Detailed Mortality Patterns in Europe during the Demographic Transition: Extension of the Dataset by Data from the Czech Republic

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Motive of the study and its goals

Study of the mortality development currently, as well as in the past, is without any doubt an inseparable part of the demographic research. However, for historical periods, mortality data for most of the countries (even developed ones) are only partially available – total numbers of deaths, data from population censuses only, estimations etc. As a result, for only a few countries a more detailed analyses of mortality conditions (e.g. life tables) before the World Wars are available. In the Human Mortality Database[3], the complete period life tables for years before the beginning of the 20th century are available only for Sweden (from 1751), France (from 1816), Denmark (from 1835), Iceland (from 1838), Belgium (from 1841), England & Wales (from 1841), Norway (from 1846), Netherlands (from 1850), Scotland (from 1855), Italy (from 1872), Switzerland (from 1876) and Finland (from 1878). It is clear, that those are only the Western or Northern European countries belonging to the most developed countries that days.

For the other European counties, only a partial information could be used for the description of mortality development in the 2nd half of the 19th century, what is a period, when the process of demographic transition took place in most of them. This study focuses on the mortality development in the Czech Republic as a representative of one of the most developed countries in the Central Europe (before 1918 it was part of the Austro-Hungarian Empire, however, disposing its own independent statistics and data collections). Although the quality of the Czech statistics in that time is generally judged as good and reliable, only partial information has been available for the period before the World Wars so far (crude mortality rates, total numbers, data from population censuses hold only every 10 years).

This paper follows several aims dealing with the data availability and possibilities of description of the mortality development in the first stages of demographic transition. All of them are based on the recently reconstructed detailed data (see below):

1. Describe specifically the last mortality crises observable in the studied population (above all during the 1870s) as well as the beginning of the systematic mortality improvements (1890s) related to the process of demographic transition.
2. Study the age-specific differences in the mortality development in the period before the World Wars. It could be supposed, that most of the positive mortality changes were obvious and first observed above all for infants and children, only then the changes affected also higher ages. On the other hand, we suppose that also mortality crises and epidemics usually affected primarily these (more vulnerable) age groups as they were mostly infectious.
3. Present a brief comparison of the observed trends with other (Western and Northern European countries). For this comparison the populations involved in the Human Mortality Database (listed in the first paragraph of this abstract) were selected. This enables to track back the currently observed differences in the mortality levels and potentially learn more about their sources and conditions.

Studied time period, data used in the study, construction of the life tables

Selection of the studied period was motivated by two important factors. First of them was the process of demographic transition taking part in the second half of the 19th century and first decades of the 20th century. Data reconstruction for this period enabled to learn more about the specifics and particular

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features of the most important demographic process in the modern human history. The second reason of the selection of the studied period was the data availability and limitation of its reconstruction. The beginning of the analysis (1870) was conditioned by the first modern population census held in the Czech population (1869) what enabled to start the data reconstruction between particular decennial censuses. The end year of the studied period (1910) was selected as a consequence of the World War I and its effects for the population development. For the period of the World Wars a specific method of data reconstruction (or rather estimation because for some years there are hardly any at least partly detailed or reliable data at all) would be needed because the distribution of deaths cannot be considered as equal in the intercensal periods as well as it could be hardly known or easily estimated from the currently available sources.

The reconstructed data for the studied period (1870–1910) is the result of a previous project focused on the construction of the first complete annual cohort life table of the Czech population. The results were published (Mazouch, Hulíková Tesárková, 2018), however, the research on this topic or period continues.[4]

During the data preparation it was possible to reconstruct (or estimate) numbers of deaths classified according to the completed age, year of death as well as year of birth (cohort). That enabled flexible data classification for the needs of construction of the cohort as well as period life tables. The first step in the construction of the below presented period life tables was calculation of age-specific mortality rates. Those were smoothed by moving average and Kannisto model at higher ages. The complete smoothing procedure was described by Fialová et al. (2020, in print). This methodology is very close to the methods used within the Human Mortality Database as well as to methods used in the Czech Statistical Office for the life table construction (Czech Statistical Office, 2018; Wilmoth et al., 2017). With only minor differences the constructed historical life tables for the Czech population could be compared with the contemporary tables as well as tables published for other countries.

Mortality development in the Czech population during the demographic transition

Clearly, the first decade of the studied period (1870s) was characterized by high variability of the mortality development, the most important deviations from the trend are observed around 1873 and 1877–1878. The first mortality excess corresponds with low-quality vaccines leading to smallpox epidemic in 1773. The second mortality increase in this decade could be related to the epidemics of cholera and diphtheria. Both these waves of epidemics were mentioned in some historical literature (e.g. Dokoupil, Nesládková, 1987), however, without any numerical proof or illustration.

Figure 1: Life expectancy at birth, infant mortality rate, males, females, Czech population, 1870–1910
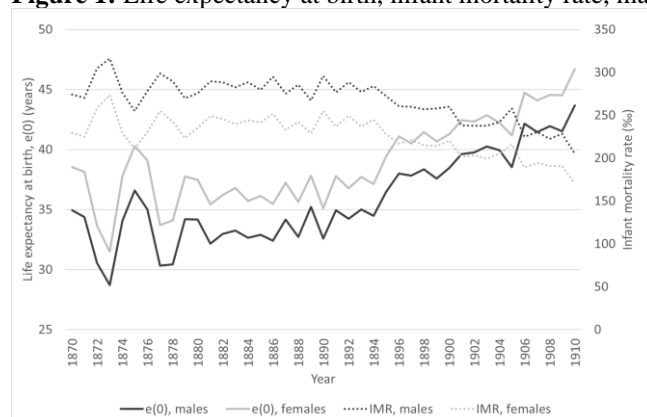
Nearly stable mortality improvements were started only during 1890s and without any doubt it was significantly influenced and conditioned by the development of the infant mortality rate (Figure 1). This positive trend was disrupted by the World Wars in the 20th century.

Age specifics of the mortality development in the Czech population during the studied time period

More methods of presentation of the age differences in the mortality development could be used. Except for the traditional life expectancy at selected ages (not only at birth) also other measures might be useful for this aim. In this study, we decided to use the temporary life expectancies for selected age intervals covering and mapping almost the whole age range. Temporary life expectancies (Arriaga, 1984) represent the average number of years which a person at exact age x is expected to live within the age interval from the exact age x to the exact age $x + n$ (clearly the value of n represents the maximal value of the temporary life expectancy related to the age interval). Existence of the maximal value enables also to calculate the potential of mortality improvements in the particular age interval.

For the needs of the paper, we calculated the temporary life expectancy for age intervals of 10 years of age, i.e. for each interval the maximal value of the measure is equal to 10. Only the population of males is presented here (Table 1). The development of the values illustrates the beginning of the mortality improvements above all in the 1890s, however, also during this and later decades several mortality worsening are observable. They, as it was assumed, affected above all the vulnerable highest age groups as well as the lowest age groups. However, the most visible are the mortality excesses in the 1870s. Above all the epidemics of smallpox affected the child population first (already in 1871 and above all 1872) and then also the higher ages (1873).

Table 1: Temporary life expectancy for particular 10-years age intervals until the age of 70, life expectancy at age of 70 ("e(70+)"), males, Czech population, 1870–1910

Males	1870	1871	1872	1873	1874	1875	1876	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887	1888	1889	1890
e(0-10)	6.52	6.46	5.98	5.86	6.44	6.78	6.51	5.96	6.05	6.51	6.44	6.21	6.25	6.39	6.25	6.38	6.22	6.42	6.27	6.50	6.19
e(10-20)	9.82	9.80	9.76	9.71	9.79	9.82	9.82	9.77	9.75	9.80	9.80	9.80	9.80	9.79	9.79	9.78	9.78	9.80	9.79	9.80	9.79
e(20-30)	9.56	9.55	9.49	9.42	9.54	9.56	9.55	9.53	9.52	9.54	9.57	9.54	9.55	9.54	9.55	9.54	9.52	9.57	9.55	9.56	9.53
e(30-40)	9.51	9.51	9.44	9.34	9.50	9.49	9.50	9.45	9.44	9.47	9.51	9.48	9.49	9.45	9.48	9.46	9.48	9.50	9.49	9.56	9.51
e(40-50)	9.29	9.31	9.26	9.17	9.28	9.30	9.29	9.22	9.22	9.25	9.28	9.22	9.26	9.24	9.26	9.21	9.25	9.28	9.26	9.38	9.30
e(50-60)	8.91	8.93	8.94	8.78	8.93	8.92	8.90	8.80	8.84	8.85	8.87	8.79	8.90	8.79	8.83	8.76	8.83	8.90	8.84	9.01	8.90
e(60-70)	7.97	8.01	8.10	7.95	8.03	8.08	8.11	7.98	7.96	8.05	8.02	7.91	8.06	7.88	7.96	7.90	7.97	8.05	7.96	8.15	8.02
e(70+)	7.36	7.68	7.67	7.80	7.89	7.88	8.15	7.89	7.88	7.73	7.77	7.54	7.92	7.40	7.82	7.74	7.86	8.18	7.83	8.39	7.62

Males	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
e(0-10)	6.43	6.33	6.47	6.34	6.60	6.78	6.75	6.81	6.81	6.86	7.05	7.05	7.11	7.05	6.95	7.30	7.25	7.33	7.23	7.52
e(10-20)	9.81	9.82	9.81	9.82	9.83	9.84	9.85	9.85	9.84	9.85	9.84	9.85	9.84	9.85	9.83	9.86	9.85	9.85	9.86	9.86
e(20-30)	9.57	9.59	9.60	9.59	9.60	9.60	9.62	9.63	9.61	9.61	9.61	9.61	9.61	9.63	9.60	9.66	9.65	9.65	9.65	9.67
e(30-40)	9.55	9.54	9.55	9.56	9.56	9.58	9.58	9.58	9.57	9.56	9.57	9.59	9.59	9.60	9.56	9.61	9.59	9.60	9.60	9.62
e(40-50)	9.36	9.33	9.35	9.33	9.37	9.37	9.37	9.38	9.32	9.35	9.36	9.37	9.37	9.38	9.34	9.42	9.39	9.39	9.40	9.40
e(50-60)	8.99	8.95	8.93	8.99	8.98	8.99	8.98	9.01	8.92	8.95	8.96	8.98	9.00	8.99	8.90	9.03	9.00	8.98	9.02	9.02
e(60-70)	8.14	8.03	8.00	8.14	8.14	8.19	8.16	8.18	8.06	8.11	8.14	8.17	8.16	8.15	8.01	8.18	8.14	8.12	8.17	8.21
e(70+)	8.21	7.56	7.61	8.44	8.21	8.47	8.33	8.54	7.88	8.16	8.16	8.22	8.25	8.14	7.59	8.51	8.35	8.16	8.27	8.36

Historical mortality development in the Czech Republic in an international context

For a brief comparison of the historical trends of mortality in the Czech lands several Western and Northern European countries were selected (Figure 2). Data from the Human Mortality Database was used and enriched by the reconstructed historical Czech data. From the presented trends it is clear, that there were differences also among the most developed countries at the end of the 19th century. Situation in Netherlands and France was a bit worse in comparison to the Scandinavian countries. However, at the beginning of the 20th century the conditions in Netherlands improved to the Scandinavian level. On the other hand, France was among the countries severely affected by the World Wars. During the whole studied period, the situation in the Czech lands was worse in comparison to the other here presented

countries. The only exception could be found after the World War II, where the level of life expectancy at birth in the Czech Republic was comparable to the level in France. The later development differs again. While the developmental delay in terms of mortality in the second half of the 20th century was caused above all by the middle age groups, the reasons of differences before the World Wars could be found above all at the youngest age groups.

Figure 2: Life expectancy at birth, selected European countries, males, 1870–2017
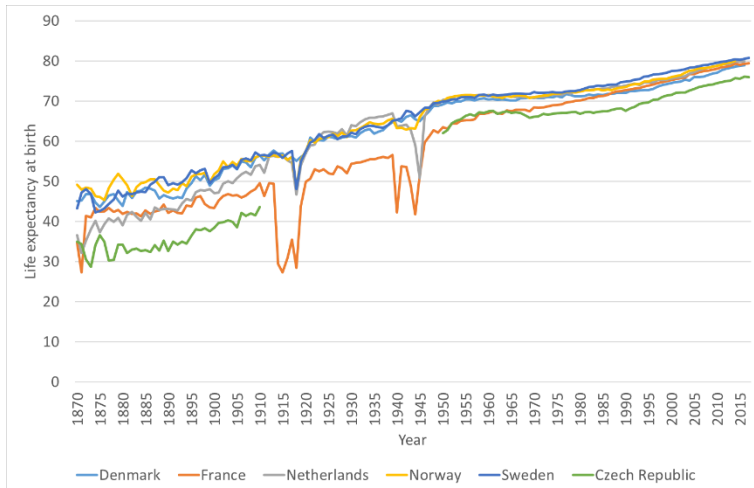
Source: Human Mortality Database, historical period life tables for the Czech population constructed by the authors

Conclusion

The presented research reveals more and rather unique information so far about the mortality development in the Central Europe during the demographic transition, as well as some age-specific features of the observed mortality trends or deviations. Moreover, methods of life table construction enable the first detailed international comparison of the mortality trends before the World Wars.

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