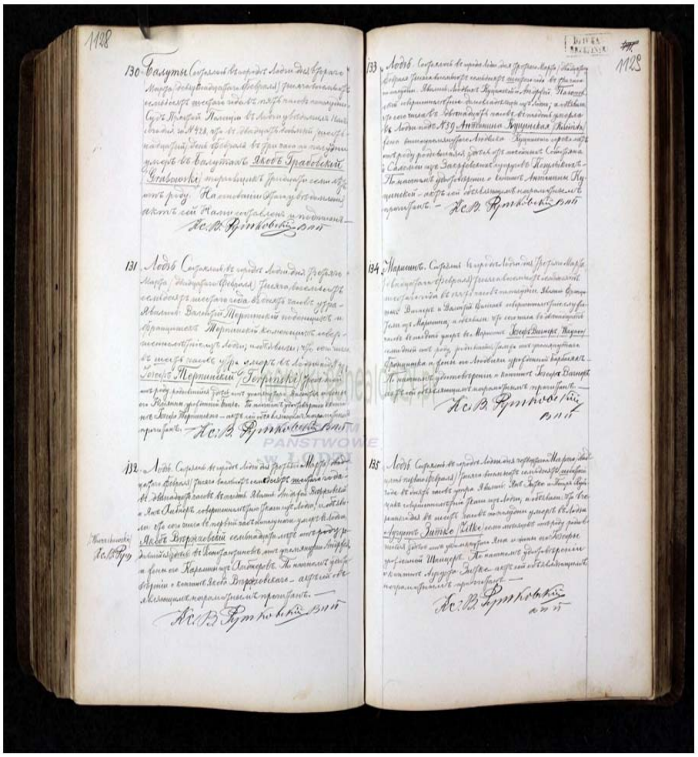
2. 2. Material

The data on mortality were derived from the following two sources:

1) Parish death and birth registers for the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (Figure 2). As it was the oldest parish in Lodz; their origin dated back to the 14th century (Budziarek 1995). The parish consisted of a working-class population, related to the dynamically developing cotton and textile industry. As far as the profession of the deceased is concerned, which was reconstructed on the basis of the information from death registers, weavers, weaving masters, weaving journeyman constituted over 40 % of all professions recorded. The second large group was represented by workers in the textile and cotton industry (workers, labourers, daily labourers, agricultural workers, farmhands). There were also a group of unemployed people, beggars and lodgers[1]. White-collar workers were represented in the parish by just 0.5% of the recorded occupations (Table 1). The reconstructed social structure of the parish roughly coincided with the description of the social status in Lodz given by Janczak (1982) for a similar period.

[1] A good description of lodgers in historical Poland is given by Szołtysek (2015).

Figure 2. Example of a death register of the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz



Source: Parish death register, unit 1876/ 1562/D, Files No. 130–135, State Archive, Lodz, available at http://metryki.genealodzy.pl/ (accessed on 1 October 2025).

This work relies on all records from the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary derived for the years 1850–1860 reporting 5,853 deceased and 6,936 born individuals. The parish registers are digitalized and access to them is available online (http://metryki.genealodzy.pl/). The information obtained from these sources included the date and place of death, age at death, occupation of the deceased or in the case of a child - father's occupation. The age of a deceased adult was declared in full years. The age of a deceased child was expressed more precisely: in years, months and days, while that of a deceased infant in months and days. In parish registers there was no information available on the causes of deaths and the nationality of the deceased. The parish registers, on the basis

of which the analysis was performed, provide fine individual details of the socio-cultural diversity of Lodz population. In this way, it was possible to obtain a more complete picture of mortality, factors impacting on it, and a relationship between them.

Table 1. Occupational structure in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (in %)

Occupation of deceased *	Fractions
Weavers (weaving masters, weaving journeyman)	40.93
Workers (labourers, daily labourers, agricultural workers, farmhands)	34.87
Craftsmen (carpenters, carpenters, shoemakers, tailors, locksmiths, turners, dyers, clothiers)	10.34
Soldiers	4.79
Unemployed, beggars, lodgers	3.07
Domestic servants	2.90
Service workers (caretakers, cabbies, traders)	0.91
White-collar workers (medical doctors, officials, teachers, pharmacists)	0.57
Unknown	1.62

Source: Calculations based on information on the professions of the deceased from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz; *in the case of deceased children, we used father's occupation

2). The aggregated numbers of deaths derived from the Municipal Registrar Archives of the City of Lodz for the years of 1860–1863 (Position Number: 361). They provided data on 3,884 deceased persons which were presented in 5-year age categories ranging from 0 to 100.

The selection of material from the beginning of the second half of the 19th century was due to two reasons: 1) the parish registers from the earlier period were characterized by poor quality and reliability of registers. The improvement was only in the second half of the 19th century; 2) information on the number of the deceased in the age categories in the Municipal Registrar Archives of the City of Lodz was only available for the years indicated.

2. 3. Methods

A link between the occupation status and the age at death, and the level of hygiene in the place of residence and the age at death was captured by chi-square test. Based on the information about profession of the deceased (in the case of children – father's profession) the material was divided into two groups: 1) workers, and 2) representatives of other professions (the so-called

"others"). The first group included the following categories: weavers, daily labourers, hired workers and the lowest-paid jacks-of-all-trade, skilled workers and peasant-migrants to Lodz searching for jobs. The category of "others" included the following professions: craftsmen (craftsmen and journeymen), servants (i.e. servants, watchmen, coachmen, etc.) and a very small group of white-collar workers (teachers, doctors, and pharmacists). In terms of the standard of hygiene two groups were distinguished: 1) living in poor hygienic conditions (overcrowded locations, without access to clean water, lack of sanitation), and 2) living in good hygienic conditions (as the opposite to the first one). The level of hygiene (poor / good) was arbitrarily matched to the place of residence of the deceased (to the district of Lodz where people lived), recorded in the death registers. Information on the level of hygiene in particular districts of the city was taken from the literature (Fijalek 1954, 1979, 1988; Fijalek and Indulski 1990).

For the chi-squared test, the variable "age at death" was categorized into the following groups: 1) 0–5 years, 2) 6–14 years, 3) 15–25 years, 4) 26–54 years, and 5) 55 years and above. To standardize age measurements recorded in units other than years (i.e., months, days, or months and days), all ages equal to or greater than one year were expressed in full years. For ages less than one year: if recorded in months, the number of months was multiplied by 30 and divided by 365 to obtain a fraction of a year; if recorded in months and days, the number of months was multiplied by 30, the number of days added, and the total divided by 365; if recorded in days only, the number of days was divided by 365. The resulting value represents age expressed in years.

Based on the numbers of deaths and births, derived from parish registers, infant mortality was characterized using infant mortality rate (IMR), which is defined as the ratio of deaths of children under than 1 year of age to the total number of live births in the period under study (Holzer 2003). The intensity of infant mortality was not identical over a one year period. Therefore, due to the time in which the infant death occurred the neonatal mortality (NMR) and postneonatal mortality (PNMR) were distinguished. The neonatal mortality rate is the ratio of the number of deaths in the first month of life to the total number of live births. The postneonatal mortality rate is defined as the number of deaths between one month and one year of age related to the number of live births (Holzer 2003). As far as postneonatal mortality is concerned, a more accurate definition describes postneonatal mortality rate as the number of postneonatal deaths (infants aged 28 days to 1 year) divided by the number of live births minus neonatal deaths (Jekel et al., 2007; Koch 2009). Such approach to calculation of postneonatal mortality rates

is caused by the fact that "infants born alive are not at risk of dying in the postneonatal period if they die during the neonatal period" (Jekel et al. 2007: 36). Often, because of the causes of deaths during the first year of life the endogenous and exogenous mortality types were distinguished. The former was a consequence of such risk factors as child's congenital malformations, innate frailty, premature birth and perinatal injuries. The latter had its source in the infant's contacts with the environment and was caused by infectious diseases, lack of hygiene, accidents or food poisoning, etc. (Holzer 2003). To some extent, it can be assumed that neonatal mortality rates correspond to the endogenous mortality rates, and postneonatal mortality rates to exogenous ones. Early child mortality was calculated as the ratio of deaths of children younger than 5 years of age to the number of live births (Beaver 1973).

In this study, infant mortality rates depending on the level of hygiene and parents' occupation (social status) were calculated. Statistically significant differences in the values of the above rates between the population living in environments with "poor level of hygiene" and "good hygiene", and between the population of "workers" and "others" were assessed with the *u* test (Oktaba 1976). The level of significance of $p=0.05$ was adopted.

In the case of small populations from the Polish lands of the 19th and early 20th centuries, in particular of a local nature, it is extremely difficult to find data reflecting the number of individuals by age. Hence, it is impossible to build life tables on the basis of the age structure of a population. In anthropology of prehistorical and historical populations this disadvantage has been successfully overcome since life tables are built on the basis on the distribution of the deceased by age, reconstructed from the numbers of skeletal samples or data derived from civil or parish death registers (e.g. Henneberg 1977; Piontek 1979; Liczbińska 2009). Since the age structure reconstructed on the basis of the distribution of the deceased by age in a given population does not reflect the real age structure of this population, such methodology has been discussed and criticized in literature quite frequently (e.g. Howell 1982; Gage 1988; Lovejoy et al. 1977). However, some demographers (e.g. Rosset 1973) emphasized that differences in the value of life expectancy of a newly born child, calculated using both methods, i.e. the Halley's one and the population structure by age, are insignificant (see also: Budnik and Liczbińska 1997).

In our paper the starting point for life tables construction was the distribution of the deceased by age. Information of age at death of individuals was derived from the parish records and the Municipal Registrar Archives of the City of Lodz. Life tables were constructed for stationary and stable population models. The stationary population model used the classical Halley's

method and is based on the assumption that fertility and mortality balance each other and that the sex-age structure does not change with time. A very good description of the construction of life tables using the classical Halley's method was given by Acsádi and Nemeskéri (1970, pp. 60–65). For longer periods of time the assumption of zero population growth is impossible. This was true especially in the case of Lodz, whose population was strongly fuelled by the migratory movement. Therefore, the stable population model for non-zero population growth is more realistic. In the case of the latter the distributions of the deceased by age were reconstructed again by introducing the value of non-zero population growth into the earlier-built tables according to stationary population model, using the Pressat's formula (1966, pp. 367–375). The idea of construction of life tables for non-zero growth stable population was implemented into skeletal populations by Weiss (1973), among others.

In this paper three values of population growth (*r*) were introduced into life tables which had been earlier built for the stationary population model. The first *r* value was calculated as the difference between the number of live births and the number of deaths related to the size of the population (Holzer 2003). In this study the numbers of deaths and births and the size of the population in the city of Lodz were extracted from the Municipal Registrar Archives of the City of Lodz (Position Number: 361). Here the calculated value of the population growth was 0.01602. The second value of the population growth was adapted from Janczak's work on Lodz (Janczak 1982; p. 197). This value was at the level of 0.011. The third *r* value was averaged from the *r* values given by Janczak (1982, p. 197) for Lodz in the years 1846–1855. This value equalled 0.0128. Three biometric functions of life table parameters were characterized, i.e. life expectancy (ex), proportion of deceased (dx) and the proportion of those surviving (lx). On the basis of the life-table parameters the operation of natural selection by the Crow's Index Im was estimated. The Crow's Index determines the proportion of children who failed to live to reproductive age (Pd) to those who lived to reach reproductive age (Ps): Im = Pd/Ps (Crow 1958). Next, it was checked if occupation influenced "the age at death" with one of the following variables as covariates: the level of hygiene related to urban ecology and sex of individuals. MANOVA was used for this purpose. Analyses were performed using STATISTICA 13.3 package. Differences were considered statistically significant at the level of $p < 0.05$.

On the basis of the number of deaths for each month of the year derived from the parish death registers and the Municipal Registrar Archives of the City of Lodz the seasonal rhythm of deaths was estimated. Since the numbers of days in particular months are unequal, they were standardized on 30 days by

multiplication of the observed number of deaths in the *i-th* month by 30 and dividing by the numbers of days in the *i-th* month. Next, relative numbers of deaths (RND) were calculated as the ratios of the number of deaths in a given month to the twelve-month mean. RND distributions were smoothed using three-month running averages with a doubled central value. The occurrence of the seasonality of deaths was assessed with the chi-square test, expecting the number of deaths in each month to be equal to the twelve-month mean. The level of statistically significant differences was $p=0.05$. In order to test whether the averaged pattern of seasonality repeats regularly in each year of the period studied, analysis of time series was used (for this purpose the ARIMA method was applied). A detailed description of the ARIMA method is given by Box and Jenkins (1970; see also Liczbińska 2015). Time series analysis was performed using STATISTICA 13.3 package (www.statsoft.com). Differences are statistically significant at the level of $p < 0.05$.

3. Results

Prior to the analysis of mortality, the reliability of the sources applied was verified. One of the basic tests of the reliability of historical registers is the rate of the deceased in the age categories of 0–1 and 0–5 in the total number of deaths reported. According to Gieysztorowa (1976) the level below 30% and below 50% for children aged 0–1 and 0–5, respectively, is caused by incomplete registration. In the Parish of the Assumption of Blessed Virgin Mary in Lodz the frequencies were 30.7% and 51.7%, respectively. Since marriage registers are considered to be the most complete and reliable among all the register books, the ratios of the number of births to the number of marriages (B / M) and the number of deaths to the number of marriages (D / M) are used as very good indicators of the reliability of registration. In the 19th century the B / M ratio should exceed 5 while the D / M ratio should exceed 3 (Gieysztorowa 1962, 1971, 1976, 1980). In the parish under study, both indicators were 5.2 and 4.5, respectively. In view of the above, the selected sources were considered to be reliable and preceded in further analysis.

The distribution of the deceased by age categories according to occupation and the level of hygiene was confirmed by the significant values of chi-square test (Table 2). From 62% to over 82% inhabitants of the Parish of the Assumption of Blessed Virgin Mary in Lodz in all age categories came from the group of workers (Table 2). The members of other professional groups, called "others" here accounted for only 17% to 37% (Table 2). In all age categories, over 80% of the deceased parishioners lived in poor sanitary

and epidemiological conditions, the rest of them, i.e. over 10–18 % had living conditions characterized here by a "good level of hygiene" (Table 2).

Table 2. Relationship between age at death and occupational status and age at death and level of hygiene in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz

	Occupation			
Age at death category	Workers N (%)	Others N (%)	*Chi-square*	*p*
0-5	2014 (82.85)	417 (17.15)	122.93	<0.05
6–14	262 (79.39)	68 (20.61)		
15–25	201 (62.42)	121 (37.58)		
26–54	776 (69.53)	340 (30.47)		
55–x	400 (76.05)	126 (23.95)		
	Level of hygiene			
Age at death category	Poor N (%)	Good N (%)	*Chi-square*	*p*
0–5	2116 (88.89)	270 (11.11)	26.65	<0.05
6–14	268 (81.21)	62 (18.79)		
15–25	288 (89.44)	34 (10.56)		
26–54	995 (89.16)	121 (10.84)		
55–x	441 (83.84)	85 (16.16)		

Source: Calculations based on information of the deceased from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz; p – values statistically significant.

In Lodz parish of the Assumption of Blessed Virgin Mary in 1850–1860 the general infant mortality rate was 305 deaths per 1,000 live births, postneonatal deaths accounted for more than 66% of infant mortality rates. Neonatal mortality was at the level of 100 deaths during the first month of life per 1,000 live births. The proportion of children dying under 5 years was almost 550 per 1,000 live births (Table 3).

Table 3. Values of infant mortality rates (IMRs), neonatal mortality rates (NMRs), postneonatal mortality rates (PNMRs), and deaths < 5 years of age in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz

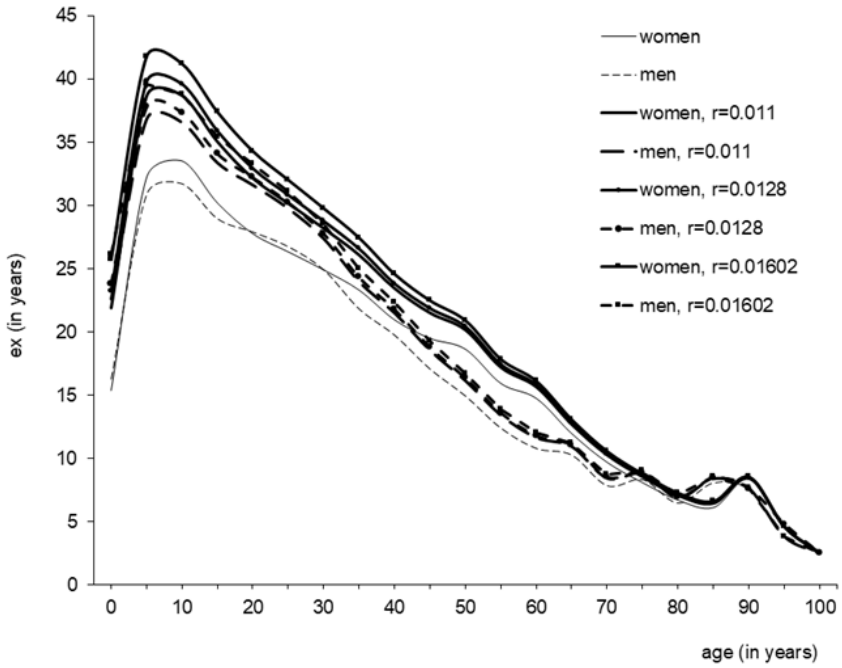
Population	IMRs	NMRs	PNMR[1]	PNMR[2]	Under 5 yrs[3]
Total	305.08	101.89	203.19	226.16	547.5
Workers	350.80	100.44	250.36	278.32	583.4
Others	259.37	103.34	156.03	174.01	422.5
Poor hygiene	329.05	117.75	211.30	239.50	543.4
Good hygiene	259.58	97.56	162.02	179.54	466.1

Source: Calculations based on information on the number of births and deaths from the birth and death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz. [1]per 1,000 live births; [2]per 1,000 live births minus neonatal deaths; [3] per 1,000 live births. Statistically significant differences between "workers" and "others" and between "poor hygiene" and "good hygiene"; *u* test, p=0.05

The values of infant mortality rates allowed capturing stratification depending on the profession, and thereby economic status, and depending on the level of hygiene in the place of residence. Among the poorest parishioners or factory workers, infant mortality accounted for almost 351 deaths per 1,000 live births, while among craftsmen, servants and a small group of white-collar workers, representing the category of "others", 259 infant deaths per 1,000 live births were recorded. In areas characterized by poor ecological conditions infant mortality was almost 330 deaths, and in those where hygiene was better - about 70 deaths less per every 1,000 live births. The early child mortality, expressed by the deaths under 5 years of age per 1,000 live births, was higher in "workers" than "others" and in places with poor than in that of good hygiene (Table 3). In the whole city of Lodz, the values of life expectancy of newly born males and females were very low and hardly differed from one another. On average a newly born female had a chance to live a little more than 15 years, and a male – just over 16 years. After applying the values of population growth, in both sexes e_0 increased by 6–10 years, with almost no differences between women and men (Figure 3).

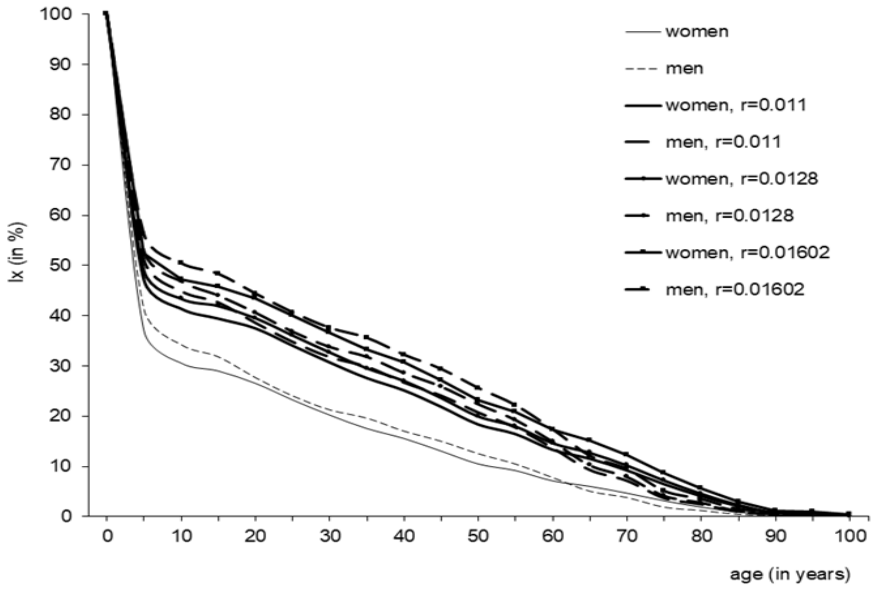
An average adult woman and an average adult man had an equal chance to live over 27 years (parameter e_{20}, stationary population model). After modifying the distribution of deceased with the value of population growth, the values of e_{20} for men and women increased to 31–33 and 32–34 years, respectively (Figure 2). Concerning the proportion of surviving (parameter l_x), 40%–45% of women and 42%–48% of men managed to survive to the onset of reproduction which was conventionally at 15 years (stable population model; Figure 4).

Figure 3. Life expectancies e_x in men and women of industrial Lodz in the second half of the 19th century (stationary and stable population models)



Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

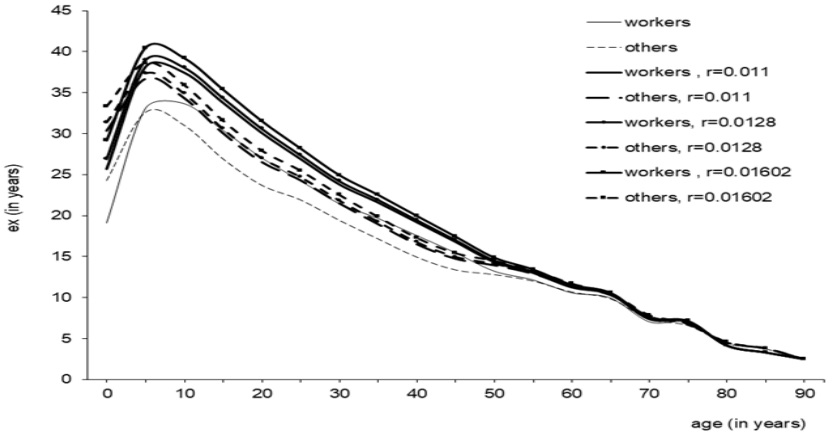
Figure 4. Proportion of surviving l_x in men and women of industrial Lodz in the second half of the 19th century (stationary and stable population models)



Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz

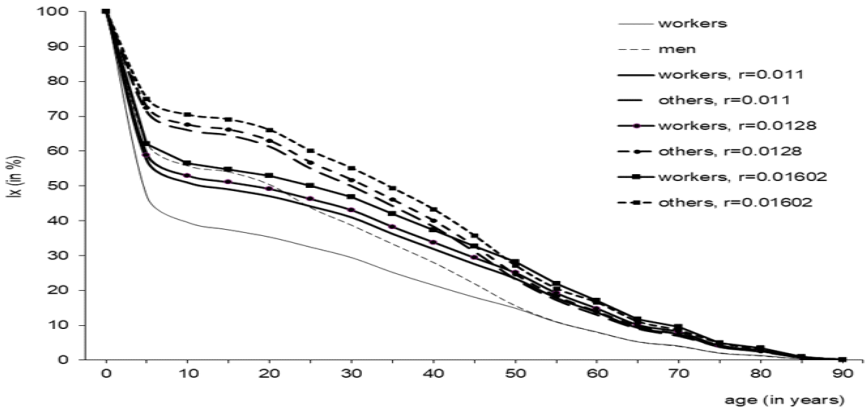
The analysis of life expectancy of a newly born child in the Parish of the Assumption of the Blessed Virgin Mary in Lodz allowed capturing stratification in its values depending on the occupation. In the group of "workers" e_0 was at the level of 19 years, while in the group of "others" – 5 years higher. After the introduction of the values of population growth, e_0 increased by 6–10 years in both cases (e_0 for "workers" and "others": 25.7–29.2 years and 30.3–33.3 years, respectively) (Figure 5). The differences in the e_x values between "workers" and "others" to the disadvantage of the former were noticeable up to 55 years, then the differences blurred (Figure 5). The age of 5 years was reached by 57%–62 % of workers' children, while in the group of "others" –14% more (stable population model; Figure 6). Among workers only 47%–52% of the population reached the onset of adulthood, while in the case of the rest of parishioners – from 61% to 66% of them (stable population model; Figure 6).

Figure 5. Life expectancies e_x in "workers" and "others" in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (stationary and stable population models; 1850–1860)



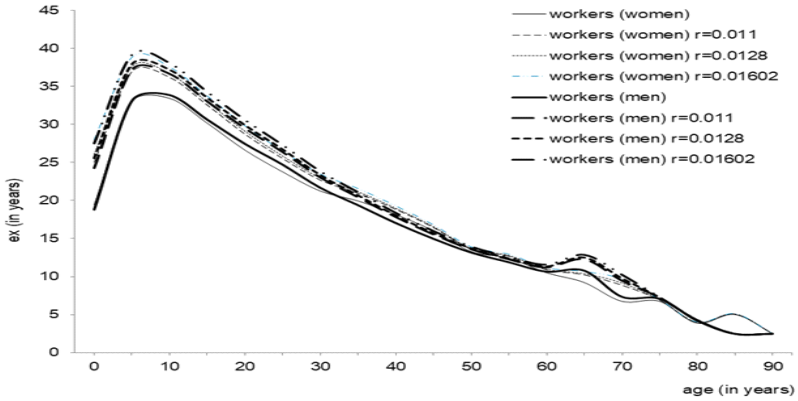
Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

Figure 6. Proportion of surviving l_x in "workers" and "others" in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (stationary and stable population models; 1850–1860)



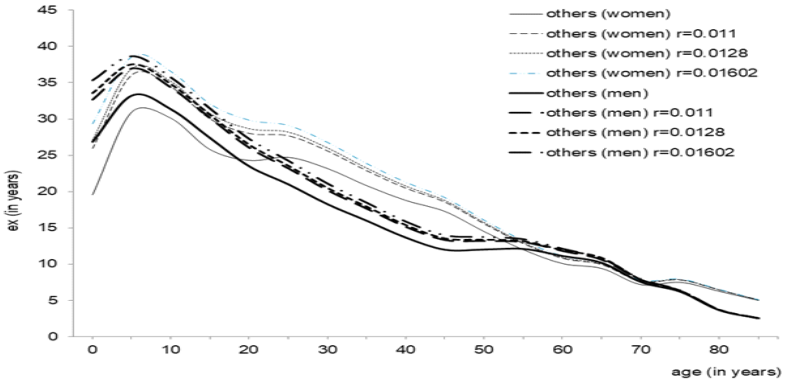
Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

Figure 7. Life expectancies e_x in women and men of "workers" in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (stationary and stable population models, 1850–1860)



Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

Figure 8. Life expectancies e_x in women and men of "others" in the Roman-Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (stationary and stable population models, 1850–1860)



Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

Among the parishioner-workers no difference in e_0 between men and women was observed, which confirmed the results obtained earlier for the city of Lodz as a whole (Figure 7). For both females and males, the e_0 parameter was at the level of 19 years (stationary population model; Figure 7). When the rates of population growth were introduced to life tables, e_0 values increased for both sexes by 6–9 years: in the case of women, it ranged 25–28 years, while in the case of men – 24.5–27.5 years (stable population model; Figure 7). In the category of "others" the value of e_0 for women was 6–7 years lower than that for men (over 19 and over 26 years, respectively; stationary population model; Figure 8). In the stable population, the e_0 value for women increased 25.9–29.3 years (Figure 8), while that for men – to 32.6–35.3 years (Figure 7).

Table 4. Effects of occupation on the age at death. The analysis adjusted for sex and level of hygiene

Models	Factors	SS	MS	F	p
Model 1	**Occupation**	14069	14069	27.094	0.000000*
	Sex	6272	6272	12.079	0.000514*
	Occupation and Sex	10686	10686	20.579	0.000006*
Model 2	**Occupation**	5038	5037.5	9.712	0.001842*
	Level of hygiene	2432	2432.5	4.689	0.003093*
	Occupation and level of hygiene	113	112.5	0.216	0.641399

Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz. MANOVA test, SS – sum of squares, MS – mean square, F–values of F-test *statistically significant differences.

The further step of our analysis was to examine whether social status influenced the age at death independently, or jointly with such factors as sex and the level of hygiene. Occupational status significantly influenced the age at death, both independently of sex and jointly with it, which is shown in Model 1 (Table 4). Adjusted means (±SE) of the age at death in workers when controlling for sex did not differ for female and male, and equaled 17 years (±0.5), while they strongly differed in "others" when sex was controlled for, being higher for men, 25 years (±0.87) than for women – 18 years (±0.16) (Table 5). Model 2 shows that occupation significantly influenced the age at death, but independently of this factor the age at death was influenced also by level of hygiene. No joint impact of these two factors was noted (Table 4).

In places with poor level of hygiene the adjusted age at death was significantly lower both for "workers" as for "others": 16 yrs. (±0.39) and 22 yrs. (±0.70), respectively, than in the environment where ecological conditions were better: for "workers" and for "others": 20 yrs. (±0.14) and 25 yrs. (±0.66), respectively. At the same time, the age at death of workers always was significantly lower than that of representatives of other professions, irrespective of their level of hygiene (Table 5).

Table 5. Adjusted means and standard errors of age at death by occupation when controlling sex and level of hygiene

Occupation	Sex	Means	SE	95% CI	p value
workers	Men	17.02	0.52	15.9; 18.0	0.0001
	Women	17.89	0.55	16.8; 18.9	
others	Men	25.00	0.87	23.3; 26.7	
	Women	18.44	0.16	16.1; 20.7	
Occupation	Level of hygiene	Means	SE		
workers	poor hygiene	16.71	0.39	15.9; 17.5	0.05
	good hygiene	20.91	0.14	18.7; 23.1	
others	poor hygiene	22.43	0.70	21.0; 23.8	
	good hygiene	25.15	0.67	17.8; 20.4	

Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

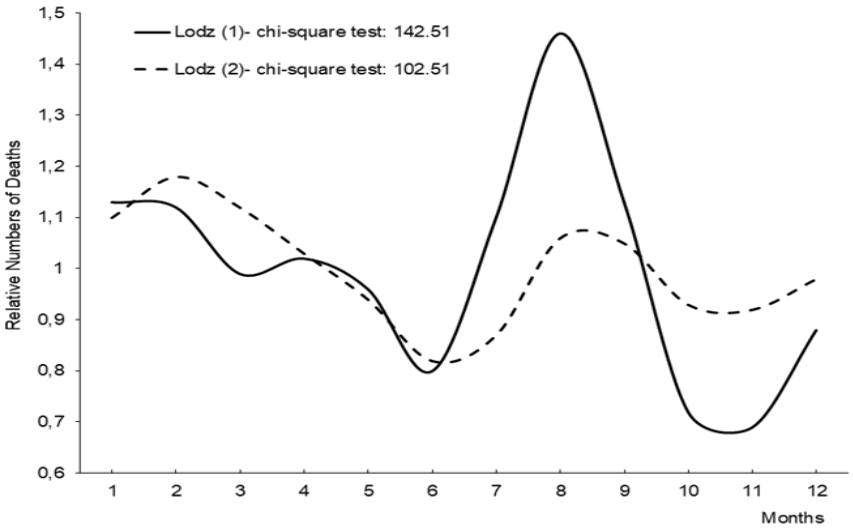
Analysis of the seasonality of deaths showed two maximum values: the first one at the end of winter and early spring months and the second one in summer (Figure 9). Seasonality of deaths for the Lodz parish and the city of Lodz as a whole was statistically significant in the light of the chi-square test (chi-square: 142.51 and 102.51, respectively). Additionally, the seasonality of deaths in the Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz was confirmed by ARIMA model. A moving average model for the seasonal component (Q) was successfully fitted: $(0,1,1)\ (0,1,1)_{12}$ (Table 6).

Table 6. Estimated parameters of ARIMA model for the city of Lodz

Parameters	Parameter values	p-value	ARIMA Model
q	0.1332	*0.2752*	$(0,1,1)\ (0,1,1)_{12}$
Q	0.6511	0.0000*	

Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz; *parameters statistically significant; q – a non-seasonal parameter of the moving average reflecting linear correlations between random errors; Q – the so-called moving average seasonal parameter that reflects correlations between cyclic errors.

Figure 9. Seasonality of deaths in industrial Lodz in the period under study



Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz (1) and the aggregated numbers of deaths from the Municipal Registrar Archives of the City of Lodz (2).

4. Discussion

4.1. Health status and medical care in the 19th-century Poland

In 1772, 1793 and 1795 the whole territory of the Polish state was split between three neighbouring powers: Russia, the Kingdom of Prussia and

Austria (after the so-called first, second and third partitions of Poland). The level of medical care and health status of residents differed between areas. In the area under the Austrian administration, the situation was definitely the worst: in Cracow in 1911 only 5.3 per cent of the city budget was spent on health care, while in Poznań controlled by Prussia it was twice as high (Fijałek 1979). The underfunding of public medical services was reflected in a small number of hospitals and medical personnel. Here again the population of the Austrian-ruled Polish lands, Galicia, came off worst. In 1862 the entire region was served by a mere 265 physicians, which meant one doctor per 18,000 inhabitants, and one hospital providing health services to 92,000 people. Even at the beginning of the 20th century there were only 29 public hospitals in Galicia with some 4,700 beds (Fijałek, 1979; Łukasiewicz, 1988). The situation was not much better in the area under Russian rule. In 1862 only 408 physicians were registered in that region, which meant that one doctor served 12,000 people; in Warsaw 208 doctors were registered, while outside the city 200 doctors only (1 doctor per 25,000 population; Łukasiewicz, 1988). There was also one hospital per 72,000 population there. At the beginning of the 20th century, in the Kingdom of Poland controlled by Russia there were only 88 public hospitals in operation with 6,051 beds, and 27 private facilities (Fijałek 1979; Łukasiewicz 1988). At the beginning of the 20th century, there were181 hospitals with 16,445 beds (Fijałek 1979) in that part of Poland. In 1882 in the Grand Duchy of Poznań (Prussian sector of Polish lands) there was statistically one doctor per 5,678 patients (authors' own calculations based on *Słownik Geograficzny… 1880–1902*), and in 1912, one doctor per 3,600 patients (Łukasiewicz 1988).

4.2. Impact of social status and environmental factors on the age at death

The rapidly growing population in Lodz, especially in the second half of the 19th century, led to the deterioration of ecological conditions in the city. The city did not keep up with the infrastructure, which meant that Lodz was the most neglected city of the 19th-century Poland (Fijałek 1979). There were no indoor plants and cesspits at homes. The whole city was cut by a network of canals that connected individual homes and factories. They contributed to the spread of epidemic of dysentery, typhoid and cholera (Fijałek 1954, 1988). In the period under study epidemics of dysentery and typhoid occurred regularly in the years 1852–1857, the epidemics of cholera broke out in 1852, 1855 and 1856 (Fijałek and Indulski 1990). Another problem was lack of deep public wells with clean drinking water. The river flowing through the city was treated

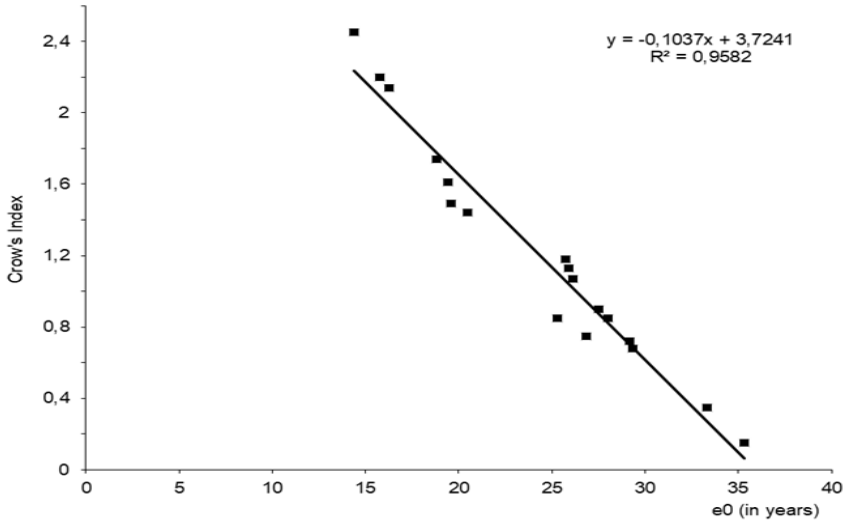
as the outflow of sewage. Domestic and factory wells were very shallow, which entailed a high risk of contamination of drinking water. Both fatal hygienic conditions and the outbreaks of infectious diseases, including that of typhoid, cholera and dysentery, were the main causes of summer surplus deaths in the parish (Figure 9). In addition, food deprivation and its poor quality was a very important factor affecting high mortality, especially within the working class. It is possible that food shortages were the cause of an additional surplus of deaths at the end of winter and in early spring (Figure 9). Such mortality increases, reflecting food shortages after winter and before crop season, were observed on historical Polish lands, mainly in rural areas with a lower level of economy and agriculture (Budnik and Liczbińska 2016; Liczbińska 2015; Puch 1993).

Generally, 19th century Lodz belonged to the Polish cities with the highest level of mortality, as the Crude Death Rate reached the level of 36.7 deaths per 1,000 people (authors' calculations based on the Municipal Registrar Archives of the City of Lodz). According to Janczak's calculations (1982), the CDRs values reached at that time even 61.2 deaths per 1,000 population (average CDR for the years 1846–1855 was 36.73 deaths per 1,000 population). In general, Polish cities under the Russian rule and also those under the Austrian one, suffered from the problem of high mortality, which undoubtedly stemmed from a very low level of medical care among other factors, which were discussed earlier in this work. In Przemyśl, Kraków and Lviv, for example, the CDRs were 34.4, 31.2, 30.1 deaths per 1,000 population, respectively (Tambor 1930). Lodz fitted very well into these values. In Wroclaw and Poznań the general mortality rate was 23.6 and 24.6 deaths per 1,000 populations, respectively (Fijałek 1979). In cities of Prussia in the years 1856–1861 the CDR amounted to 28.9 deaths per 1,000 population, i.e. was significantly lower than in Lodz (Vögele 1996).

Poor ecological conditions were reflected in the level of infant mortality, which in the areas lacking infrastructure was almost 330 deaths per every 1,000 live births. Postneonatal mortality was very high, strongly reflecting the level of hygiene, particularly in poor areas of Lodz. The most frequent causes of infant deaths in Lodz were such as diarrhoea, pneumonia and congenital weakness. Still at the beginning of the 20th century more than 7% of infants died from diarrhoea, while 29% and 30% died of pneumonia and congenital weakness, respectively (Miklaszewski 1928). These numbers are quite high, since in comparison, in the poor parish of St. Margaret in Poznań, which in the second half of the 19th century was inhabited mainly by workers,

infant deaths due to diarrhoea, pneumonia and congenital weakness were 1.3%, 0.2% and 18.8%, respectively (Liczbińska 2009).

Figure 10. Relationships between the Crow's Index and life expectancy of a newly born child in Lodz



Source: Calculations based on information on the number of deaths from the death registers of the Roman Catholic parish of the Assumption of the Blessed Virgin Mary in Lodz.

Infant mortality was very high in working class families, over 350 deaths per 1,000 live births, which meant about 100 infant deaths per every 1,000 live births more than in the group of the rest of parishioners. In Warsaw, for example, at the end of the 19th century infant mortality rate was at the level of 350 deaths per every 1,000 live births (*Słownik Geograficzny*… 1880–1902). Kalisz, another city of the Kingdom of Poland which struggled with similar health problems as Lodz did, infant mortality rate was at the level of 370 infant deaths per 1,000 live births (Liczbińska and Stachura 2013). In the province of Galicia annexed by Austria at the same time the IMR was as high as 313 deaths per 1,000 live births (Fijałek 1979). In contrast, Poznań located administratively in the Poznań province in 1855–1884 had the IMR at the level of 217 per 1,000 births, and in another city of the region – Leszno – only 160 infant deaths (Liczbińska 2015). In industrial Wrocław and Legnica in Silesia, it exceeded 300 deaths (Liczbińska, unpublished data). In German cities such as Frankfurt, Düsseldorf, Kiel and Hannover in 1875–1880 infant mortality was slightly over

200 infants' deaths (author's calculation based on Vögele 1994), i.e. lower than that recorded in Lodz. The high mortality rates of children could have been influenced by the fact that they were employed in factories. In the whole city 45–50% of children did not live up to 5 years (life table parameter of d_0; stable population model) and only 43–48% reached reproductive age (conventionally 15 years of age; stable population model). In the studied parish, as many as 38–43% workers' children did not live to the age of 5, while in the group of "others", only 25–29% children did not reach this age (life table parameter of d_0; stable population model). The decline in high infant and young children mortality in Lodz, expressed by decreased values of the Crow's Index from 2.5 to 0.2, translated into an increase in the values of life expectancy of newly born children from about 15 to over 35 years (Figure 10).

Polish historians have mentioned the cases of falsification of birth certificates of children and bribes for arranging the employment of a child to work in a factory (Bołdyrew 2013). Even in the late 19th century in the Kingdom of Poland almost 5% of industrial workers were under the age of 12, while in the group of 16 to 19 years old there were twice as many (Bołdyrew 2013).

Workers lived less than craftsmen irrespective of the level of hygiene in the place of residence. An average factory worker who resided in places with better ecological conditions and the one inhabited area lacking infrastructure lived 5–8 years less than a wealthier inhabitant of Lodz from similar places, respectively. Dense and chaotic housing structure made the poor sanitation in the city even worse. In Lodz the so-called "house wells" were built, where small yards were surrounded by tall buildings. In the dark outbuildings of such tenement houses residents were deprived of sufficient amount of sunlight and air. This led to frequent cases of tuberculosis, e.g. 100,000 thousand died of tuberculosis in Lodz. Meanwhile, in Edinburgh and in London, 3.5 times fewer (Fijałek and Supady 2002). Disastrous technology in industrial plants, lack of standards in the field of occupational health and safety led to frequent accidents at work. This fact was pointed out by doctors working in Lodz in the late 19th century (e.g. Sonnenberg 1896). Factory halls were stuffy, saturated with dust and fumes of chemicals. The situation was worsened by noise of equipment and machines (Sonenberg 1896). In such conditions labourers were crowded on a daily basis and in single shift factories and their working days ranged from 12 to 15 hours (Fijalek and Supady, 2002). Until the 1870s the length of a working day in the textile industry was not determined by any rules (Fijałek and Indulski, 1990). Also, the general level of medical care was very low in Lodz. In the 1850s in Lodz worked 3 doctors only, and 10 years later

merely 6 physicians. The first hospital was opened in Lodz only in 1846 (Fijałek and Indulski 1990).

Women constituted a high share of working class in industrial cities (Fauve-Chamoux 2000, 2001), and performed significant productive activities In the factories of Lodz women accounted for more than 50% of all workers. In textile factories most women worked in the cotton industry. They earned on average from 30% to even 70% less than men. In the Scheibler's factory, the largest entrepreneur of Lodz, the average weekly wages of a female worker ranged from 3.50 to 4 rubbles, while that of a male worker from 5 to 6 rubbles. In the factory of another entrepreneur Poznański, men and women earned 2.50–5 rubbles and 4–11 rubbles per week, respectively (Sikorska-Kowalska 2013). In Lodz's factories women outnumbered men and became cheap labour. In textile industry they worked with the use of spinning or weaving machines. They were forced to work shortly after giving birth, while pregnant women went to work throughout pregnancy. Young female textile workers already at the age of 21 suffered from consumption (Sikorska-Kowalska 2013). The lack of obstetric care, the shortage of places in hospitals and low standards in them influenced their life expectancy. The self-proclaimed midwives assisted at birth. They worked with dirty hands which led to deaths from puerperal fever. They also often incompetently accelerated the process of labour. The situation improved only in the late 19th century (Bołdyrew 2013). Therefore, the lack of difference in life expectancies of female workers and male workers of Lodz is not surprising. This is a new phenomenon, since in relation to historical Poland and Europe, higher e_0 values for women than for men constituted a biological regularity, observed frequently by researchers (e.g. Borowski 1967; Kędelski 1985, 1986; Piasecki 1990; Puch 1993; Spree 1988; Zielińska 2012). It was different in the case of "others", for whom the age at death of men was higher than that of women. This was perhaps due to the fact that in the group of "others" there were many female servants, whose living and working conditions were as bad as female workers (Sikorska-Kowalska 2013) and they lowered the average age at death in this group.

In Polish cities during the same period, the value of life expectancy of a newly born child was also determined by ecological and cultural conditions, including social and economic ones. The value of e_0 in the city of Poznań in 1850–1874 ranged between 16 years in the poor Catholic parish of St. Margaret to 28 years in the Lutheran parish of the Holy Cross (Liczbińska 2010). In the poor Catholic parish of St. Joseph from Kalisz in the same period the e_0 value was at a similar level to that recorded among workers of Lodz (Liczbińska 2010). In the industrial cities of Lower Silesia in 1875–1884 e_0 values were also at the

level recorded in Lodz: in Wroclaw and Legnica it ranged from 26 to 29 years. Meanwhile in Gdańsk, e_0 was already 34 years (Liczbińska unpublished data). Life expectancy calculated for cities of Prussia of 1877 was significantly higher than that of Lodz and also that in the Prussian sector and accounted for over 37 years for women and almost 33 years for men (Vögele 1996). In England and Wales between 1851 and 1860, e_0 values were similar to those of Prussia. In London and Bristol, they were 38 and 39 years, respectively, while in Liverpool and Manchester 31 and 32, respectively (Szreter and Mooney 1998).

References

Acsádi, G., & Nemeskéri, J. (1970). *History of Human Life Span and Mortality*. Budapest: Akadémiai Kiadó.

Akta Miasta Łodzi. Position Number: 361.

Baranowski, B. (1988). Lodz i okolice na przełomie XVIII i XIX wieku. In Baranowski, B., Fijałek, J. (eds). *Lodz. Dzieje miasta. Tom1*. Lodz: PWN, pp. 134–147.

Beaver, M. W. (1973). "Population, Infant Mortality and Milk. Population Study". *Population Studies* 27(2): 243–245.

Bołdyrew, A. (2013). "Dziecko w rodzinie robotniczej w Królestwie Polskim na przełomie XIX i XX wieku. Warunki życia i normy wychowania". *Wychowanie w Rodzinie* 7: 181–213.

Borowski, S. (1967). "Zgony i wiek zmarłych w Wielkopolsce w latach 1806–1914". *Przeszłość Demograficzna Polski* 1: 111–130.

Box, G.E.P., Jenkins G.M. (1970). *Time Series Analysis: Forecasting and Control*. San Francisco: Holden-Day.

Budnik, A, Liczbińska, G. (1997). "Mortality in the populations of Danzig and the District of Danzig (Regierungsbezirk Danzik) in the second half of the 19th century". *Anthropological Review* 60: 13–24.

Budnik, A., Liczbińska, G. (2016). "Biological and cultural causes of seasonality of deaths in historical populations from Poland". *Collegium Antropologicum* 39(3): 491–499.

Budziarek, M. (1995). "Wyznania i religie w Łodzi w XIX wieku". *Łódzkie Studia Teologiczne* 4: 7–20.

Crow, J. F. (1958). "Some Possibilities for Measuring Selection Intensities in Man". *Human Biology* 30(1): 763–775.

Fauve-Chamoux, A. (2000)."Urban population and female labour: the fortunes of women workers in Rheims before the Industrial revolution". In Siddle, D. J. (ed). *Migration, mobility and modernization*. Liverpool: Liverpool University Press, pp. 119–130.

Fauve-Chamoux, A. (2001). "Familles urbaines et maternité consciente au XVIII[e] siècle, Reims entre Genève et Rouen". In Head-König, A. L., Lorenzetti, L., Veyrassat, B. (eds). *Famille, parenté et réseaux en Occident (XVII[e]-XX[e] siècles)*. Genève: Société d'histoire et d'archéologie de Genève, pp. 359-380.

Fijałek, J. (1954). "Wpływ rozwoju Łodzi na jej stan sanitarny i zagadnienia zdrowotne ludzi pracy w pierwszej połowie XIX wieku". *Przegląd Nauk Historycznych i Społecznych* 5: 149–156.

Fijałek, J. (1988). Położenie ludności. In Baranowski, B., Fijałek, J. (eds). *Lodz. Dzieje miasta. Tom 1. Lodz:* PWN, pp. 306–357.

Fijałek, J. (1979). "Warunki higieniczno-lecznicze". In Baranowski, B., Bartyś, J., Sobczak, T. (eds.). *Historia kultury materialnej Polski. Tom VI od 1870 do 1918*. Warszawa: Wydawnictwo PWN, pp. 459–468.

Fijałek, J., Indulski, J. (1990). *Opieka zdrowotna w Łodzi do roku 1945. Studium organizacyjno-historyczne*. Lodz.

Fijałek, A., Supady, J. (2002). *Gruźlica płuc w Łodzi od schyłku XIX wieku do 1918 r. Z dziejów walki z chorobą*. Lodz.

Gage, T. B. (1988). "Mathematical hazard models of mortality: an alternative to model life tables". *American Journak of Physical Anthropology* 76(4): 429–441.

Gieysztorowa, I. (1962). "Badania demograficzne na podstawie metryk parafialnych". *Kwartalnik Historii Kultury Materialnej* 10(1–2): 103–121.

Gieysztorowa, I. (1971). „Niebezpieczeństwa metodyczne polskich badań metrykalnych XVII – XVIII wieku". *Kwartalnik Historii Kultury Materialnej* 19(4): 557–603.

Gieysztorowa, I. (1976). *Wstęp do demografii staropolskie*. Warszawa: PWN.

Gieysztorowa, I. (1980). "Niewiarygodność statystyki demograficznej ziem polskich w XIX w. i potrzeba jej korekty". *Przeszłość Demograficzna Polski* 12: 179–190.

Gehrmann, R. (2011). "Infant Mortality in Germany in the 19th Century". *Comparative Population Studies* 36(4): 807–-838.

Henneberg, M. (1977). "Ocena dynamiki biologicznej wielkopolskiej dziewiętnastowiecznej populacji wiejskiej. I. Ogólna charakterystyka demograficzna". *Przegląd Antropologiczny* 43: 67–89.

Holzer, J. Z. (2003). *Demografia*. Warszawa: Państwowe Wydawnictwo Ekonomiczne.

Howell, N. (1982). "Village composition implied by a paleodemographic life table: the Libben site". *American Journal of Physical Anthropology* 59(3): 263–269.http://metryki.genealodzy.pl/ (accessed on 5 October 2025).

Janczak, J. (1982). "Ludność Łodzi przemysłowej 1820-1914". *Acta Universitatis Lodziensis. Folia Historica* 11. Lodz: Wydawnictwo Uniwersytetu Łódzkiego.

Janczak, J. (1988). "Ludność". In Baranowski, B., Fijałek, J. (eds). *Lodz. Dzieje miasta.* Tom 1. Lodz: PWN, pp. 192–220.

Jekel, J. F., Katz, D. L., Elmore, J. G. (2007). *Epidemiology, biostatistics and preventive medicine*. Philadelphia: Saunders Elsevier.

Kędelski, M. (1985). "Umieralność i trwanie życia w Wielkopolsce w latach 1818–1875". *Przeszłość Demograficzna Polski* 16: 109–138.

Kędelski, M. (1986). "Ewolucja umieralności i trwania życia ludności miasta Poznania w wiekach XIX i XX". *Studia Demograficzne* 2: 3–27.

Koch, G. (2009). *Basic Allied Health Statistics and Analysis*. Clifton Park: Delmar Cengage Learning.

Kossmann, O. (1936). "Das alte deutsche Lodz auf Grund der städtischen". *Deutschen Wissenschaftlichen Zeitschrift für Polen*: Heft 30.

Koter, M. (1988). "Rozwój przestrzenny i zabudowa miasta". In Baranowski, B., Fijałek, J. (eds). *Lodz. Dzieje miasta. Tom 1*. Lodz: PWN, pp. 148–190.

Liczbińska, G. (2009). "Infant and child mortality among Catholics and Lutherans in 19th century Poznań". *Journal of Biosocial Science* 41(5): 661–683.

Liczbińska, G. (2010). "Diseases, health status and mortality in urban and rural environments: The case of Catholics and Lutherans in 19th-century Greater Poland". *Anthropological Review* 73: 21–36.

Liczbińska, G. (2011). "Ecological conditions vs. religious denomination. Mortality among Catholics and Lutherans in 19th-century Poznań". *Human Ecology* 39(6): 795–806.

Liczbińska, G. (2015). *Lutherans in the Poznań province. Biological dynamics of the Lutheran population from the 19th century and early 20th centuries*. Hamburg: Verlag Dr. Kovač.

Liczbińska, G. (2017). "Between Religion and Environment. Mortality and its Causative Factors in Greater Poland in the 19th Century". *Historical Social Research* 42(2): 114–133.

Liczbińska, G., Holom, E. C. (2025). "Early Child Mortality in Nineteenth-Century Poznań: Causes, Trends, and Urban Ecology". *The Journal of Interdisciplinary History* (under review).

Liczbińska, G., Stachura, K. (2013). "The problem of accuracy of historical sources: Mortality in the Polish territories under Russian rule". *Romanian Journal of Population Studies* 7(2): 5–20.

Lovejoy, C.O., Meindl, R. S., Pryzbeck, T. R., Barton, T. S., Heiple, K. G., Kotting, D. (1977). "Paleodemography of the Libben Site, Ottawa County, Ohio". *Science* 198(4314): 291–293.

Łukasiewicz, J. (1988). *Początki cywilizacji przemysłowej na ziemiach polskich*. Warszawa: Krajowa Agencja Wydawnicza.

Miklaszewski, W. (1928). W*spółczynnik śmiertelności w Warszawie i w Łodzi*. Lodz: Biblioteka Oficerskiej Szkoły Sanitarnej i Główna Księgarnia Wojskowa.

Oktaba, W. (1976). *Elementy statystyki matematycznej i metodyka doświadczalnictwa*. Warszawa: Wydawnictwo Naukowe PWN.

Piasecki, E. (1990). *Ludność parafii bejskiej (woj. kieleckie) w świetle ksiąg metrykalnych z XVIII–XX w*. Warszawa: Wydawnictwo Naukowe PWN.

Piontek, J. (1979). *Procesy mikroewolucyjne w Europejskich populacjach ludzkich*. Poznań: Wydawnictwo Naukowe UAM.

Pressat, R. (1966). *Analiza demograficzna: metody, wyniki, zastosowania*. Warszawa: Wydawnictwo Naukowe PWN.

Puch, E. A. (1993). "Dynamika biologiczna polskich społeczności wiejskich z różnych systemów ekologiczno-kulturowych w XVIII i XIX wieku". *Przegląd Antropologiczny* 56(1–2): 5–35.

Rosset, E. (1973). "Związki antropologii z demografie". *Przegląd Antropologiczny* 39(2): 169–201.

Sikorska-Kowalska, M. (2001). *Kobieta w Łodzi*. Lodz: Ibidem.

Sikorska-Kowalska, M. (2013.) "Czy Lodz w XIX wieku była miastem kobiet?". *Studia z Historii Społeczno-Gospodarczej* 11: 19–28.

Słownik Geograficzny Królestwa Polskiego i innych krajów słowiańskich. (1880–1902). In Sulimierski, F., Chlebowski, B., Walewski, W. (eds). Warszawa: Wiek -Nowy Świat.

Sonenberg, E. (1896). "Miasto Zgierz ze stanowiska sanitarnego". *Zdrowie* 126: 86–102.

Spree, R. (1988). *Health and Social Class in Imperial Germany. A Social History of Mortality, Morbidity and Inequality*. Oxford: Berg Publishers.

Szołtysek, M. (2015). *Rethinking East-Central Europe: family systems and co-residence in the Polish-Lithuanian Commonwealth. Volume 1*. Bern- Berlin- Bruxelles- Frankfurt am Main- New York- Oxford- Wien: Peter Lang.

Szram, A., Wach, A., Wiktorowski, J. (1987). *Lodz*. Warszawa: Krajowa Agencja Wydawnicza.

Szreter, S., Mooney, G. (1998). "Urbanization, mortality, and the standard of living debate: new estimates of the expectation of life at birth in 19th – century British cities". *Economic History Review* 51(1): 84–112

TIBCO Software Inc. (2017). *STATISTICA* (version 13.3) [Computer software]. https://www.tibco.com/products/tibco-statistica (accessed on 1 October 2025).

Tambor, J. (1930). *Trwanie życia ludzkiego w Krakowie w okresie od r. 1881–1925*. Kraków: Nakładem Akademii Umiejętności.

Vögele, J. (1994). "Urban Infant Mortality in Imperial Germany". *The Society for the Social History of Medicine* 7(3): 401–425.

Vögele, J. (1996). "Differences Entre Ville et Campagne et evolution de la Mortalite en allemagne pendant l'Industrialisation". *Annales de Demographie Historique*: 249–268.

Vögele, J. (1998). *Urban Mortality Change in Britain and Germany 1870–1913*. Liverpool: Liverpool University Press.

Vögele, J. (2000). "Urbanization and the urban mortality change in Imperial Germany". *Health & Place* 6(1): 41–55.

Vögele, J., Woelk, W. (2002). "Public health and the development of infant mortality in Germany, 1875-1930". *The History of the Family* 7(4): 585–599.

Weiss, K. M. (1973). "Demographic models for anthropology". *Memoirs of the Society for American Archeology* 27: 1–186.

Zielińska, A. (2012). *Przemiany struktur demograficznych w Toruniu w XIX i na początku XX wieku*. Toruń: Wydawnictwo Adam Marszałek.

Żarnowska, A. (1992). "Wychodźcy ze wsi w mieście przemysłowym (Królestwo Polskie na przełomie XIX I XX wieku)". *Acta Universitas Lodziensis* 46: 133–150.