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The Operation of Natural Selection through Differential Mortality: The Detva Population during the Great Epidemics, 1831–1920

Działanie doboru naturalnego przez zróżnicowaną umieralność. Populacja Detvy w czasie wielkich epidemii w latach 1831–1920

Abstract

This paper centers on the infectious disease epidemics which swept through the Detva region, located in Upper Hungary (currently the territory of central Slovakia) in 1831–1920. The goal of this study is twofold: firstly, to examine the extent to which deaths caused by epidemics of infectious disease influenced life expectancy, the proportion of the deceased and survivors, and the probability of death in the Detva population, and secondly, to measure selection pressures

Abstrakt

W pracy skupiono się na epidemiach chorób zakaźnych, które przetoczyły się przez region Detva, położony w Górnych Węgrzech (współcześnie obszar centralnej Słowacji) w latach 1831–1920. Cel pracy jest dwojaki: po pierwsze – zbadanie, w jakim stopniu zgony spowodowane epidemiami chorób zakaźnych wpłynęły na wartość oczekiwanego dalszego trwania życia, frakcję zmarłych i dożywających oraz prawdopodobieństwo zgonu w populacji Detvy, through differential mortality, with a focus on deaths caused by infectious disease epidemics. We used individual information on age at death and causes of death in the Detva region, derived from the Detva parish records (*N* = 29,338). Infectious disease epidemics were the main regulator of mortality in the Detva region, as confirmed by our findings. Excluding deaths caused by infectious diseases from the dataset raised the life expectancy of a new-born and of an adult by 1–5 years and 1–2 years, respectively. The fraction of those surviving to the age of 5, the onset of maturity (15 years) and the onset of senility (60 years) also increased, while there was a decline in the proportion of deceased and the probability of dying. When deaths caused by infectious disease epidemics were removed from the analyses, selection pressures also weakened, as evidenced by the values of measures for the operation of natural selection.

Keywords

Upper Hungary, mortality, life expectancy, natural selection, rural areas, epidemics

a po drugie – zmierzenie presji selekcyjnej poprzez zróżnicowaną umieralność, ze szczególnym uwzględnieniem zgonów wywołanych przez epidemie chorób zakaźnych. W pracy wykorzystano indywidualne informacje o wieku w chwili śmierci i przyczynach zgonu w regionie, spisane z ksiąg metrykalnych parafii Detva (*N* = 29,338). Epidemie chorób zakaźnych były głównym regulatorem śmiertelności w regionie Detva, co potwierdziły wyniki naszych badań. Wyłączenie z bazy zgonów na choroby zakaźne podniosło wartość oczekiwanego dalszego trwania życia noworodka i osobnika dorosłego o odpowiednio 1–5 lat i 1–2 lata. Wzrosła także frakcja dożywających do 5. roku, początku dojrzałości (15 lat) i do początku starości (60 lat), zaś obniżeniu uległa frakcja zmarłych i wartość prawdopodobieństwa zgonu. Po usunięciu z analiz zgonów na choroby zakaźne osłabieniu uległy także naciski selekcyjne, co potwierdzają wartości mierników sposobności do działania selekcji naturalnej.

Słowa kluczowe

Górne Węgry, umieralność, oczekiwane dalsze trwanie życia, dobór naturalny, tereny wiejskie, epidemie

Introduction

Infectious diseases have tormented humans from time immemorial and have had a huge impact on the history of humanity.[1] As highlighted by historians, every historical epoch has its epidemics, which paradoxically have triggered social and economic changes in human populations.[2] For example, the plague favored

[1] Judyta Gładykowska-Rzeczycka, “Paleoepidemiologia-archeoepidemie,” *Funeralia Lednickie* 10 (2008): 37–52.

[2] Jörg Vögele, Luisa Rittershaus, and Katharina Schuler, “Epidemics and Pandemics—The Historical Perspective: Introduction,” *Historical Social Research. Supplement* 33 (2021): 7–33.

innovations such as book printing, and cholera epidemics led to a sanitary revolution in urban areas, etc.[3] Natural disasters, wars, famine, crop failure, and growing poverty were factors conducive to the development of infectious disease epidemics.[4] Studies of epidemics foster knowledge of their management in historical times and give insight into the cultural heritage of historical societies in Europe struggling with pestilence, revealing them as mortality regulators in human populations and very good tests of inadequacies in sanitary infrastructure.[5] Infectious disease epidemics, which cause mass and rapid changes in population size, may have changed the genetic structure of the human species. Therefore, studies of infectious disease epidemics can contribute to a better understanding of the microevolutionary processes in human populations in the past.[6]

The aim of this work is twofold: 1) to examine the extent to which deaths caused by infectious disease epidemics influenced the values of life expectancy, the fraction of the deceased and survivors for a given age class, and the probability of dying in the Detva population, 1831–1920; 2) to measure selection pressures through differential mortality with a particular emphasis on deaths caused by infectious disease epidemics. The period 1831–1920 was chosen for several reasons. First, several state standards were introduced in the territory of the Kingdom of Hungary, present-day Slovakia, increasing the quality of the registry content. From this period onwards, causes of death were listed in the registers, which turned out to be crucial for research. In addition, many epidemics swept through the region during this period, and these began to appear in the registers. In the early 1830s, the first wave of the cholera epidemic took place. In the following decades, there were several cholera epidemics, waves of childhood infectious diseases and, at the end of the period studied, a wave of Spanish flu occurred.

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[3] Jörg Vögele, "Cholera, Pest und Innovation," *Pandemie* 6 (2020): 22–25.

[4] Gładykowska-Rzeczycka, "Paleoepidemiologia-archeoepidemie."

[5] Grażyna Liczbińska, "Ecological Conditions vs. Religious Denomination: Mortality among Catholics and Lutherans in Nineteenth-Century Poznań," *Human Ecology* 39 (2011): 795–806; Grażyna Liczbińska, "Infant and Child Mortality among Catholics and Lutherans in Nineteenth Century Poznań," *Journal of Biosocial Science* 41 (2009): 661–83; Grażyna Liczbińska, *Lutherans in the Poznań Province: Biological Dynamics of the Lutheran Population in the 19th and Early 20th Centuries* (Hamburg: Verlag Dr. Kovač, 2015); Vögele, "Cholera"; Jörg Vögele, *Urban Mortality Change in England and Germany, 1870–1913* (Liverpool: Liverpool University Press, 1998); Jörg Vögele, "Urbanization and the Urban Mortality Change in Imperial Germany," *Health & Place* 6 (2000): 41–55.

[6] James H. Mielke and Alan G. Fix, "The Confluence of Anthropological Genetics and Anthropological Demography," in *Anthropological Genetics: Theory, Methods and Applications*, ed. Michael H. Crawford (Cambridge: Cambridge University Press, 2012), 112–40.

Background to the Detva Region

Detva was founded in the middle of the 17th century as an agricultural area. However, the first generations had to cultivate the land in the primeval forests, as the result of which the settlement took on a scattered character. The Catholic parish consisted of two different parts: the town of Detva was an administrative and ecclesiastical center where basic offices were located, while small and isolated settlements were founded in the surrounding area, where mainly smallholders and shepherds lived. These settlements often consisted of just a few houses with farm buildings.[7] This way of living evolved until the 19th century, when in the town of Detva, in addition to municipal and church offices, there were also residences of representatives of the landowner, forest estate, and gendarmerie classes. The town became a center for all the parish residents, including those living in the surrounding hamlets, but also the wider area. From the 1870s, it was included in the category of "Large municipalities" and became the seat of an electoral district.[8] The town acquired the right to hold regular quarterly fairs and weekly markets, which significantly contributed to a higher turnover of local residents, but also of people from the wider area. At the beginning of the 1870s, Detva was the seventh most populous town in present-day Slovakia.[9]

Not only did economic life in Detva itself contribute to the potential spread of diseases, but also to the way of life in isolated settlements. Extended families, made up of several nuclear families, lived together in one household. The endogamous way of life thus concentrated several families of siblings under one roof, headed by their father, the main householder. Therefore, especially in the second half of the 19th century, statistical sources often list several adults and many children in these households.[10] The poor economic situation did not allow housing to be built; as a result, these extended families often lived together in one or two rooms. These conditions had a significant impact on the spread of childhood infectious diseases, but also of epidemics affecting the adult population, since the possibility to isolate the infected and sick hardly existed.[11]

[7] Mária Ďurková, "Podpoľanie a najstaršie dejiny Detvy," *Historický časopis* 47 (1999): 383–403.

[8] Juraj Žudel, "Administratívne členenie územia Slovenska za dualizmu (1867–1918)," *Slovenská archivistika* 28 (1993): 79–80.

[9] Ján Zemko et al., *Detva* (Martin: Osveta, 1988).

[10] *Štátny archív v Banskej Bystrici*, fond Zvolenská župa, Podžupanské písomnosti Zvolenskej župy 1869–1918, kart. 562–564, sčítacie hárky Detva z roku 1869.

[11] Ján Golian, "Detva zahalená do smútku. Tri ničivé epidémie pustošiace mestečko v roku 1873," in *Pohromy, katastrofy a nešťastia v dejinách našich miest*, eds. Michal Bada and Diana Duchoňová (Bratislava: Igor Iliť–RádioPrint, 2019).

Characterization of the Population

In our research, we analyzed the population of Detva, located in Upper Hungary (currently the territory of central Slovakia) in present-day Slovakia (figure 1). The region consisted primarily of Catholics (approximately 98% to 99%). Detva inhabitants predominantly made a living as farmers, and to a lesser extent craftsmen, glassmakers, and shepherds. From the ethnic point of view, the region was primarily inhabited by Slovaks (96%), with linguistic minorities consisting of Germans, Hungarians, and Roma people.[12] Around the year 1830, there were 7,200 inhabitants in Detva. By the mid-1840s this had risen to 8,413, but subsequently nearly 1,000 people moved out of the region due to an economic crisis.[13] In the second half of the 19th century, the population grew, and at the end of the 1860s, there were 10,035 people in the region, while in the 1890s, 12,161 lived there.[14] Shortly before the First World War 14,529 inhabitants lived in the Detva region,[15] and after World War I, 14,300.[16]

Figure 1. The Detva region on the map of the Austrian Hungary Empire (in blue) against the boundaries of contemporary Slovakia (in white)

Map prepared based on "Distribution of Races in Austria-Hungary" from the *Historical Atlas* by William R. Shepherd, 1911, https://commons.wikimedia.org/wiki/File:Austria_hungary_1911_and_post_war_borders.jpg, last access 20 January 2024.

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[12] Ján Golian, *Život ľudu detvianskyho* (Ružomberok: The Society for Human Studies, 2019); *A Magyar Szent korona országainak* (1910).

[13] *Schematismus Almae Dioecesis Neosoliensis pro Anno* (Neosolii: Typis Philippi Machold, 1844); *Schematismus Almae Dioecesis Neosoliensis pro Anno MDCCCXLV* (Neosolii: Typis Philippi Machold, 1845).

[14] *Az 1869 évi népszámlálás vallási adatai* (KSH Levéltar 2005); *A Magyar korona országainak* (1892).

[15] *A Magyar Szent*.

[16] *Štatistický lexikón obcí v republike Československej III. Slovensko* (Praha: Státní úřad statistický, 1927).

The population size grew mainly due to a rising natural increase. In principle, young people did not have to overcome economic and social difficulties that would have delayed their entry into marriage. Especially in peasant families, after marriage they could live in their parents' house (usually in the groom's parents' house) and could work on the home farm. As a result, the age at first (protogamous) marriage was extremely low; until the 1850s, grooms were on average around 20 years old, with their brides a few years younger. In the second half of the 19th century, the age at marriage slowly rose, but not beyond 25, which created excellent conditions for an increase in population growth. As health and hygiene conditions in households improved in the second half of the 19th century, the proportion of children surviving to adulthood increased, which naturally increased the population size.[17]

For this study, material was derived from church death registers of the parish of Detva for the years 1831–1920 (N = 29,338): 1831–1860 (N = 7,939), 1861–1890 (N = 11,368), and 1891–1920 (N = 10,031). The church registers for this period were in good condition, of high quality and with reliable content. In Austrian lands, the many reforms introduced by Maria Theresa and Joseph II raised the quality and protection of the registers to a higher level.[18] From the 1830s, information on causes of death began to be recorded in Detva's parish registers. This was due to the cholera epidemic, during which the priests indicated whose death had been caused by the epidemic and who had died from another unspecified cause (cholera vs. non-cholera). In the records, we can also find data on the age at death of both adults and children. Information on the date of death and the date of burial began to appear in the records in the 1840s. Detva's parish registers were first kept in Latin, in the 1840s in Hungarian, and then, until the end of the 19th century, again in Latin. In the 1850s, new forms of burial registration were applied. Pre-printed books with fixed columns were used, and both the dates of death and the date of burial were also provided.

The quality of the sources studied in this work was verified with the use of the ratio of the number of births to the number of marriages (B/M), the number of deaths to the number of marriages (D/M), and the proportion of the number of boys to the number of girls born alive (B/G). The value of the B/M index ranged in villages from 4.5 to 5 and was often above 5.[19] In Detva, the B/M rates calculated for 1831–1860, 1861–1890, and 1891–1920 accounted for 4.91, 4.8, and 4.75, respectively. In the 19th century, the value of the D/M index was around 3, in some cases between 2.5 and 4, while in rural areas even above 4.[20] In our research, D/M ranged from 2.9 to 3.4: in 1831–1860, 1861–1890, and 1891–1920

[17] Golian, *Život.*

[18] Eva Cimmermannová, "Matrika ako historický prameň," *Historický časopis* 22 (1974): 76.

[19] Eduard Maur, "O počátcích a vývoji cirkevních matrik se zvláštním zřetelem k českým poměrům," *Historická demografie* 3 (1969): 4–19.

[20] Zygmund Sułowski, "O właściwą metodę wykorzystywania metryk kościelnych dla badań demograficznych," *Kwartalnik Historii Kultury Materialnej* 1–2 (1862): 81–101.

the D/M ratios were 3.2, 3.4, and 2.9, respectively. The sex ratio, i.e., the proportion of boys to girls born alive, is a very simple but accurate test of register accuracy. According to biological law, the sex ratio ranged between 101 and 107 boys per 100 girls, usually 105 boys per 100 girls.[21] The B/G ratios calculated for 1831–1860, 1861–1890, and 1891–1920 were 105, 101, and 102 boys per 100 girls, respectively.[22]

Methods

Life tables offer a complete statistical picture of mortality. In this work, life tables for the Detva region were compiled using the distribution of the deceased by age for three 30-year periods: 1831–1860, 1861–1890, and 1891–1920. They were made for the following model situations:

1. a stationary population model, assuming that fertility and mortality balance each other, and that sex and age structure do not change over time. In this case, the life tables were constructed using Halley's classical method;[23]
2. for longer periods, however, the stationary population model is an oversimplification, and the stable population model is closer to reality. In this case, before the calculation of life table parameters, distributions of the deceased were reconstructed, with the introduction of the population growth value. In this paper, population growth was introduced into life tables built for the stationary population model (the situation described in 1) according to Holzer's formula:[24]

$$Dx' = Dx\left(1+\frac{r}{1000}\right)^{x}$$

In the formula, D_x' represents the number of deceased at age *x* for a stable population, while D_x is the number of deceased at age *x* for a stationary population, *r* is the annual population growth, and *x* is the number of years from birth to death.

[21] Irena Gieysztorowa, "Od metryk do szacunków ludności," *Kwartalnik Historii Kultury Materialnej* 12 (1964): 283–98; Irena Gieysztorowa, *Wstęp do demografii staropolskiej* (Warszawa: PWN, 1976).

[22] Calculated on the basis of information derived from the Detva parish registers. *Štátny archív v Banskej Bystrici*, fond Zbierka cirkevných matrík, Matričné knihy farnosti Detva; Diecézny archív Banská Bystrica, Druhopisy matrík farnosti Detva.

[23] György Acsádi and János Nemeskéri, *History of Human Life Span and Mortality* (Budapest: Akadémiai Kiadó, 1970).

[24] Jerzy Z. Holzer, *Demografia* (Warszawa: PWN, 1970).

3. In the last model situation, a stable population was used again, but deaths due to infectious diseases were excluded from each age category and the population growth value was re-calculated using the numbers of deaths reduced by deaths due to infectious diseases.

The population growth, *r*, was calculated as the difference between the number of births and the number of deaths related to the population size.[25] In 1831–1860 there were three cholera outbreaks noted in the Detva region, responsible for 315 deaths (r = 16‰). When cholera deaths were excluded from the dataset, the population growth increased from 16‰ to 17.6‰. In 1861–1890 there were 10 infectious disease epidemics that swept through the Detva region: smallpox (1864, 1873, 1881), whooping cough (1864, 1869, 1873, 1885), cholera (1873), and measles (1865, 1885). All of these caused 1,180 deaths. The population growth for 1861–1890 was at a level of 11.3‰. After the exclusion of all deaths caused by epidemics of infectious diseases, its value increased to 16‰. In 1891–1920, outbreaks of diphtheria (in 1891 and 1902), whooping cough (1892), smallpox (1902), measles (1915), and Spanish flu (1918–1920) were noted in the region. These epidemics were responsible for 465 deaths (r = 16‰). When these deaths were excluded from the dataset, the *r* value increased to 17‰.

The most widely known and most commonly used parameter in life tables is life expectancy at birth, e_0. This details how many years an average individual in a given population at the time of birth is expected to live. Life expectancies were calculated for selected age categories: 0, 5, 15, 20, and 60 years. Further, for the same age groups the proportion of deceased (d_x), the fraction of surviving to a given age group (l_x), and the probability of dying (q_x) were computed and characterized in this work.

On the basis of the life table parameters, the measures of the opportunity for natural selection through differential mortality were calculated for 3 periods: 1831–1860, 1861–1890, and 1891–1920. One of these was the classic Crow's index I_m,[26] which measures the opportunity for natural selection through differential mortality among sexually immature individuals. It enumerates the proportion of children who failed to survive until reproductive age (P_d; conventionally, individuals dying before age 15) to the number of children who reached reproductive age (P_s). The index is calculated from the following formula: $I_m = P_d / P_s$.[27]

[25] Roland Pressat, *Analiza demograficzna: metody, wyniki, zastosowania* (Warszawa: PWN, 1961).

[26] James F. Crow, "Some Possibilities for Measuring Selection Intensities in Man," *Human Biology* 30 (1958): 763–75.

[27] Crow, "Some Possibilities."

Crow's index does not reflect the differences in adult mortality. More complete information on mortality in a population is given by the biological state index I_{bs},[28] which reflects both mortality among sexually immature individuals and those of reproductive age, and is calculated from the following formula:

$$I_{bs} = 1 - \sum_{x=0}^{\omega} d_x s_x, \text{ where}$$

d_x is the fraction of individuals who died at age x, ω is the age of the oldest individual in the group, and s_x is the reproductive loss index. This is the probability there will be no possession of a total number of offspring by individuals at age x. It stems from an "archetype of fertility" for non-Malthusian populations. In this study, the authors used s_x values estimated by Henneberg.[29] The biological state index I_{bs} has a component: the potential gross reproductive rate R_{pot}. It is defined as a measure of opportunity for natural selection through the differential mortality of adult individuals and is described by the following formula:[30]

$R_{pot} = 1 - \sum_{x=15}^{\omega} d_x s_x$. The symbols in the formula have been explained above.

In other words, when calculating R_{pot} we take into account the fraction of sexually mature deceased, i.e., from the age of 15 (parameter d_{15}) up to the oldest age category (parameter d_{ω}).[31] The values of R_{pot} and I_{bs} range from 0–1: 0 means a lack of adaptation and impossibility to give life to the next generations, while 1 means total adaptation of a population, with no operation of natural selection.

Results

The values of the abbreviated life tables' biometric functions in the three periods are shown in table 1. In 1831–1860, life expectancy at birth e_0 assumed the value of only 22.2 years, 50.6% of the population survived to the age of 5 years (parameter: l_5), 42% reached reproductive age (conventionally 15 years of age; parameter: l_{15}),

[28] Maciej Henneberg, "Notes on the Reproduction Possibilities of Human Prehistorical Populations," *Przegląd Antropologiczny* 41 (1975): 75–89; Maciej Henneberg, "Reproductive Possibilities and Estimations of the Biological Dynamics of Earlier Human Populations," in *The Demographic Evolution of Human Populations*, eds. Richard H. Ward and Kenneth M. Weiss (London: Academic Press, 1976), 41–8; Maciej Henneberg and Janusz Piontek, "Biological State Index of Human Groups," *Przegląd Antropologiczny* 41 (1975): 191–201.

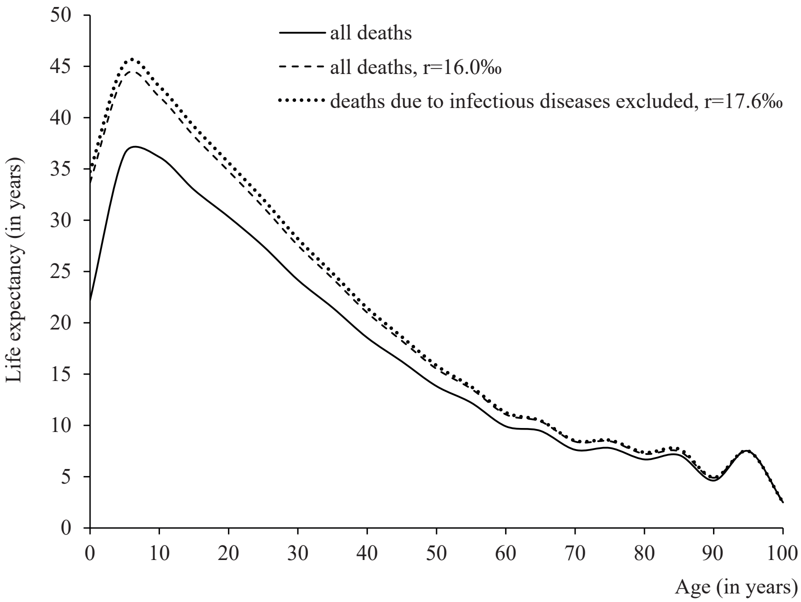
[29] Henneberg, "Notes," "Reproductive Possibilities."

[30] Ibidem.

[31] Ibidem.

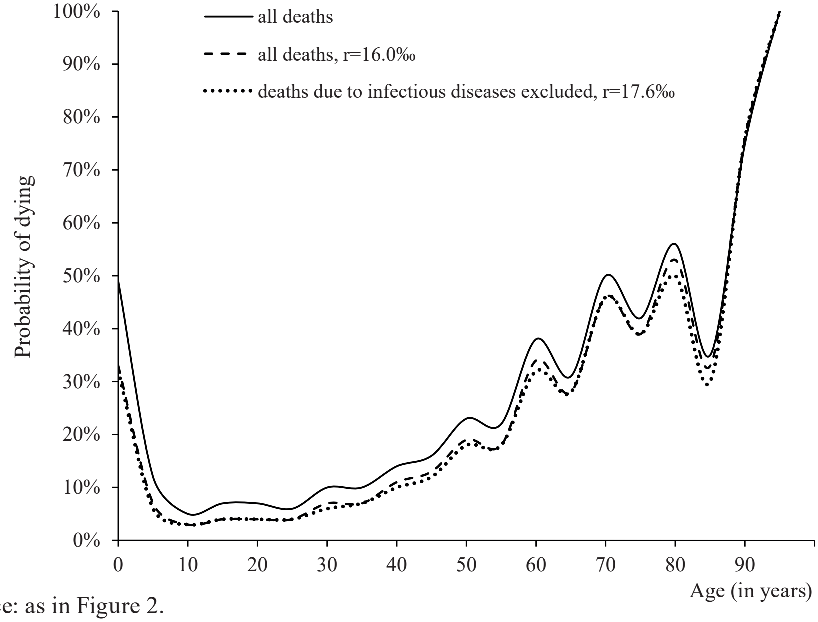
while 12% reached senility (conventionally 60 years of age; parameter: l_{60}). The probability of dying at 0–4.99 (parameter q_0) was 49%. The introduction of population growth, r = 16.0‰, to the distribution of the deceased in the stationary population model, improves the parameters of the life tables. A new-born had a chance of living 33.7 years, an adult (conventionally 20 years; parameter: e_{20}) 34.8 years, almost 67% and over 23% of the population survived to the ages of 5 and 60, respectively, and the probability of dying in the class 0–4.99 was 33%. The exclusion of deaths caused by infectious disease epidemics (in this period there were cholera epidemics responsible for 315 deaths) increased the value of population growth to 17.6‰ which again improved the life-table parameters. The life expectancy of a new-born and of an adult increased by 1 year compared to the previous situation. Over 67% and 61% of the population survived to the age of 5 and the onset of maturity (l_{15} years), respectively, while over 25% reached the onset of senility (60 years). Apart from table 1, the values of life expectancies and probabilities of dying for 1831–1860 are shown in figures 2–3.

Figure 2. Life expectancy in the Detva population, 1831–1860



Source: Authors' calculations based on church death registers of the parish of Detva for the years 1831–1920, derived from State Archive of Banska Bystrica, Fond: The Collection of parish books of the Detva parish.

Figure 3. Probability of dying in the Detva population, 1831–1860

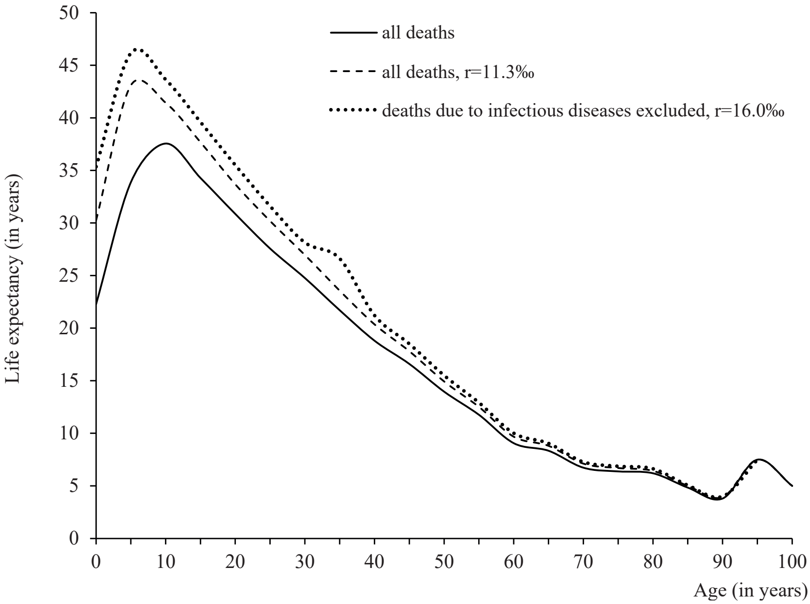


Source: as in Figure 2.

As mentioned earlier (in the *Methods* section), in 1861–1890, 10 infectious disease epidemics swept through the Detva region, in turn: smallpox, whooping cough, cholera, and measles, causing 1,180 deaths altogether. The population growth rate was 11.3‰. The life expectancy of a statistically newly born child was 30 years (parameter: e_0), while after the first 5 years of life, an average child had a chance of living 43 years (parameter: e_5). The probability of dying ($q_{0\text{-}4.9}$) was 39%, while 54.5%, 52.8%, and 21.6% of individuals survived to the beginning of reproduction (parameter: l_{15}), adulthood (parameter: l_{20}), and senility (parameter: l_{60}), respectively. The exclusion of deaths due to infectious diseases significantly improved the value of the population growth rate (an increase to 16‰) and consequently the life-table parameters: e_0 increased by 5 years (35.4 years), and e_{20} increased by almost 2 years (see also figure 4). To the beginning of 15, 20, and 60 years 62.5%, almost 61%, and 27.5% of individuals survived, respectively. The probability of dying, q_0, declined from 39% (r = 11.3‰) to 32% (r = 16‰) (see also figure 5).

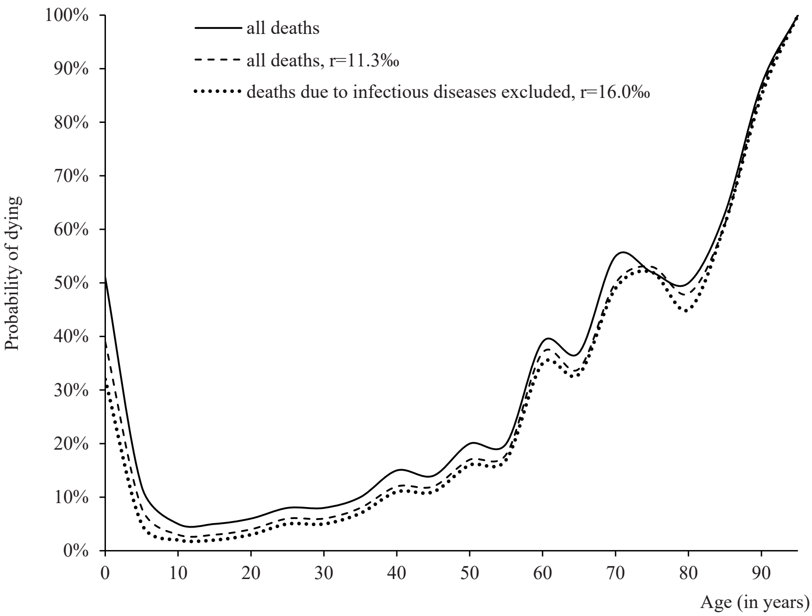
In 1891–1920, epidemics of diphtheria, whooping cough, smallpox, measles, and Spanish flu were responsible for 465 deaths altogether (r = 16‰). After their exclusion, the *r* value increased to 17‰, and then an average newborn had a chance of living 38 years (table 1; see also figure 6), while the probability of dying at 0–4.99 was at the level of 31% (table 1, see also figure 7). The fraction of surviving to the beginning of reproduction, adulthood, and senility was 63.8%, 62%, and 33%, respectively (table 1).

Figure 4. Life expectancy in the Detva population, 1861–1890



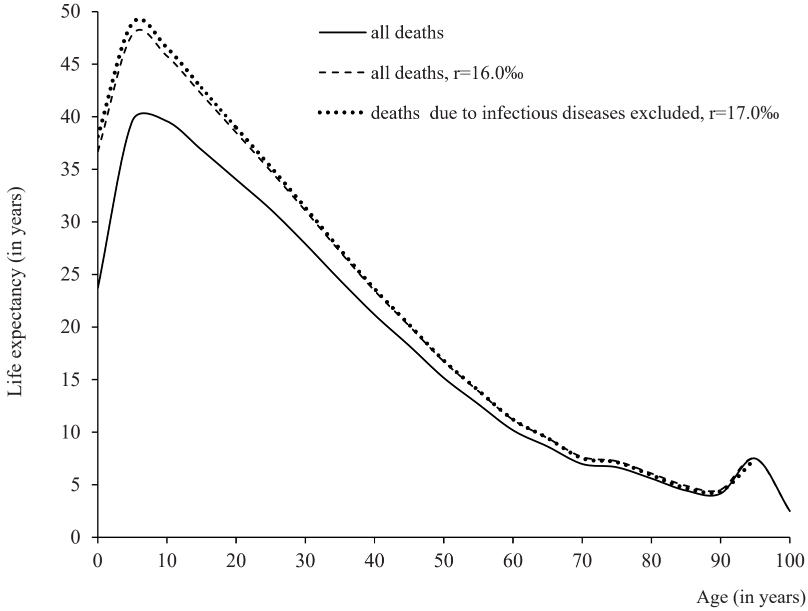
Source: as in Figure 2.

Figure 5. Probability of dying in the Detva population, 1861–1890



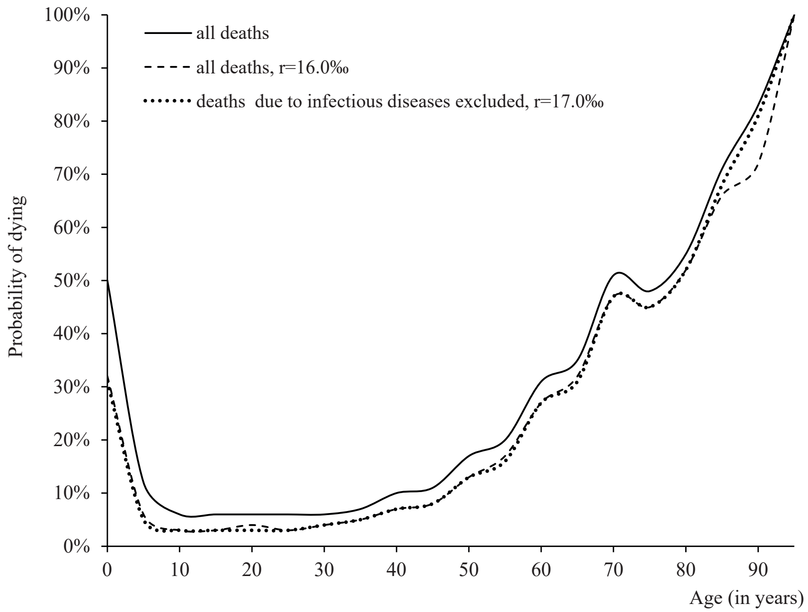
Source: as in Figure 2.

Figure 6. Life expectancy in the Detva population, 1891–1920



Source: as in Figure 2.

Figure 7. Probability of dying in the Detva population, 1891–1920



Source: as in Figure 2.

Table 1. Abbreviated life-table biometric functions in the population under study (selected age categories)

1831–1860	Stationary population model				Stable population model, r = 16.0‰				Stable population model, r = 17.6‰*			
Age	d_x	l_x	q_x	e_x	d_x	l_x	q_x	e_x	d_x	l_x	q_x	e_x
0	49.39	100.00	0.49	22.23	33.09	100.00	0.33	33.68	32.49	100.00	0.32	34.76
5	6.12	50.61	0.12	36.49	4.44	66.91	0.07	44.09	4.11	67.51	0.06	45.28
15	3.02	42.22	0.07	32.98	2.57	60.69	0.04	38.21	2.36	61.71	0.04	39.16
20	2.80	39.20	0.07	30.33	2.57	58.12	0.04	34.79	2.45	59.36	0.04	35.62
60	4.58	12.05	0.38	9.91	7.96	23.76	0.34	11.07	8.23	25.43	0.32	11.26
1861–1890	Stationary population model				Stable population model, r = 11.3‰				Stable population model, r = 16.0‰*			
0	50.99	100.00	0.51	22.29	39.08	100.00	0.39	30.27	32.45	100.00	0.32	35.36
5	5.73	49.01	0.12	37.88	4.64	60.92	0.08	43.09	3.66	67.55	0.05	46.15
15	1.94	41.25	0.05	34.29	1.76	54.52	0.03	37.69	1.50	62.46	0.02	39.60
20	2.23	39.30	0.06	30.86	2.14	52.76	0.04	33.86	1.98	60.96	0.03	35.51
60	5.25	13.31	0.39	9.06	7.90	21.63	0.37	9.68	9.62	27.50	0.35	10.01
1891–1920	Stationary population model				Stable population model, r = 16.0‰				Stable population model, r = 17.0‰*			
0	49.63	100.00	0.50	23.71	32.06	100.00	0.32	36.69	30.65	100.00	0.31	38.14
5	5.95	50.37	0.12	39.61	4.16	67.94	0.06	47.82	3.76	69.35	0.05	48.90
15	2.49	41.86	0.06	36.85	2.04	61.84	0.03	42.14	1.85	63.85	0.03	42.75
20	2.51	39.37	0.06	34.03	2.23	59.79	0.04	38.49	2.09	62.00	0.03	38.96
60	5.07	16.32	0.31	10.18	8.50	31.18	0.27	11.18	8.95	33.04	0.27	11.21

* Deaths due to infectious diseases excluded

Source: as in Figure 2.

Table 2 demonstrates the values of measures for the opportunity for natural selection through differential mortality, calculated on the life-table parameters. In the stationary population models, a high selective pressure against infants and children was observed, which was confirmed by Crow's Index values, at over 1. The biological state index I_{bs} indicated high mortality levels in both children and adults. In all the periods under study, only 34–35% of individuals had a chance of fully participating in reproduction (I_{bs}), while 81%–84% of adults had this chance (R_{pot}). After introducing the population growth value into the stationary population model, the natural selection operation measures clearly improved (table 2). This is especially evident when deaths due to infectious diseases were excluded: the values of Crow's Index dropped by more than half. In the subsequent 30-year periods the values fell to 0.62, 0.60, and 0.56, respectively. The value of the biological state index, $I_{bs,}$ increased by one and a half: 54%, 56%, and 58% of individuals had a chance of participating in reproduction, respectively. In the Detva region, in the last period, even 91% of adults had a chance of achieving a certain level of reproduction, limited by the mortality of individuals of reproductive age.

Table 2. Measures of the opportunity for natural selection through differential mortality in the population under study

Period	Model situations	I_m	R_{pot}	I_{bs}
	All deaths, r = 0.0‰	1.37	0.81	0.34
1831–1860	All deaths, r = 16.0‰	0.64	0.87	0.53
	Deaths due to infectious diseases excluded, r = 17.6‰	0.62	0.88	0.54
	All deaths, r = 0.0‰	1.42	0.83	0.34
1861–1890	All deaths, r = 11.3‰	0.83	0.87	0.48
	Deaths due to infectious diseases excluded, r = 16.0‰	0.60	0.90	0.56
	All deaths, r = 0.0‰	1.39	0.84	0.35
1891–1920	All deaths, r = 16.0‰	0.62	0.90	0.56
	Deaths due to infectious diseases excluded, r = 17.0‰	0.56	0.91	0.58

Source: as in Figure 2.

Discussion

In the 19th century, the population size in the Detva region was fundamentally affected by infectious disease epidemics. However, at that time epidemics affected the demographic behavior in Europe as a whole, not only in the Habsburg Monarchy.

In the 19th century, infectious diseases were the main regulator of population size in Europe and the United States.[32] For example, in the Opole district of the second half of the 19th century, 13.5% of the inhabitants died of whooping cough, scarlet fever and diphtheria.[33] In the rural and industrial towns of Victorian England in the 1880s and 1890s, deaths from whooping cough, measles and scarlet fever accounted for 5.9% and 13.5% of all causes of death, respectively,[34] and due to diarrhea, 4.8% and 39.6% of the population died in rural and town areas, respectively.[35] A lack of hygiene, poor access to clean water and lack of sanitary sewage systems were the main causes of infectious disease epidemics in the city

[32] Ole Jørgen Benedictow, "Morbidity in Historical Plague Epidemics," *Population Studies* 41 (1987): 401–31; Patrice Bourdelais, "Cholera: A Victory for Medicine?," in *The Decline of Mortality in Europe*, eds. Roger Schofield, David S. Reher, and Alain Bideau (Oxford: Clarendon Press, 1991), 118–30; Kent Johansson, *Child Mortality during the Demographic Transition: A Longitudinal Analysis of a Rural Population in Southern Sweden, 1766–1894* (Lund: Lund University Press, 2004); John Landers, "Historical Epidemiology and the Structural Analysis of Mortality," *Health Transition Review* 2 (1992): 47–75; *Death and the Metropolis: Studies in the Demographic History of London 1670–1830* (Cambridge: Cambridge University Press, 1993); Johan P. Mackenbach and Caspar W. N. Looman, "Secular Trends of Infectious Disease Mortality in the Netherlands, 1911–1978: Quantitative Estimates of Changes Coinciding with the Introduction of Antibiotics," *International Journal of Epidemiology* 17 (1988): 618–24; Kari J. Pitkänen, James H. Mielke, and Lynn B. Jorde, "Smallpox and Its Eradication in Finland: Implications for Disease Control," *Population Studies* 43 (1995): 95–111; Samuel H. Preston and Michael R. Haines, *Fatal Years: Child Mortality in Late Nineteenth-Century America* (Princeton, NJ: Princeton University Press, 1991); Samuel H. Preston and Etienne van de Walle, "Urban French Mortality in the Nineteenth Century," *Population Studies* 32 (1978): 275–97; Frans van Poppel, Marianne Jonker, and Kees Mandemakers, "Differential Infant and Child Mortality in Three Dutch Regions, 1812–1909," *Economic History Reviews* 58 (2005): 272–309; Naomi Williams and Chris Galley, "Urban-Rural Differentials in Infant Mortality in Victorian England," *Population Studies* 49 (1997): 401–20; Judith H. Wolleswinkel-van den Bosch, Caspar W. N. Looman, Frans W. A. van Poppel, and Johan P. Mackenbach, "Cause-Specific Mortality Trends in The Netherlands, 1875–1992: A Formal Analysis of the Epidemic Transition," *International Journal of Epidemiology* 26 (1997): 772–81; Judith H. Wolleswinkel-van den Bosch, Frans W. A. van Poppel, Caspar W. N. Looman, and Johan P. Mackenbach, "Determinants of Infant and Early Childhood Mortality Levels and Their Decline in the Netherlands in the Late Nineteenth Century," *International Journal of Epidemiology* 29 (2000): 1031–40; Judith H. Wolleswinkel-van den Bosch, Frans W.A. van Poppel, Ewa Tabeau, and Johan P. Mackenbach, "Mortality Decline in the Netherlands in the Period 1850–1992: A Turning Point Analysis," *Social Science & Medicine* 47 (1998): 429–43; Judith H. Wolleswinkel-van den Bosch, Frans W. A. van Poppel, Caspar W. N. Looman, and Johan P. Mackenbach, "The Role of Cultural and Economic Determinants in Mortality Decline in the Netherlands, 1875/1879–1920/1924: A Regional Analysis," *Social Science & Medicine* 53 (2001): 1439–53; Robert I. Woods, Patricia A. Watterson, and John H. Woodward, "The Causes of Rapid Infant Mortality Decline in England and Wales, 1861–1921 Part I," *Population Studies* 42 (1988): 343–66; Robert I. Woods, Patricia A. Watterson, and John H. Woodward, "The Causes of Rapid Infant Mortality Decline in England and Wales, 1861–1921. Part II," *Population Studies* 43 (1989): 113–32.

[33] Michael R. Haines, "Population and Economic Change in Nineteenth-Century Eastern Europe: Prussian Upper Silesia, 1840–1913," *Journal of Economic History*, 36 (1976): 334–59.

[34] Authors' calculations based on Williams, Galley, *Urban-Rural*.

[35] Williams and Galley, *Urban-Rural.*

of Poznań, capital of the 19th-century Poznań Province.[36] The high infant death rates in England and Wales in 1890 were due to excess deaths from diarrhea during the summer.[37] Excess infant mortality due to diarrhea and dysentery during the summer months was recorded for the English city of Birmingham in 1892 and 1911.[38] Nineteenth-century London followed a similar pattern.[39]

Since the 1830s several waves of infectious disease epidemics of various origins had been recorded in the Detva region. This translated into an increase in the crude death rates in the epidemic years from over 30 deaths per 1,000 population to over 90 deaths per 1,000 population in 1873, when another wave of cholera hit the population (figure 8). At the beginning of 1831, the first wave of the cholera epidemic hit here. It killed 84 people in the parish: 42 men and 42 women. One-quarter of the victims were children under the age of 14 years, almost 48% were individuals in the reproductive age category, i.e., aged 15–49, and slightly over 27% were 50 and older. The most significant epidemic of childhood diseases occurred in the first half of 1842 and was responsible for 243 children's deaths out of 429 total deaths in this year. Child deaths, therefore, accounted for almost 57% of all deaths in 1842. It could have been the widespread smallpox epidemic which at that time was raging in the largest city of Zvolen county, in Banská Bystrica, 40 kilometers from Detva. The end of the 1840s was additionally marked by crop failure and famine, and the 1850s were affected by economic crises. Two more waves of cholera spread through the region in these years. In 1849, the cholera epidemic killed 84 people. The highest proportion of victims, over 64%, were again individuals of reproductive age, 15–49 years. In 1855, an even bigger wave of cholera hit the region and was responsible for 162 deaths: 93 men and 62 women; 39% of children under 14 years and 42% in the reproductive age category. The great number of immature victims and individuals of reproductive age was confirmed in this study by the values of the measures of selection pressure: the high value of Crow's index and a low chance to achieve a certain level of reproduction (parameters: I_{bs} and R_{pot}). All the infectious disease epidemics that occurred in 1831–1860 shortened the life expectancy of a newborn by one year. In addition to the epidemics, the region was hit by other disasters, for example, the great fire in Detva in September 1833. It was the most devastating fire Detva had experienced in its 120-year history. Almost all of Detva was burnt down

[36] Liczbińska, "Ecological Conditions," "Infant," *Lutherans*.

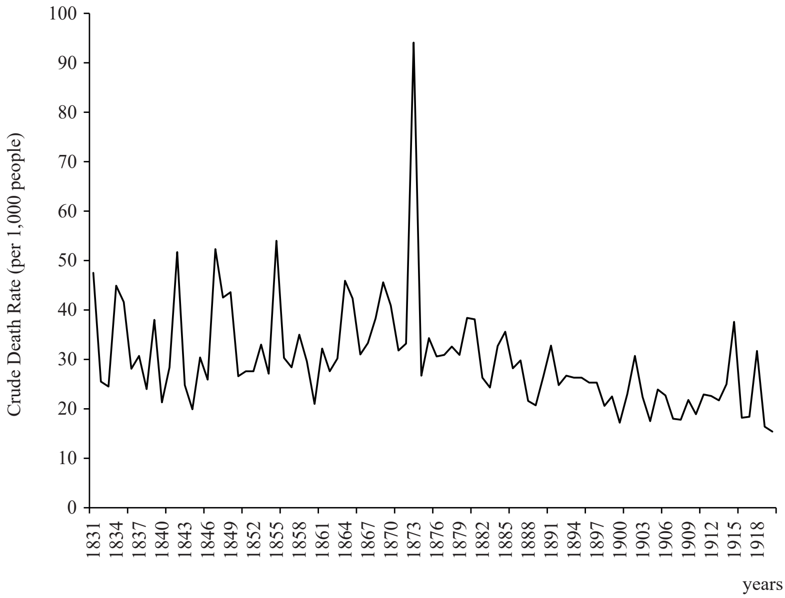
[37] Woods, Watterson, and Woodward, *The Causes*.

[38] Robert Woods, "Public Health and Public Hygiene: The Urban Environment in the Late Nineteenth and Early Twentieth Centuries," in *The Decline of Mortality in Europe*, eds. Roger Schofield, David S. Reher, and Alain Bideau (Oxford: Clarendon Press, 1991), 233–47; Woods, Watterson, and Woodward, *The Causes*.

[39] Landers, *Historical Epidemiology*.

and people lost their property.[40] Moreover, the economic crisis and poverty in the mid-1850s were noted in the region as the results of the cholera epidemic's impact on the regional economy.[41]

Figure 8. Changes in the Crude Death Rates over time in the Detva population, 1831–1920



Source: as in Figure 2.

In the following three decades, infectious disease epidemics hit the Detva region to a stronger extent compared to 1831–1860. From January to May 1864, epidemics of whooping cough (*tussis* or *pertussis*) and smallpox (*variola*) spread through the region. Whooping cough affected mainly children under 1 year of age, while smallpox affected children under 4. Between March and July 1865, the child population aged 1 month to 4 years was affected by measles, recorded in the parish books as *morbilli*. Meanwhile, the wave of the cholera epidemic in 1866 almost passed the Detva region by, with only 7 people dying of it. When compared to the city of Banská Bystrica, this was a completely different trend; there, the wave of cholera was most destructive and claimed significantly more victims than in Detva.

[40] Štátny archív Banská Bystrica, Sťažnosť obyvateľov mesta 1836.

[41] Ján Golian and Grażyna Liczbińska, "The Influence of Extreme Exogenous Shocks on the Sex Ratio at Birth: A Study of the Detva Population (Upper Hungary), 1801–1920," *Romanian Journal for Population Studies* 16, no. 2 (2022): 27–52.

In 1869, a whooping cough epidemic again affected the child population aged under 4, while four years later, i.e., in 1873, whooping cough, smallpox, and cholera swept the region: 179 children below the age of 4 years died of whooping cough. In the same age category, smallpox killed more than 100 children. The greatest number of people fell victim to the last wave of the cholera epidemic, which killed more than 400, 220 males and 184 females, including children aged under 14, and individuals in the reproductive age group. The recurrence of a major smallpox epidemic in Detva was recorded from February to May 1881. In the first half of 1885, whooping cough and smallpox once again affected the children's population. Epidemics in 1861–1890 caused 1,180 deaths. The epidemics' effects were felt in the local economy in the following years.[42] It was the largest number of victims against the background of the three periods analyzed. To illustrate how strong their impact was, after the elimination of deaths caused by all infectious disease epidemics from the material, the life expectancy of a newborn increased by 5 years, while the value of the Crow's index I_m dropped to slightly over 0.6, and 56% of the total population and 90% of adults had a chance of reproduction. This confirms the strong selection pressures against children and adults caused by infectious disease epidemics at that time and the lack of tools to combat them.

In 1891–1920, the population in Detva was again affected by epidemics of infectious diseases. Moreover, in the first decade of the 20th century a deterioration in the economic situation of the region, caused by an economic crisis in Hungary, was observed.[43] It was a very difficult time for Detva's inhabitants due to the conscription of men, loss of property and family members, the economic crisis, a lack of food and no sense of security.[44] One of the most serious epidemics was of whooping cough, which occurred in early 1891. Although this disease did not take as many victims as in its previous waves, the majority were children between their 1st month and their 1st year of life. The second epidemic was of diphtheria (*dipheritis*), in March and May 1891, killing children up to the age of 14. In 1902, 3 epidemics broke out in Detva, all from January to August. In the first three months of 1901 there was an outbreak of diphtheria, while in March scarlet fever (*scarlatina*) began circulating. Scarlet fever was already widespread in Europe in the middle of the 19th century, but it reached Detva quite late.[45] From April to August 1902, smallpox was reported in Detva, as was whooping cough in January 1915. In the final years of the 1890–1920 period, infectious diseases predominated among children. The exception was

[42] Golian, "Detva."

[43] Milan Podrimavský, Dušan Kováč, and Palo Hapák, *Dejiny Slovenska IV (od konca 19. storočia do roku 1918)* (Bratislava: Veda, 1986).

[44] Golian and Život.

[45] Stephen R. Duncan, Susan Scott, and Christopher. J. Duncan, "Modelling the Dynamics of Scarlet Fever Epidemics in the 19th Century," *European Journal of Epidemiology* 16 (2000): 619–26.

Spanish flu, which arrived in Slovakia at the end of 1918. It was the second wave of this epidemic, since the first had hardly made itself felt in Upper Hungary.[46] From the end of September to the end of 1918, 212 people died of Spanish flu in the region, mainly at a young age.

The gradual decrease in the number of deaths caused by infectious disease epidemics was a result of the improvement in rural sanitary conditions, the development of a network of doctors and hospitals, and a general improvement in health and hygiene education in the region. In the early 19th century, the number of medical personnel was very limited, with only one doctor per 75,000 people. Very often "medical personnel" were not university-educated doctors but healers or army medics who could not give any effective help against epidemics. By the end of the 19th century, tertiary medical education had become more effective and the number of doctors increased, the number of clinics increased, including outpatient clinics, especially in cities, but also the development of health spas, which was associated with the presence of medical doctors. Due to these reforms, the number of patients per physician dropped to approximately 4,000.

Education and increasing levels of hygiene also helped to reduce the number of victims of epidemics. This was especially true in rural areas through professionally trained midwives who, in addition to childbirth and postpartum care, also helped during epidemics and pandemics. At the turn of the 20th century, the dissemination of information through newspapers, calendars, and educational books were effective in helping combat epidemics. Literacy rates increased among ordinary people and thus became an ally in the fight, coping with, and helping prevent epidemics.[47] According to the 1880 population census, the literacy rate was 44.6%, but by 1910 it had reached 72.3%, while in cities it was around 90%.[48] This health awareness, combined with medical progress, including mandatory (smallpox) vaccination, effectively reduced the number of victims of all types of epidemics.[49]

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[46] Veronika Szeghy-Gayer, "The Second Wave of the Spanish Influenza Pandemic in Selected Regions and Towns of Slovakia (1918)," *Individual and Society/ Človek a spoločnosť* 25, no. 2 (2022): 1–12.

[47] Pavol Tišliar and Branislav Šprocha, *Premeny vybraných charakteristík obyvateľstva Slovenska v 18.–1. pol. 20. storočia* (Bratislava: Muzeológia a kultúrne dedičstvo o.z.; Centrum pre historickú demografiu a populačný vývoj Slovenska FiF UK v Bratislave, 2017).

[48] Ibidem.

[49] See examples in Ján Golian, "Possibilities of Studying Epidemics of Cholera in Upper Hungary (Contemporary Slovakia) in the 19th Century," *Studia Historiae Oeconomicae* 40, no. 1 (2022): 71–4.

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The Operation of Natural Selection through Differential Mortality: The Detva Population during the Great Epidemics, 1831–1920

Summary

This work had two aims: firstly, to examine the extent to which deaths caused by infectious disease epidemics influenced the life expectancy, the proportion of deceased and survivors, and the probability of dying in the Detva population, 1831–1920, and secondly, to measure selection pressures through differential mortality with a special emphasis on deaths caused by infectious disease epidemics. The Detva population (Upper Hungary), located in contemporary central Slovakia, was analyzed. Church death registers for the parish of Detva, for three 30-year periods: 1831–1860 (*N* = 7,939), 1861–1890 (*N* = 11,368), and 1891–1920 (*N* = 10,031) were examined in this study. Life tables were constructed based on the distribution of deceased for a stationary population model (Halley's classical method), a stable population model with the introduction of the population growth value, and for a stable population model with deaths due to infectious diseases excluded from each age category. From the life-table parameters, measures of the opportunity for natural selection through differential mortality were calculated: the classic Crow's Index I_m, the biological state index I_{bs}, and the potential gross reproductive rate R_{pot}. In 1831–1860 there were three cholera outbreaks recorded in the region, which were responsible for 315 deaths. When cholera deaths were excluded from the dataset, the population growth increased from 16‰ to 17.6‰. In 1861–1890, there were 10 infectious disease epidemics that swept through Detva: smallpox (1864, 1873, 1881), whooping cough (1864, 1869, 1873, 1885), cholera (1873), and measles (1865, 1885). In total they resulted in 1,180 deaths. Population growth in 1861–1890 was at a level of 11.3‰. After the exclusion of all deaths caused by epidemics of infectious diseases, its value increased to 16‰. In 1891–1920 outbreaks of diphtheria (in 1891 and 1902), whooping cough (1892), smallpox (1902), measles (1915), and Spanish flu (1918–1920) were noted in the region. These epidemics were responsible for 465 deaths, r = 16‰. When these deaths were excluded from the analysis, the r value increased to 17‰. In all 3 periods studied, the exclusion of deaths caused by infectious disease epidemics improved the life-table parameters. In 1831–1860 the life expectancy of a newborn and of an adult increased by over 1 year compared to the model based on the distribution of all deaths. Over 67% and 61% of the population survived to the age

of 5 and to the onset of maturity (15 years), respectively, while over 25% to the onset of senility (60 years). In 1861–1890 the e_0 value increased by 5 years (35.4 years), and e_{20} by almost 2 years. 62.5% of individuals survived to the beginning of maturity (15 years), while almost 61% and 27.5% of individuals survived to 20 and 60 years, respectively. The q_0 value declined from 39% (r = 11.3‰) to 32% (r = 16‰). In 1891–1920 an average newborn now had a chance to live 38 years, while the probability of dying at 0–4.99 was 31%. The fraction of those surviving to the beginning of reproduction (15 years), adulthood (20 years), and senility (60 years) was 63.8%, 62%, and 33%, respectively. The values of measures for the operation of natural selection improved when deaths due to infectious diseases were excluded from the analysis: the Crow's Index value dropped by more than half, the value of the biological state index, I_{bs}, increased by one and a half, and over 90% of adults had a chance of achieving a certain level of reproduction, limited by the mortality of individuals at reproductive age. The improvement in the biological status of the Detva population was influenced by the development of medical care, including infrastructure and an increase in the number of well-qualified medical personnel, and, ultimately, the development of pro-health awareness among the Detva inhabitants, which made it possible to effectively fight epidemics and reduce the number of cases and deaths due to infectious diseases.

Działanie doboru naturalnego przez zróżnicowaną umieralność. Populacja Detvy w czasie wielkich epidemii w latach 1831–1920

Streszczenie

W pracy sformułowano dwa cele: po pierwsze zbadanie, w jakim stopniu zgony spowodowane epidemiami chorób zakaźnych wpłynęły na wartość oczekiwanego dalszego trwania życia, frakcję zmarłych i dożywających oraz prawdopodobieństwo zgonu w populacji Detva w latach 1831–1920, po drugie – zmierzenie nacisków selekcyjnych poprzez zróżnicowaną umieralność, ze szczególnym uwzględnieniem zgonów wywołanych przez epidemie chorób zakaźnych. Analizie poddano populację Detvy (Górne Węgry), położoną obecnie na terenie środkowej Słowacji. Wykorzystano wypisy z parafialnych ksiąg zgonów parafii Detva, dla trzech 30-letnich okresów: 1831–1860 (N = 7939), 1861–1890 (N = 11368) i 1891–1920 (N = 10031), dla których zbudowano tablice wymieralności na podstawie rozkładów zmarłych w klasach wieku: dla modelu populacji zastojowej (klasyczna metoda Halleya), modelu populacji ustabilizowanej na wartość przyrostu naturalnego oraz dla populacji ustabilizowanej na przyrost naturalny po usunięciu z poszczególnych kategorii wieku zgonów wywołanych epidemiami chorób zakaźnych. Parametry tablic wymieralności posłużyły do obliczeń mierników sposobności do działania doboru naturalnego przez różnicową wymieralność: klasycznego wskaźnika Crowa I_m, wskaźnika stanu biologicznego populacji I_{bs} oraz współczynnika reprodukcji potencjalnej R_{pot}. W latach 1831–1860

odnotowano trzy ogniska cholery, które spowodowały łącznie 315 zgonów w badanym regionie. Po wykluczeniu z bazy zgonów na cholerę współczynnik przyrostu naturalnego wzrósł z 16‰ do 17,6‰. W latach 1861–1890 przez region Detva przetoczyło się 10 epidemii chorób zakaźnych: ospy (1864, 1873, 1881), krztuśca (1864, 1869, 1873, 1885), cholery (1873) i odry (1865, 1885). Wszystkie spowodowały śmierć 1180 osób. Przyrost naturalny w latach 1861–1890 kształtował się na poziomie 11,3‰. Po wyłączeniu zgonów na choroby zakaźne jego wartość wzrosła do 16‰. W latach 1891–1920 odnotowano epidemię błonicy (w 1891 i 1902), krztuśca (1892), ospy (1902), odry (1915) i grypy hiszpanki (1918–1920). Epidemie te były odpowiedzialne za 465 zgonów, r = 16‰. Po ich usunięciu wartość *r* wzrosła do 17‰. We wszystkich badanych okresach wyłączenie z analiz zgonów na choroby zakaźne poprawiło parametry tablicy wymieralności. W latach 1831–1860 oczekiwane dalsze trwanie życia noworodka i osobnika dorosłego wzrosło o ponad rok. Ponad 67% i 61% populacji dożyło odpowiednio do 5. roku i początku dojrzałości (15 lat), a ponad 25% do początku starości (60 lat). W latach 1861–1890 wartość e_0 wzrosła o 5 lat (35,4 lat), e_{20} o prawie 2 lata. Do początku dojrzałości (15 lat) dożyło 62,5% osobników, zaś do początku 20 i 60 lat odpowiednio: prawie 61% i 27,5%. Wartość q_0 spadła z 39% (r = 11,3‰) do 32% (r = 16‰). W latach 1891–1920 przeciętny noworodek miał szansę żyć już 38 lat, podczas gdy prawdopodobieństwo zgonu w wieku 0–4,99 kształtowało się na poziomie 31%. Odsetki osób, które dożyły początku reprodukcji (15 lat), dorosłości (20 lat) i starości (60 lat) wynosiły odpowiednio: 63,8%, 62% i 33%. Mierniki sposobności do działania doboru naturalnego wyraźnie poprawiły się po wyłączeniu z analiz zgonów wywołanych epidemiami chorób zakaźnych: wartość wskaźnika I_m Crowa spadła o ponad połowę, wartość wskaźnika stanu biologicznego populacji I_{bs} wzrosła półtora razy, zaś pond 90% osobników dorosłych miało szansę na osiągnięcie określonego poziomu rozrodu, ograniczonego śmiertelnością w wieku rozrodczym. Na poprawę stanu biologicznego ludności Detvy wpłynął rozwój opieki medycznej, w tym infrastruktury, i wzrost liczby dobrze wykwalifikowanego personelu medycznego, a także wzrost świadomości prozdrowotnej mieszkańców, co umożliwiło skuteczne zwalczanie epidemii chorób zakaźnych oraz zmniejszenie liczb wywołanych przez nie zachorowań i zgonów.

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