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SOME REMARKS ON THE FERTILITY TRANSITION IN SLOVAKIA IN THE EARLY 20TH CENTURY

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ABSTRACT

The demographic transition in Slovakia from the point of view of fertility began in the early 20th century. In connection with these changes in fertility in Slovakia in the first half of the 20th century there was a significant and historically unique transformation of the intensity and the character of age-specific fertility rates. The main aim of this paper is to analyse the changes in fertility of the Slovak population in the first half of the 20th century in connection with the onset and spread of the demographic transition. Special attention is paid to the level of voluntary fertility restriction and its impact on the intensity and nature of the process of fertility.

Keywords: fertility, demographic transition, 1st half of the 20th century, Slovakia **Demografie,** 2017, **59: 287–302**

INTRODUCTION

The demographic transition is a historically unique qualitative and quantitative transformation of the nature of a population´s reproductive behaviour that is marked by significant changes in the processes of mortality and fertility and in the population age structure as a whole (*Pavlík et al.*, 1986). While demographic reproduction prior to the transition is largely determined biologically, once the transition is completed, socio-economic factors are the primary determinants of reproductive behaviour (*Pavlík*, 1977). The theoretical concept of natural fertility dictates that the reproductive behaviour of populations before the onset of the demographic transition would not be influenced by the number of children (see *Henry*, 1953, 1961, 1964). A married couple would therefore act (from a reproductive point of view) the same way no matter how many children they already have (*Henry*, 1961). The changes to reproductive behaviour that take place during the process of the demographic transition do not affect all countries and their populations at the same time, but generally affect various populations and subpopulations differently in terms of both timing and dynamics. Slovakia, according to several indicators, falls within the area of countries in Europe where this process has been delayed. Several studies (*Fialová*, 1987; *Pavlík et al.*, 1990) have shown that marital fertility on the territory of the Slovak Republic began to decline after 1900 without any prior significant changes in the age at marriage. The end of the demographic transition came during the 1960s (*Vereš*, 1986). From this it is obvious that fertility in Slovakia in the first half of the 20th century underwent a significant and very important transition.

The fertility transition in Slovakia during the 19th and the first half of the 20th century has received some attention in research (see, e.g., *Vereš*, 1983, 1986; *Pavlík et al.*, 1990), but many questions remain unanswered.

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At the same time, neither the methods nor the data provided by the Hungarian and later Czechoslovak demographic statistics were used in these analyzes. At present, Slovak historical demography is focusing its attention mainly on local analyses (e.g. *Furmaník*, 2017; *Golian*, 2016a,b and 2017), and synthesising works at the national level are rather an exception (e.g. *Šprocha – Tišliar*, 2014; 2016).

The primary aim of this paper is to analyse the changes in the fertility of the Slovak population in the first half of the 20th century. For this purpose we use both classic analytical tools such as Coale's indices (*Coale*, 1973, *Coale – Treadway*, 1986) and the Coale-Trussell fertility model (*Coale – Trussell*, 1974 and 1978), and we also examine cohort changes in the intensity and structure of women by parity. In addition, we use the crude birth rate, the total fertility rate, and mean age at birth and first birth in an effort to determine how the fertility of women in Slovakia changed in the first half of the 20th century.

DATA AND METHODS

There are several problems that arise when one tries to analyse the nature, intensity and development of fertility in pre-WWI Slovakia. The biggest problem is the lack of data required to reconstruct some of the more fine-grained indicators: the data available up to 1900 are essentially limited to the crude birth rate and only the 1880, 1890 and 1900 censuses can be used to construct the Coale indices. Starting in 1900, more data become available with which to calculate the age-specific fertility rate. Data on the number of live births for the period 1900–1912 were published in broad age groups (up to age 17, ages 17–19, 20–24, 25–29, 30–39, 40–49). The number of women of reproductive age was estimated for each year by linear interpolation from the 1900 and 1910 census results. After World War I, more detailed data become available on the age of mothers at the time of birth of a live-born child (up to age 17, ages 17–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49). The number of women of reproductive age was published by the Czech Statistical Office (1987) for the period 1920–1937. From 1925 on, absolute birth figures are combined not only with the age at birth, but also with true birth order. For second- and higher-order births, the published data also include the length of time since the previous birth. From 1938 until 1944, the crude birth rate is once again the only type of data available; the State Statistical Office in the Slovak Republic in 1939–1945 did collect birth data, but those data were never processed or published in detail, except for the crude birth rate. Moreover, the original documents were probably irretrievably lost during the Slovak National Uprising in 1944 when the headquarters of the State Statistical Office were moved from Bratislava to Central Slovakia (the epicentre of the uprising) and many of its employees then joined the insurgents. After the reunification of Czechoslovakia, beginning in 1946, fine-grained data again became available for calculating cross-sectional indicators of fertility.

The other problem involves that arises in this type of analysis relates to geographical and administrative divisions. Up until 1918, Slovakia was a part of the Austro-Hungarian Empire as a vaguely defined region without clear borders. However, statistical and census data are only available for individual administrative divisions (provinces), a number of which lie on the territory of present-day Slovakia but also of neighbouring countries (i.e. present-day Hungary, Ukraine, Poland, and Austria). We therefore decided to only use data for those provinces where the majority of the population lived on the territory of what is now the Slovak Republic. These included 17 provinces. This issue (of practical significance to historical demography) was ultimately only resolved with the formation of the Czechoslovak Republic in 1918 and the conclusion of the Treaty of Trianon in 1920. This treaty defined the borders of Slovakia as they remain (with very minor modifications) to this day, save for one period – in the years 1938–1945. The First Vienna Award of 2 November 1938 resulted in the transfer of large parts of Southern Slovakia to Hungary and the annexation of a number of small enclaves in Northern Slovakia by Poland. In total, over 10,600 km^2 inhabited by some 860,000 people were transferred to Hungary and Poland and only returned after WWII was over.

Turning now to the issue of methodology, we chose to use Coale's indices in our analysis, which are commonly employed to analyse various stages in the population process and the dynamics of its transformation in the course of the demographic transition. Coale's indices are based on indirect standardisation, where a population assumed not to be engaging in fertility control is used as the standard; the population typically used for this is the Hutterite religious community of North Dakota, noted for its strict rejection of any type of fertility control. For the purposes of our analysis, we used available census data from the years 1880, 1890, 1900, 1910, 1921, 1930, 1950, and 1961 to calculate the three basic indices for the population of Slovakia: If – the index of overall fertility; Ig – the index of marital fertility; and Im – the index of proportion married.

We also made an attempt to calculate the degree of fertility control using the Coale-Trussell fertility model (*Coale – Trussell*, 1974 and 1978). The model defines fertility control as a married couple's conscious decision to avoid having more children based on the number of children they already have. This, in turn, assumes that such a decision will be reflected in the age-specific birth rates for married women in these populations as opposed to women in populations that do not practice deliberate fertility control. Consequently, in populations with fertility control, the frequential fertility curve should decrease faster in proportion to age than in populations with natural fertility. The model then produces an estimate of the rate of deliberate fertility control (lower '*m*').

According to Coale and Trussell (1978), the model hypothesised that, in any population, the ratio of marital fertility $f_{(x)}$ to natural fertility $F_{(x)}$ at a specified age *(x)* is given by:

$$f_{(x)} / F_{(x)} = M \exp (m \cdot v_{(x)}).$$

Parameter M is a scale factor and measures the fertility level of the observed population and parameter m indicates the degree of control of marital fertility. $V(x)$ is the typical age-specific deviation of controlled fertility from natural fertility and was derived from 43 fertility schedules reported in the United Nation's Demographic Yearbook 1965. $F(x)$ was estimated by taking age-specific averages of 10 natural fertility schedules.

Taking the logarithms of both sides of the previous equation, we can write:

$$\ln \frac{f_{(x)}}{F_{(x)}} = \ln(M) + mv_{(x)}$$

As such, the Coale-Trussell fertility model is fundamentally based on the comparison of two series of age-specific fertility rates – that of the studied population and that of populations with a natural fertility rate as estimated by the authors using real data from populations that do not engage in fertility control. In these calculations, the extremes (age groups <20 and 45>) are usually left out due to the small event size and – in the youngest age groups only – the high prevalence of premarital conception. In general, the higher 'm' is, the higher the degree of fertility control. Negative values and positive values up to 0.3 indicate (see *Coale – Trussell*, 1974, 1978) no or weak fertility control. Values upwards of 0.5 speak of a clear intent to limit family size (*Coale – Trussell*, 1974, 1978).

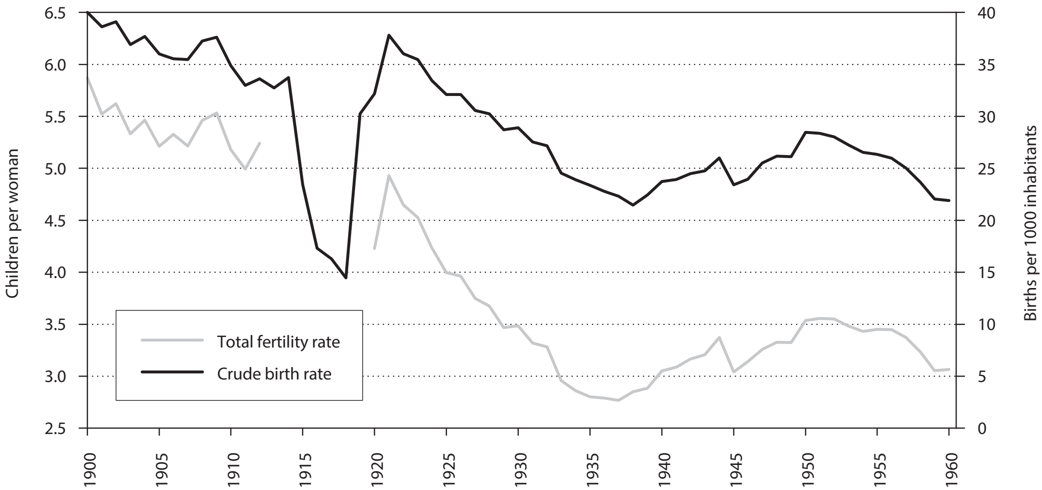
The 1930 census was the first to ask women about the number of children they had given birth to and the censuses of 1950 and 1961 followed suit. We used the data obtained in all three censuses to conduct a detailed cohort analysis of fertility changes focusing on the development of completed fertility and intergenerational changes in the structure of the female population by number of children (parity) and cohort parity progression ratios.

THE FERTILITY TRANSITION: FIRST SIGNS

In Slovakia, the crude birth rate remained above 40‰ for all of the 19th century. The total fertility rate in 1900 reached about 6 children per woman. The first decade of the 20th century, however, brought the first signs of a gradual decline. This trend continued after World War I and the post-war recuperation phase until the 1938. Slovakia finally attained a 30‰ crude birth rate in the late 1920s, which *Chesnais* (1992) considers the beginning of the modern paradigm of controlled fertility. The total fertility rate dropped to under 4 children per woman and below 3 after a sharp decline in 1932–1933.

During World War II, Slovakia experienced significant population growth, which was greatly aided by new pro-natality and pro-family measures implemented by the authorities of the newly independent Slovakia in imitation of similar steps taken by the Third

Figure 1 **The total fertility rate and the crude birth rate in Slovakia 1900–1960**



Source: Népmozgalma 1900–1912; Pohyb obyvatelstva (Population Dynamics) 1919–1937; Štatistické zprávy (Statistical Reports) 1942–1943; Pohyb obyvateľstva na Slovensku (Population Dynamics in Slovakia) 1945–1948, 1949–1960; Věkové složení obyvatelstva v letech (Age Structure of the Population in the Years) 1920–1937 a 1945–1979; authors' calculations.

Reich[3]. The cohort effect also played a significant role, as the populous cohorts of women born after World War I reached reproductive age.

After World War II there was a temporary increase in fertility, which halted in 1953, after which birth rates in Slovakia began to steadily decline. The first half of the 1960s then saw the country pass the 20‰ line, which (so *Chesnais*, 1992) implies general control of fertility and marks the start of the post-transitional phase. At the same time, the total fertility rate decreased to 3 children per woman.

As a society implements fertility control, it is not only the intensity of the process that changes, but also the character of age-specific fertility rates. With some degree of overgeneralisation, we can describe those changes as attempts to prevent the conception of (unwanted) higher-order children. As we showed above, Slovakia's population did not during the period in question adopt the practice of postponing marriage and both men and women typically entered marriage at a young age and with a high intensity (i.e. what is known as the non-European model of nuptiality still prevailed). This observation is also confirmed by mean age at first birth, which was approximately 24 years of age throughout the 1920s and 1930s. On the other hand, the same period saw the median age of fertility drop from 29 to 27 and the interdecile range of fertility gradually decrease from 18.5 to 17.4 years, while the lower decile remained virtually the same. This means that about half of all fertility was concentrated at an increasingly younger age and 80% of the total fertility rate was realised in a shorter age span.

Having reached the compensation maximum after the Great War, fertility began to decline in all age groups except the youngest one. Shortly before the breakup of Czechoslovakia, it was at 50–75% of the 1920s levels for those age groups and at 70% of the level for the group aged 30 and under.

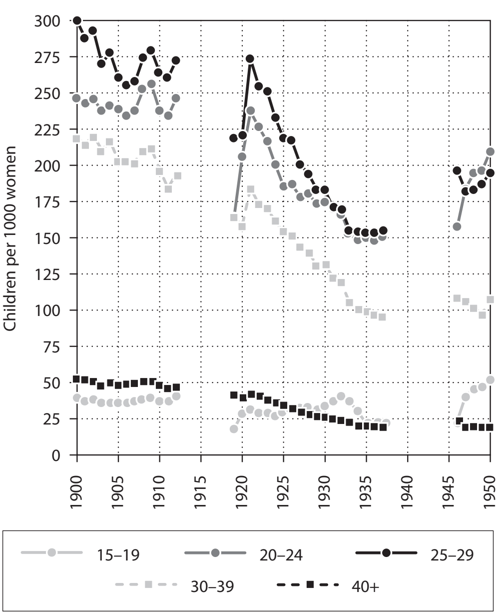
3) In Slovakia, such measures reflected both the totalitarian nature of the ruling regime and the conservative Christian nature of society and included a total ban on abortions, even in situations where the mother's life was at risk, as well as a strict ban on the sale and distribution of any type of birth control. In terms of social policy, the regime was intent on returning women to their proper place in the home (*Tišliar*, 2013; 2015).

As a consequence of this development, the contribution of individual age groups to the total fertility rate began to shift. First, the share of women aged 35 and over began to decline. The contribution of the 25–29 and 30–34 age groups remained relatively stable; however, that of the 20–24 age group increased, and starting in 1925 so did the contribution of the age group 15–19. Considering the development of fertility rates, we can assume that the primary contribution of the economic downturn of the 1930s was the decrease in higher-order births and the increase in marriage postponement to over the age of 20. The latter is evidenced not only by a decrease in fertility in women under the age of 20, but also the stabilisation of fertility in the 20–29 age group and a slight increase in the average age at first birth (from 23.7 to 24.0), which is first observed in 1933.

Between 1925 and 1950 first-order fertility remained largely stable, ranging between 0.8 and 1.1 children per woman, but fifth- and higher-order fertility declined sharply (by more than 0.7). A similar downward trend can be observed in the total fertility rates of fourth-order births and to some extent third-order births as well, but some caution is warranted when interpreting these data given the changing structure of the female population by parity. We will address the issue of changes in birth intensity by order when considering the cohort perspective.

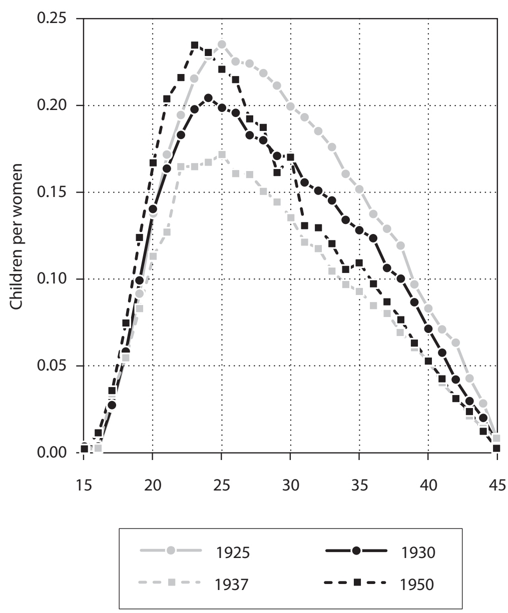
A very important tool of historical demographic studies is the analysis of birth intervals (e.g. *Fialová et al.*, 2015). One of the first signs, albeit an indirect one, of the onset of fertility control in the population of Slovakia can be found in the trend of birth intervals. The years between 1925 and 1937 saw a sharp increase in the number of years between all higher-order births (specifically, we looked at the number of years between the second and the fifth child). The most significant change was observed in the length of time between the second and the third child, but the interbirth period between the third and fourth child also saw a sizeable increase (see Figure 4).

Figure 2 Fertility levels by age, 1900–1950



Source: Népmozgalma 1900–1912; Pohyb obyvatelstva (Population Dynamics) 1919–1937; Štatistické zprávy (Statistical Reports) 1942–1943; Pohyb obyvateľstva na Slovensku (Population Dynamics in Slovakia) 1945–1948, 1949 and 1950; Věkové složení obyvatelstva v letech (Age Structure of the Population in the Years …) 1920–1937 a 1945–1979; authors' calculations.

Figure 3 Fertility levels by age in selected years



Source: Pohyb obyvatelstva (Population Dynamics) 1925, 1930, 1937; Pohyb obyvateľstva na Slovensku (Population Dynamics in Slovakia) 1950; Věkové složení obyvatelstva v letech (Age Structure of the Population in the Years …) 1920–1937 a 1945–1979; authors' calculations.

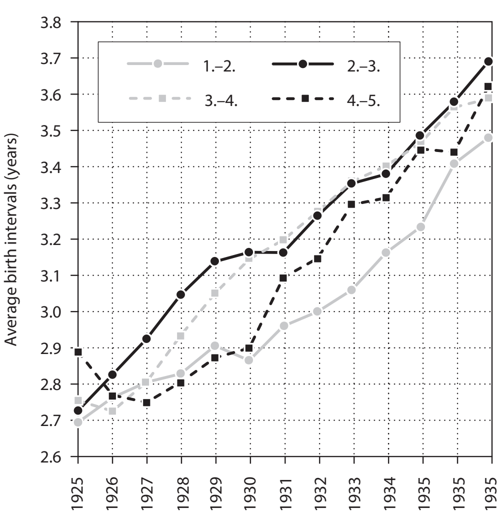
According to *van de Walle* (1974), a decline in marital fertility caused by deliberate fertility control is unambiguously observed if Coale's index of marital fertility (*Ig*) drops below 0.5. With *Ig* ~ 0.6, it can only be assumed that the population as a whole has begun to implement some sort of regulation of family size.

In Slovakia, the marital fertility index (calculated from Hungarian census data 1880–1910) first decreased below 0.6 in 1910 and remained at the same level in 1921 when the first official Czechoslovak census took place. This, however, needs to be viewed in the light of the post-war compensation phase, which culminated in Slovakia in 1921 and which skewed the figures. It would appear that it was in the 1920s when fertility control was finally adopted by society as a whole; this is evident from the Ig dropping below 0.5 by the end of the decade (cf. Figure 5). Fertility transition in Slovakia can be considered completed by the end of the 1950s. As census data show, in 1961, the marital fertility index finally dropped below 0.35; this value is generally considered (e.g. *Pavlík et al.*, 1986) to definitively mark the end of the fertility transition.

According to census data, the index of overall fertility remained relatively stable at 0.4. It fell below that level by the early 1920s to then stabilise in 1930 at 30% of Hutterite fertility, and the early 1960s then saw a further decline to 0.24.

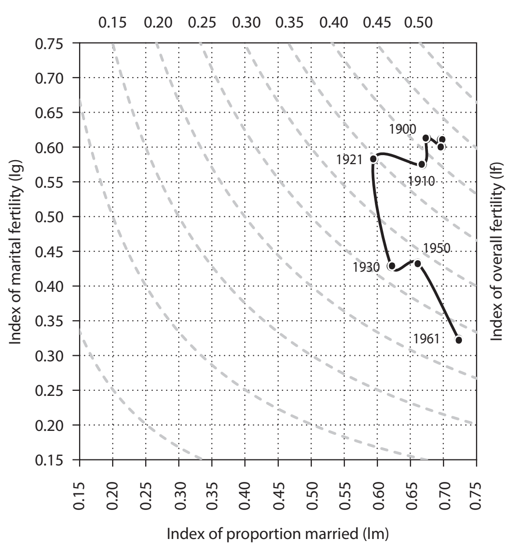
The high *Im* values (see Figure 5) confirm the crucial role of a woman's marital status for the fertility levels in pre-WWII Slovakia when in all census years for which data is available – save for 1921 – the *Im* exceeded 0.6, a figure above the 0.55 threshold which, according *Hajnal* (1965), distinguishes populations with European marriage patterns from populations with non-European marriage patterns. Slovakia thus ranked among the latter and, as is typical for such a population, most women in Slovakia married at least once and often at a young age (see *Šprocha*, 2016). These women then began to take part in the reproductive process while in the first half of their reproductive age, which was then reflected in the nature

Figure 4 Average birth intervals in marriage, 1925–1937



Source: Pohyb obyvatelstva (Population Dynamics) 1925–1927, 1928–1930, 1934–1937; authors' calculations.

Figure 5 Trajectories of Im, Ig and If for Slovakia1880–1961



Source: Authors' calculations

of reproduction: in European-type populations the bulk of fertility was realised in the second half of a woman's reproductive years (i.e. at the age of 30 and above), in Slovakia fertility was concentrated – and increasingly so – in the first half of a woman's reproductive years. This is due not only to the different nature of nuptiality (especially its timing), but also to gradual fertility control, in this case efforts to prevent higher-order conception, which – logically – would take place once a woman has reached the age of 30.

In order to quantify the degree to which fertility control was practiced, we opted to employ the Coale--Trussell fertility model (*Coale – Trussell*, 1974; 1978). The model assumes that efforts by a married couple to avoid (further) conceptions will be reflected in the development of age-specific marital fertility rates: in a population which practices fertility control, these rates are expected to decrease faster with age than they would in a population which does not practice fertility control, i.e. where a couple's reproductive behaviour does not take into account the number of children they already have. This rate of decrease is expressed by *m*. The higher the value of m, the more widely fertility control is practiced within a population and, conversely, values lower than 0.3 and negative values of m are typical for populations with very low or no fertility control at all. Consequently, Coale and Trussell established *m*>0.5 as a threshold that marks populations where one can with some degree of certainty speak of commonly practiced deliberate fertility control (*Coale – Trussell*, 1978).

The results of our calculations for the years 1900–1961 are shown in Table1 and they confirm some of our findings above: the first decade of the 20th century shows very little evidence of fertility control, with *m*> 0.3 only in the 35–39 age group. The overall rate of fertility control began to rise just before the Great War, but even the early 1920s do not yet see fertility control being widely practiced, save perhaps in the 30–34 age group, where, for the first time in history, *m* rises above the 0.5 threshold. In 1930, however, the 25–29 age group crossed that threshold as well and even older age groups (35–44) came quite close. This, along with the rising overall values of *m*, which in 1930 nearly reached 0.5, is clear evidence of the gradual society-wide implementation of fertility control. The years after World War II then finally see m breaking the 0.5 threshold across all age groups, in most cases by a large margin, and by the late 1950s, *m* finally rises above 1.0 in all age groups, indicating that the process of fertility transition had been completed.

In terms of the dynamics of *m*, the first signs of fertility control appear in the early 1900s and it is at first primarily older women who are practicing in it. The interbellum period then sees fertility control spreading to younger age groups and the process of fertility transition begins to affect the entire reproductive age range. In terms of cohorts – on which more below – it is plain to see that in addition to older cohorts (women born in the 1880s and 1890s), women born in the early 1900s began to limit the number of children they had. This confirms the generally accepted irreversible nature of deliberate fertility control and its intergenerational spread.

Table 1 Degree of fertility control according to Coale and Trussell's *'m'* based on census data for Slovakia, 1900–1961

Population	*'m'*	*'m'* in **age groups**			
		25–29	**30–34**	**35–39**	**40–44**
'Slovak provinces' 1900	0.26	0.27	0.16	0.33	0.25
'Slovak provinces' 1910	0.31	0.38	0.19	0.45	0.26
Slovakia 1921	0.38	0.23	0.53	0.37	0.37
Slovakia 1930	0.49	0.66	0.60	0.49	0.46
Slovakia 1950	0.85	0.98	0.84	0.92	0.82
Slovakia 1961	1.24	1.50	1.36	1.30	1.18
Hutterites 1921–1930	–0.08	–0.05	0.02	–0.09	–0.10

Source: Authors' calculations.

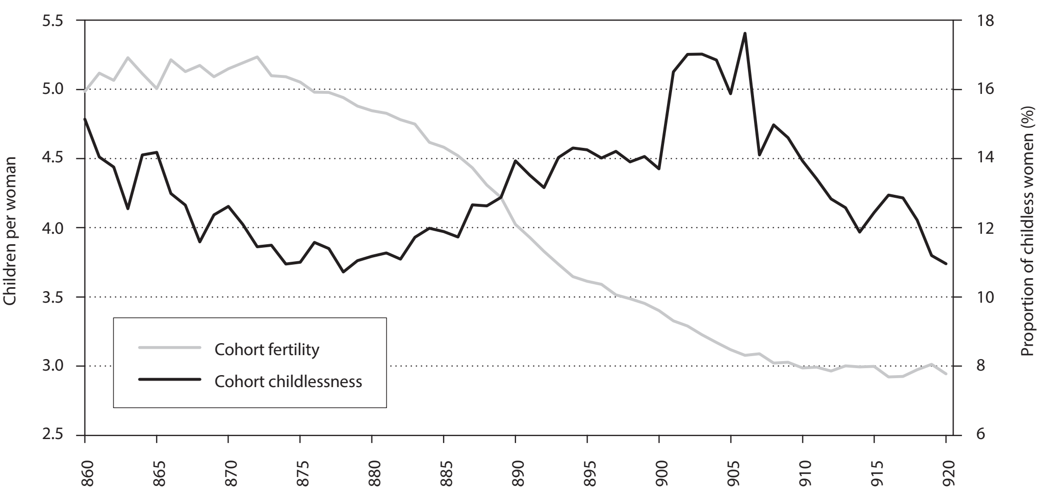
THE FERTILITY TRANSITION: A COHORT PERSPECTIVE

In every country that has undergone the fertility transition, it is possible to identify forerunners, i.e. population groups and areas that were the first to undergo the changes, and from which the changes spread not only through space but also through various societal strata as the new paradigm of reproductive behaviour was adopted by more and more couples (see *Livi-Bacci*, 1986). Cohort analysis is a tool with which it is possible to track the dynamics of the fertility transition from its onset to its conclusion by showing the intergenerational nature of the process. Slovakia is a particularly noteworthy example here: thanks to the unique census of 1930 and the subsequent censuses which collected data on how many children a woman had, we are able to track the entirety of the intergenerational fertility transition, starting with the cohorts of women born in the second half of the 19th century. In this section, we will be using the data from the censuses conducted in 1930, 1950, and 1970 to analyse changes to the completed fertility of women born between 1860 and 1920. At the same time, the reader should also be aware that in the case of the oldest cohorts, the data may be partly influenced by the large sample size of women, as they were the population that had been in the 1930 population census for over 60 years.

The completed fertility rate of women born in the years 1860–1875 regularly reached levels of 5 and above, but beginning with the cohorts born in the second half of the 1870s, completed fertility rate started to decline. Initially, the yearly decrease was small, and so the first drop by 0.5 children was achieved within ten birth cohorts, when, on average, women born in the first half of the 1880s had 4.5 children. In younger birth cohorts, the decline was much faster, with the fastest rate recorded among women born between 1885 and 1895, when at the end of that period, cohort fertility dropped by 1 child to 3.5 children. The decline then continued in younger cohorts, but at a slower pace: for women born in 1905, the average number of children was 3, but for cohorts born in 1908 through 1920, it dropped to approximately 2.85–2.96. This leads us to the conclusion that the crucial decline of the completed fertility rate in Slovakia took place in the cohorts between 1880 and 1905.

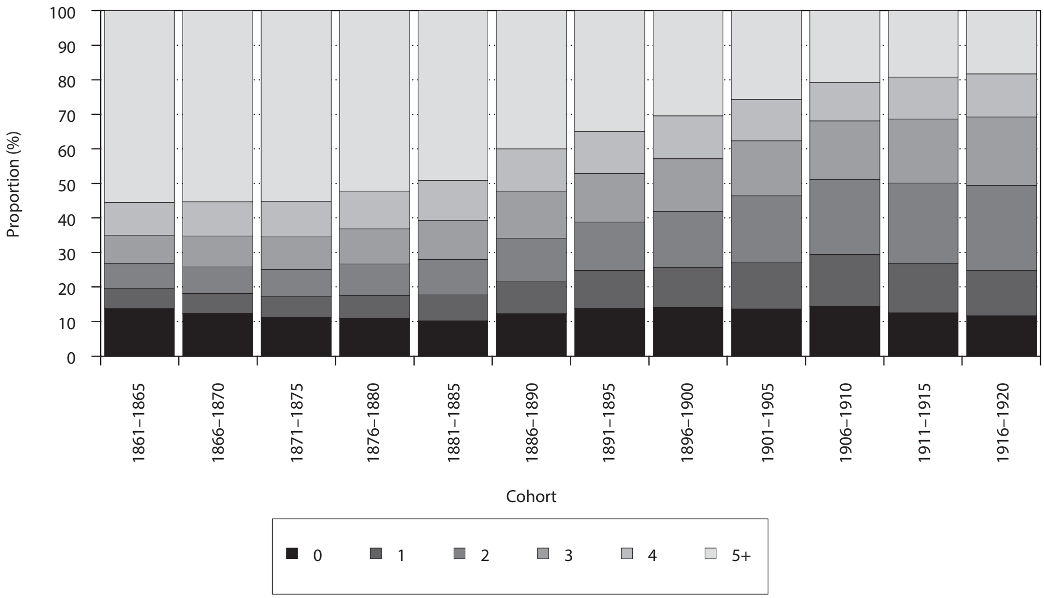
These changes, however, are a reflection of the dramatic shifts in the cohort parity progression ratios. Up to the cohorts from the late 1870s, women with 5

Figure 6 The completed fertility rate and cohort childlessness



Note: Data for the 1860–1880 cohorts are from the 1930 population census, for the 1881–1900 cohorts from the 1950 census, and for the 1901–1920 cohorts from the 1970 census.
Source: Sčítaní lidu (Population Census) 1930, 1950 and 1970; authors' calculations.

Figure 7 Women by number of children



Source: Sčítaní lidu (Population Census) 1930, 1950 and 1970; authors' calculations.

or more children constituted over one-half of the female population. Beginning with the cohort born in 1885, their share began to decline and in the cohorts born by the end of the 19th century, it dropped to one-third. This intercohort decline is a reflection of increasing attempts at fertility control for higher-order children, which is, in turn, one of the major signs that the fertility transition is in progress, and so the share of women with 5 or more children continued to decrease until it stabilised at one-fifth in the 1911–1920 cohorts.

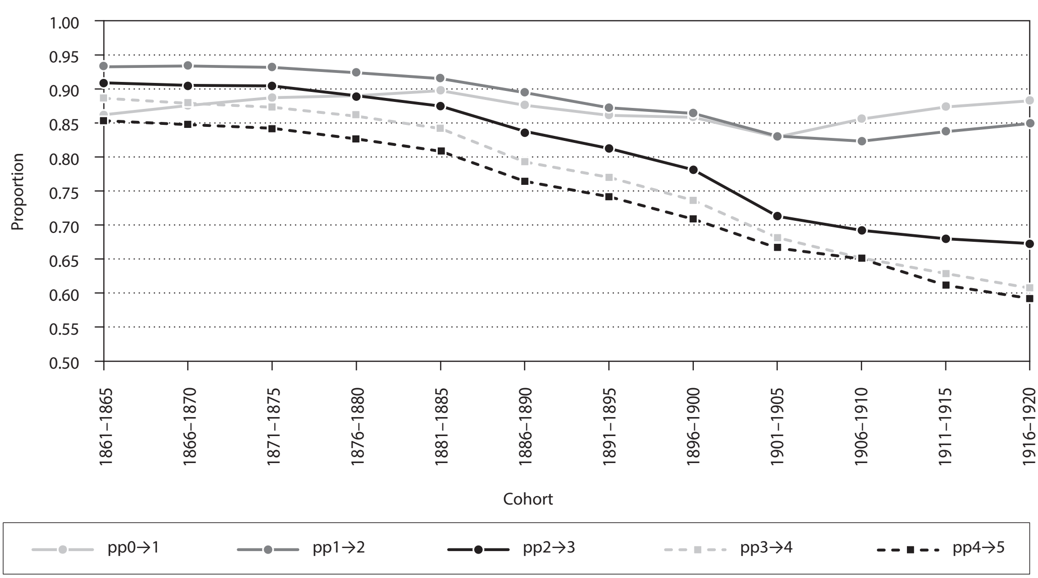
At the same time, the share of women with two or three children rose: while in the oldest cohorts, that group constituted a mere 15% of the entire female population, for cohorts born in the first decade of the 20th century their share rose to 40%, with a growing intercohort trend. In contrast, the share of childless women and women with only one child remained stable for much of the period in question at 6–10% for the former group and 10% for the latter. Those figures increased slightly at the turn of the 19th and 20th century, as both these groups were the ones most severely affected by the adverse conditions of the Great War and its aftermath and by the economic crisis of the 1930s. As noted by *Rowland* (1998, 2007) and *Sobotka* (2006, 2017) in several Western and Northern European countries, the childlessness of women born in the early 20th century was significantly above the 20% threshold. Slovakia continued to belong to those European populations with a low share of childless women and having a single child remained only a marginal reproductive strategy.

In populations that do not practice fertility control, the probabilities of family size increase were relatively high even for higher-order children, as married couple does not take any steps to prevent further conception and the total number of their children is thus not dependent on the number of children they already have (*Henry*, 1961; 1964). In such populations, the slow decline in the probability of family size increase with age is not evidence of fertility control, but rather the result of biological limitations, i.e. the increasing difficulty of conception and live birth at a higher age. Consequently, the parity progression ratios remain high even with higher-order children. In Slovakia, this can be observed in cohorts of women born in the 1860s through the early 1870s where the difference in the probability of giving birth to a second child and the probability of giving birth to a fifth child was a mere 8–9 p.p. The level of probability was thus relatively stable intergenerationally and also quite high (at 80%) regardless of parity. However, starting with cohorts born in the second half of the 1870s, but especially in cohorts born in the 1880s, we begin to notice a consistent intergenerational decline in the probability of third- and higher-order births. Understandably, the first to decline was the probability of a fifth child (and beyond), but soon the same was true of the fourth child. In cohorts born in the final years of the 19th century, the difference in probability of giving birth to a second child and the probability of giving birth to a fifth child nearly doubled to 16 p.p. and for cohorts born between 1916 and 1920 it increased to as much as 26 p.p. A sharp increase can be seen in the difference between the probabilities of a second and a fourth child (20 p.p. for cohorts born between 1916 and 1920) and a second and a third child (16 p.p.).

Considering the data above, one would be justified in concluding that in Slovakia the process of the fertility transition began with the group of women born in the second half of the 1870s, but took full effect in the cohorts born in the 1880s and continued to deepen with the following cohorts. This clearly shows the intergenerational irreversibility of the process in the population of Slovakia as well.

And for final proof of this irreversibility, we consider the paradox of the higher probability of second-order births compared to first births. For populations with natural fertility, it has been found that the chance that a woman will give birth to a second child is higher than that for a first child. In populations with planned reproduction, however, the opposite is true, which is explained by the conditional nature of this probability in populations practicing fertility control and by the biological nature of reproduction in populations with natural fertility. In every population, there are a number of women who cannot have children. However, this group only has a statistical effect on first-order births since, logically, only women who have already given birth to one child can be spoken of as being likely to give birth to a second one. In Slovakia, this paradox

Figure 8 Parity progression ratios for women in Slovakia



Note: pp0→1 probability of a childless woman giving birth to her first child; pp1→2 probability of a woman with a 1 child giving birth to second child etc.
Source: Sčítaní lidu (Population Census) 1930, 1950 and 1970; authors' calculations.

was first recorded in women born in the first decade of the 20th century.

In populations with deliberate fertility control, these probability levels are affected not only by biological factors, but also by attempts to prevent further conceptions. This is demonstrated particularly by attempts to prevent further pregnancies once the couple has a set number of children. This, in turn, is manifested by a sharp decline in the probabilities of family size increase. In Slovakia, this can be clearly observed in the cohorts of women born in and after the 1880s.

CONCLUSION

Our detailed analysis confirmed that the beginnings of the fertility transition in Slovakia can be dated to the first decade of the 20th century, but society-wide deliberate fertility control only took hold in the 1920s. The process of the fertility transition was then completed by the 1950s.

Coale's indices and the Coale-Trussell fertility model supplemented by an analysis of cohort parity progression ratios confirmed that the main feature was the onset and spread of voluntary fertility restriction, which reflected the completed fertility rate and the structure of women by parity. A comparison of the fertility of single cohorts showed the gradual spread of permanent changes in fertility.

According to our findings, in Slovakia the process of the fertility transition began with the group of women born in the second half of the 1870s, but took full effect in the cohorts born in the 1880s and continued to deepen with the following cohorts. The completed fertility rate decreased from more than 5 children per woman to below 3 children per woman. Similarly, we could see an intercohort decrease in the parity progression ratios for third- and higher-order child, while the probability of a first and second birth changed only a little. These shifts resulted in a significant reduction in the proportion of women with five or more children and, on the other side, an increase in the proportion of women with two or three children.

Up until the cohorts from the late 1870s, women with 5 or more children made up over one-half of the female population. Beginning with the cohorts born in 1885, their share began to decline and in the cohorts born by the end of the 19th century it had dropped to one-third and stabilised at one-fifth in the 1911–1920 cohorts. At the same time, the share of women with two or three children rose (from 15% to 40%). With the exception of women born at the end of the 19th and the beginning of the 20th century, which suffered from the adverse effects of World War I and the economic crisis of the 1930s, childlessness and one-child families remained marginal reproductive models.

The level of parity progression ratios in older cohorts was relatively stable and also quite high regardless of parity. The transition of probabilities began with the group of women born in the second half of the 1870s, but took full effect in the cohorts born in the 1880s and continued to deepen with the following cohorts. The result was a drop in the probability of the birth of higher-order children, while the chances of the birth of a first and a second child remained high. Their intergenerational decline in women born in the late 19th and the early 20th century was the result of unfavourable reproductive conditions during the World War I and the economic crisis of the early 1930s.

Our analysis showed that changes also occurred in cross-sectional indicators. The total fertility rate went down from almost 6 children to below 3 children per woman. The character of age-specific fertility rates also changed. Above all, the age-specific fertility rates were reduced except among younger ages. When examining this development, it becomes apparent that the main reason for the decline in fertility can be traced to the overall decline of higher-order fertility. While first- and second-order fertility was stable or slightly decreased, third and successive births becoming much rarer than ever before. Birth intervals also increased in length. The median age fell and the interdecil range grew shorter.

According to our findings, the fertility transition in Slovakia (in terms of major changes) did not differ significantly in its main features from other European countries. The main feature was the decline in the higher-order fertility rate and the increase in the proportion of women with two or three children. Compared to Western and Northern Europe, there was generally less childlessness and a lower proportion of women with only one child. These reproductive models were not characteristic for Slovakia even after the end of the demographic transition.

On the other hand, the relatively low value of the index of marital fertility (in the last two decades of the 19th century) before the start of the demographic transition was quite surprising. Compared with available data for selected European countries (with the exception of France) this level was one of the lowest in Europe (see, for example, *Coale – Watkins*, 1986). It is interesting that the European Fertility Project as well as *Andorka* (1971), *Andorka – Balasz-Kovács* (1986) and *Demeny* (1968) identified these specificities also in other Hungarian counties. The low levels of the marital fertility index in the southern regions of Slovakia were also highlighted by *Vereš* (1983, 1986). On the other hand, our research as well as the results of Coale´s European Fertility Project confirmed that the irreversible beginning of the decline in marital fertility began only in the first and the second decade of the 20th century and was more pronounced in the inter-war period. This made Slovakia unevenly behind Northern and Western Europe.

In addition to the direct effect of limiting higher-order children, it is important to mention the indirect effect of extensive foreign emigration. The absence of young men as well as spouses in families, the imbalance in the marriage market, could be an important factor in the increase in childlessness and growing birth intervals, thereby accelerating the decline in fertility and family size. At the same time, we may believe that emigration has also contributed to the more rapid spread of innovation and the diffusion of new forms of reproductive behaviour.

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Appendix

Appendix 1 **Historical provinces in Slovakia, 1900**

Note: Black provinces were not included in the analysis.

Appendix 2 **Selected fertility indicators of women in Slovakia**

Year	Crude birth rate	Total fertility rate	Cohort	Cohort fertility	Cohort childlessness
1900	40.5	5.91	1860	5.01	15.2
1905	36.4	5.24	1865	5.03	14.2
1910	35.3	5.21	1870	5.18	12.6
1920	32.6	4.25	1875	5.07	10.9
1925	32.5	4.01	1880	4.86	11.1
1930	29.2	3.49	1885	4.59	11.8
1935	23.6	2.80	1890	4.00	13.9
1940	24.0	3.06	1895	3.58	14.3
1945	23.7	3.04	1900	3.35	13.7
1950	28.8	3.55	1905	3.06	16.0
1955	26.6	3.46	1910	2.92	13.9
1960	22.1	3.07	1915	2.93	12.4

Source: Népmozgalma 1900–1912; Pohyb obyvatelstva (Population Dynamics) 1919–1937; Štatistické zprávy (Statistical Reports) 1942–1943; Pohyb obyvateľstva na Slovensku (Population Dynamics in Slovakia) 1945–1948, 1949–1960; Věkové složení obyvatelstva v letech (Age Structure of the Population in the Years …) 1920–1937 a 1945–1979; Sčítaní lidu (Population Census) 1930, 1950 and 1970; authors' calculations.

Appendix 3 Structure of women in Slovakia according to the number of children

Cohort	Proportion of women with the number of children (%)					
	0	1	2	3	4	5
1861–1865	13.7	5.8	7.3	8.3	9.5	55.5
1866–1870	12.4	5.8	7.7	8.9	9.9	55.4
1871–1875	11.2	6.0	7.9	9.4	10.3	55.2
1876–1880	10.9	6.7	9.0	10.2	10.9	52.2
1881–1885	10.2	7.6	10.2	11.3	11.6	49.1
1886–1890	12.3	9.2	12.7	13.6	12.3	40.0
1891–1895	13.8	11.0	14.0	14.0	12.1	35.0
1896–1900	14.1	11.6	16.2	15.3	12.4	30.4
1901–1905	13.7	13.3	19.4	15.9	12.0	25.7
1906–1910	14.3	15.1	21.7	17.0	11.1	20.8
1911–1915	12.6	14.2	23.4	18.5	12.2	19.2
1916–1920	13.2	14.2	23.2	18.2	11.8	19.4

Source: Sčítaní lidu (Population Census) 1930, 1950 and 1970; authors' calculations.

DEMOGRAPHIC AGEING IN THE REGIONS OF SLOVAKIA AND THE CZECH REPUBLIC IN 2011–2015

Eva Grmanová[1)]

ABSTRACT

The aim of this paper is to analyse demographic ageing in the regions of Slovakia and the Czech Republic using the ageing index and to compare the convergence of demographic ageing in both countries. The convergence of demographic ageing in the two populations was analysed using the beta convergence method.

Keywords: demographic ageing, ageing index, convergence, regions, Czech Republic, Slovak Republic

Demografie, 2017, **59: 303–314**

INTRODUCTION

Population ageing is characterised by an increase of the proportion of older individuals and a by decrease in the proportion of young individuals (*Amado – Säo José – Santos*, 2016). It is not short-term trend but rather involves changes that occur over a long period of time. We consider demographic ageing the process of transition from a progressive type of population to a stationary type of population, or from a stationary type of population to a regressive type of population (*Klufová – Poláková*, 2010). It is caused by the extension of the life expectancy, also called population ageing from the top, and by the decreasing birth rate, also called population ageing from the bottom. The state of demographic development of the population is a result of previous economic and social development of the society (*Krajňáková – Vojtovič*, 2017). The intensity of population ageing is significantly influenced by demographic processes, especially the birth rate, mortality rate, and migration. These processes can cause unequal changes in the age structure. An uneven age structure in the population influences the intensity of population ageing. However, as *Klapková, Šídlo* and *Šprocha* (2016) note, demographic ageing is a complex process. It is often presented in a negative way, especially in regard to the expected impact on the economic, social and health systems. However, population ageing is closely linked to progress.

Demographic ageing is monitored by several indicators. These indicators allow us to compare changes in the population structure. According to *Koprlová* and *Koprla* (2010), population ageing is significantly reflected in the following indicators: life expectancy at birth, the ageing index, and the economic burden index. International comparisons of active ageing use a more complex index – the Active Ageing Index. The ageing index is the most widely used measure of demographic ageing at the regional level.

The ageing index reflects the proportion of people of post-productive age (65 and over) per 100 people of pre-productive age (0–14). Its value is therefore mainly influenced by the demographic processes of population natality and mortality. The indicator values are also monitored in a time series by statistical authorities at the NUTS 3 regional level.

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Active ageing and successful ageing are ubiquitous concepts in contemporary societies (*Säo José et al.*, 2017). As population ageing leads to great changes in the population structure, it is necessary for society to respond to this trend in several areas of social life. In addition to adjusting the pension system, it is important to implement changes in services, health care, labour markets, technologies, transport, culture, entrepreneurial activities, etc. These changes should be conceptual and should lead to active ageing, which is a key paradigm for policymaking (*Vidovićová – Kafková Petrová*, 2016).

A policy to prepare for population ageing needs to respond to two key challenges: integrating older people into economic and social development and creating an age-inclusive society. It is important to adapt the employment policy, pension policy, and other policies and services that are impacted by social and demographic changes. The main principles of such a policy include an emphasis on human rights, a lifelong approach to ageing and health, emphasis on family and intergenerational relationships, and the creation of research-based measures (*Ministry of Labour and Social Affairs of the Czech Republic*).

Regional demographic analysis and a subsequent population prognosis are necessary prerequisites for shaping any concepts of regional development (*Šprocha – Vaňo – Bleha*, 2014). Reducing disparities promotes the economic and social development of individual regions, so the prerequisite for this is to achieve sustainable development across the whole country (*Habánik – Koišová*, 2011). The existing differences in population development and the associated differences in the number and especially the structure of regional populations are not only a consequence, but also one of the main factors of the formation of disparities in socio-economic development (*Šprocha – Vaňo – Bleha*, 2014).

In the Slovak Republic (SR) and the Czech Republic (CR) the concept of demographic ageing has been worked into the national programmes. In Slovakia there is the National Active Ageing Programme for the years 2014–2020, in which Slovakia addresses to the issue of active ageing as a political priority in its entire complexity (*Ministry of Labour, Social Affairs and Family of the Slovak Republic,* 2013). In the CR there is the National Action Plan Supporting Positive Ageing for the period 2013–2017 (*Ministry of Labour and Social Affairs of the Czech Republic, 2014*), which has been in effect since 2012.

For Slovakia and the Czech Republic it is characteristic that the current development of the demographic behaviour is manifested especially by ageing of population and ongoing problems characterised by the drop in reproduction behaviour (*Ladzianska,* 2009). The share of older people is growing at the expense of the declining proportion of productive population (*Šimková – Sixta*, 2015). Moreover, for both countries, it applies that the period of retirement is gradually extending, but it also leads to increase of life expectancy and time lived without significant health restrictions. The problems of ageing will probably first appear in countries with a high proportion of industry and construction in the GDP. Economies with a high proportion of services will be affected to a lesser degree (*Arltová et al.*, 2016). Both the Czech Republic and Slovakia are countries with a large share of industry.

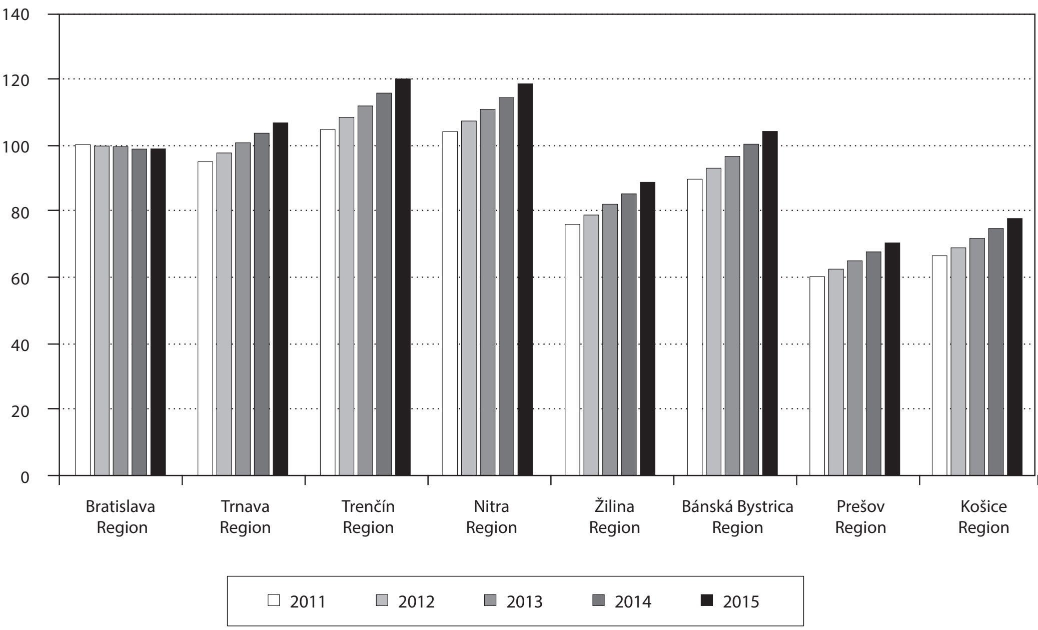
DEMOGRAPHIC AGEING IN THE SLOVAK REPUBLIC

At the beginning of our analysis we compared the index of ageing in the regions of the SR. Then we compared the index of ageing in the regions of the Czech Republic.

According to the data in the Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016) the arithmetic mean of the ageing index based on regional values in 2011–2015 in the SR has been increasing. Its variation, expressed by the standard deviation, has been increasing too. However, there are significant differences in the values of the ageing index between regions. The highest value of the ageing index throughout the period analysed was observed in the Trenčín Region. The second-highest value was in the Nitra Region (2012–2015). The Prešov Region had the lowest ageing index value. The second-lowest value was in the Košice Region. The Bratislava Region had an above-average ageing index value, and it was also the only region in which the ageing index was decreasing. Figure 1 shows the ageing index in the regions of the Slovak Republic.

As demographic ageing is influenced by the rise in life expectancy and by the birth rate, their dynamics

Figure 1 **The ageing index in the regions of Slovakia, 2011–2015 (%)**



Source: Author's analysis based on data from the Statistical Yearbook of Slovak Regions, 2016.

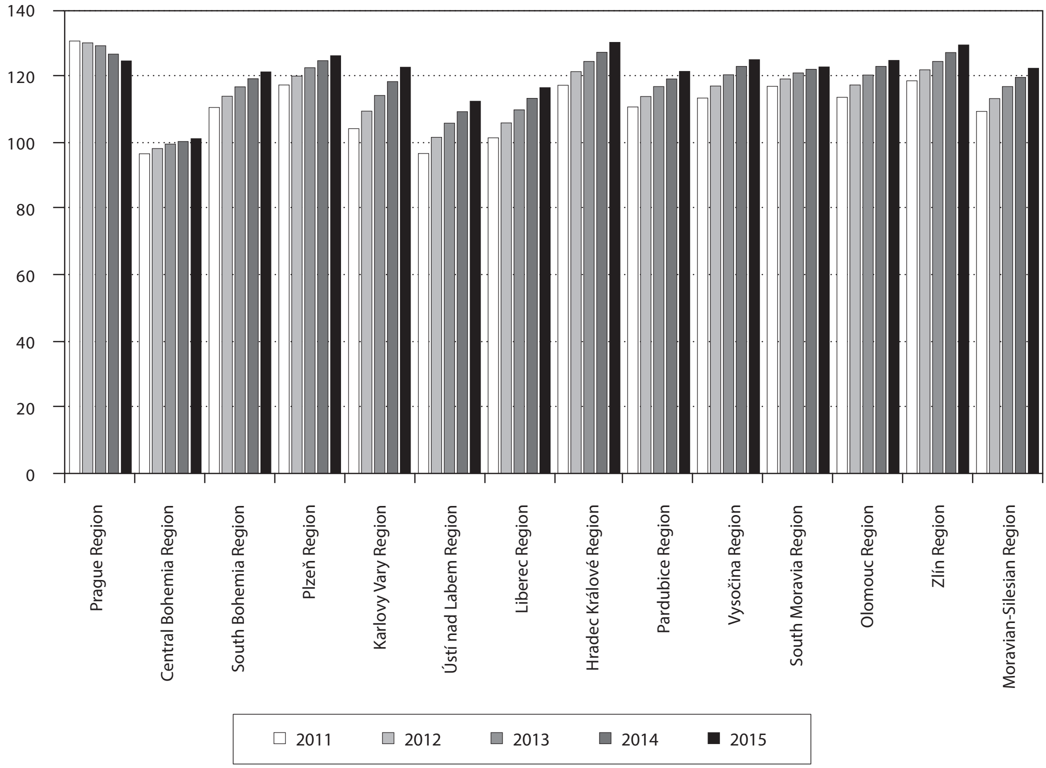
has an influence on the dynamics of the ageing index. There are significant differences in life expectancy at birth across the SR. According to the data in Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016) the highest life expectancy at birth for both men and women in the period analysed was in the Bratislava Region. This region is characterised by the strongest economic performance. Regional GDP per capita in this region significantly exceeds GDPs in other regions. According to the data in the Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016), the second--highest value for men and women was in the Trenčín Region. Conversely, the lowest value of this indicator at the beginning of the period for men and throughout the period for women was in the Košice Region. The Prešov Region had a higher life expectancy at birth throughout the period analysed than the Košice Region. At the end of the period analysed, the lowest life expectancy at birth was in the Banská Bystrica Region. In all the regions of the SR life expectancy at birth was increasing over time.

There were regional differences also in the number of live-born children. According to the data in the Statistical Yearbook of Slovak Regions (*Statistical Office of the Slovak Republic,* 2016), the largest number of births per 1,000 inhabitants was in the Bratislava Region. This is the region with the largest number of job opportunities and, in terms of internal migration, it is also the region to which the largest number of people of reproductive age move. This region was followed by regions in eastern Slovakia: the Prešov and Košice Regions. According to the data in the DATA cube (*Statistical Office of the Slovak Republic,* 2016), these are the regions with the largest number of Roma inhabitants. The Nitra Region had the smallest number of births per 1,000 inhabitants. It was followed by the Trenčín Region.

DEMOGRAPHIC AGEING IN THE CZECH REPUBLIC

Several conclusions can be drawn from the analysis of the ageing index in the CR. The arithmetic mean

Figure 2 **The ageing index in the regions of the Czech Republic, 2011–2015 (%)**



Source: Author's analysis based on data from 'A Comparison of Regions in the Czech Republic' 2015, 'A Comparison of Regions in the Czech Republic' 2016, and the Demographic Yearbook of Regions 2005–2014.

Table 1 **Descriptive statistics of the ageing index in the regions of Slovakia and the Czech Republic, 2011–2015**

	N	Arithmetic mean (%)	Min. (%)	Max. (%)	St. deviation
SR 2011	8	86.71	59.94	104.31	17.3037
SR 2012	8	89.19	62.19	108.03	17.3750
SR 2013	8	91.94	64.47	111.41	17.4066
SR 2014	8	94.71	67.47	115.30	17.5286
SR 2015	8	97.78	70.12	119.55	17.9721
CR 2011	14	110.49	95.93	129.70	9.2392
CR 2012	14	113.72	97.44	129.20	8.4963
CR 2013	14	116.50	98.78	128.30	7.8941
CR 2014	14	118.68	99.56	126.38	7.5014
CR 2015	14	120.67	100.48	129.31	7.3736

Source: Author's analysis.

of the ageing index based on regional values increased in the 2011–2015 period, like in the SR. However, in contrast to the SR, the variation of the indicator, expressed by the standard deviation, was decreasing. In the period between 2011 and 2013, the highest ageing index was in the Prague Region. Throughout the period analysed the ageing index declined only in the Prague Region. Figure 2 shows the ageing index in the regions of the CR.

According to the *Czech Statistical Office* (2014, 2015a), the dynamics of the ageing index influenced the dynamics of life expectancy at birth and the dynamics of the number of births. Life expectancy at birth increased in all the regions of the CR. Life expectancy at birth was the highest for both men and women in the Prague Region. This region also has the strongest economic performance. GDP in this region significantly exceeds GDP levels in the other regions. According to the *Czech Statistical Office* (2014, 2015b, 2016), the largest number of births per 1,000 inhabitants was in the Prague Region. This region also has the largest number of job opportunities and is the region to which the largest numbers of people of reproductive age move in terms of both internal and external migration. The regions with the smallest number of births per 1,000 inhabitants included the Zlín Region and the Moravian-Silesian Region.

A COMPARISON OF THE AGEING INDEX IN SLOVAKIA AND THE CZECH REPUBLIC

In 2011–2015 the ageing index was higher in the CR than in the SR. From the above analysis it can be concluded that the process of demographic ageing was more dynamic in the CR than in the SR. In 2015, all regions in the CR had an ageing index higher than 100%. In the SR, only 4 regions had ageing index values higher than 100%. The arithmetic mean of the ageing index based on regional values in the SR was under 100% throughout the period; in the CR it was over 100%.

The same trend can be identified in the capital cities of both states: both capitals have the highest mean life expectancy and the largest number of live-born children per 1,000 inhabitants. At the same time, these were the only regions in which the ageing index declined. The difference is the fact that in the SR there were no changes in the regions with the maximum and minimum ageing index values. In the CR, these regions changed during the period analysed. While in the Slovak Republic there was a slight increase in the variation of the ageing index, expressed by the standard deviation, in the Czech Republic there was a significant decline. The decreasing standard deviation in the CR may indicate that the regions have similar ageing index values. Table 1 presents the descriptive statistics of the ageing index in the SR and the CR.

AIM, DATA AND RESEARCH METHODOLOGY

Demographic ageing is a process that concerns all the regions in the SR and the CR. The effects vary according to the dynamics of the process. The different dynamics could result in the regions becoming more or less alike over the period analysed. The aim of this paper is to analyse and compare the convergence of ageing in the regions of the SR and the CR. The analysis focuses on the period between 2011 and 2015. Data for the regions in the CR were obtained from the following publications: 'A Comparison of Regions in the Czech Republic 2015', 'A Comparison of Regions in the Czech Republic 2016', 'The Demographic Yearbook of Regions 2005–2014', and 'The Demographic Yearbook of Regions 2006–2015'. Data for the regions in the SR were obtained from 'The Statistical Yearbook of the Slovak Regions 2016'. The beta convergence method was used in the analysis.

Demographic ageing was analysed using the ageing index (AI), expressed as follows:

$$AI(\%) = \frac{S(65+)}{S(0-14)} 100, \tag{1}$$

S(65+) is the number of people in the population aged 65 and over,
S(0–14) is the number of people in the population aged 0 to 14 years.

BETA CONVERGENCE

The convergence of regions is understood as the convergence of regions over a specific period of time at the value of a certain indicator. There are several methods that can be used to analyse regional convergence. The two basic methods are based on two concepts: sigma convergence and beta convergence. Sigma convergence is based on the assumption that when the regions converge, the variation in the logarithm of values expressed by their standard deviation decreases. On the other hand, when the regions diverge, the variation of the logarithm of values expressed by their standard deviation increases. Beta convergence is based on the assumption that regions converge over a specific period of time if the regions that had low values at the beginning of the period show faster growth than regions that had higher values at the beginning of the time interval. And regions diverge when the regions that had low levels at the beginning of the period show slower growth than regions that had higher values at the beginning of the time interval.

To measure the beta convergence, we collected data on values of the variable at the beginning of the time interval (initial value) and at the end of the time interval (*Minařík – Borůvková – Vystrčil*, 2013). In beta convergence, point estimates of linear regression parameters are determined by the method of least squares, where the dependent variable is the logarithm of the average growth coefficients and the independent variable is the logarithm of the initial values. The average growth coefficient is expressed as the geometric mean of the growth coefficients. From the time series of growth coefficient k_t for $t = 2, 3,...,T$, which were determined from the values of the time series y_t for $t = 1, 2,...,T$, the average growth coefficient will be calculated as (2)

$$\bar{k} = \sqrt[T-1]{k_2 k_3 \ldots k_T} = \sqrt[T-1]{\frac{y_2}{y_1}\frac{y_3}{y_2}\cdots\frac{y_T}{y_{T-1}}} = \sqrt[T-1]{\frac{y_T}{y_1}} \qquad (2)$$

If the estimated linear regression function is declining, we can talk about a predominant trend towards convergence. If the estimated linear regression function is increasing, we can talk about a predominant trend towards divergence. In addition to estimating the linear regression parameters, it is important to express also the determination coefficient of the model. The determination coefficient expresses how great a percentage of the total variation is explained by the model. When the values of the determination coefficient are high, we can talk about highly proven convergence or divergence. If the tendency towards convergence or divergence is not highly proven, the analysis should be supplemented with a correlation diagram. The correlation diagram is a point figure with values, like in the regression analysis. The points in the figure are separated by lines. One goes through the mean of the logarithm of the initial values. The second goes through the mean of the logarithm of the average-growth factor. Thus, all the points (in our case representing the regions) are divided into four groups with a below-average or above-average value of the logarithm of initial values and with a below-average or above-average value of the logarithm of the average-growth coefficient (*Minařík – Borůvková – Vystrčil*, 2013).

In this analysis, I decided to use beta convergence because if beta convergence is met, sigma convergence is met as well. However, if there is sigma convergence, there need not necessarily be beta convergence.

RESEARCH RESULTS AND DISCUSSION THE CONVERGENCE OF REGIONS IN SLOVAKIA

For the purpose of this analysis the logarithm of the initial values and the logarithm of the average-growth coefficient of the ageing index in the regions of the SR in the period analysed were calculated and the parameters of linear regression were estimated using the Statistica program. The estimated regression coefficient indicates that the regression coefficient is almost 0, so there is neither convergence nor divergence. The determination coefficient is only 22.36%. Thus, only 22.36% of the total variation is explained by the model. Table 2 presents the estimated parameters of the linear regression function.

In the next step, a correlation diagram (Figure 3) was constructed to divide the regions into groups. The groups of regions are shown in Table 3. The values in the brackets indicate the region's designation in Figure 3. The first group consists of the following regions: Trenčín, Nitra and Banská Bystrica. They have above-average initial values and an above average growth coefficient. These regions decrease the evidence of convergence. These regions show a tendency to diverge from the other regions. The second group consists of regions with below-average initial values and above-average values of the average growth

Table 2 **Estimated parameters of the linear regression function (regions in Slovakia)**

	Estimated parameters
Constant	0.07452
Regression coefficient	–0.0316

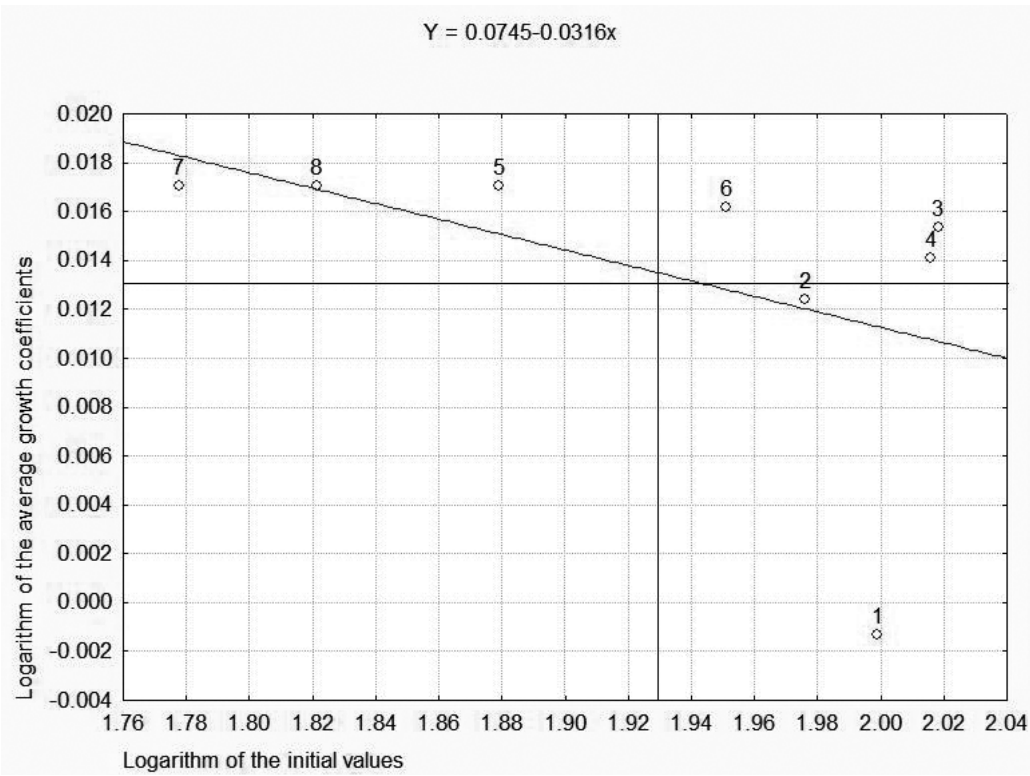
Source: Author's analysis using Statistica.

Table 3 **Regions by group (in Slovakia)**

1.	**2.**	**3.**	**4.**
Trenčín Region (3)	Žilina Region (5)		Bratislava Region (1)
Nitra Region (4)	Prešov Region (7)		Trnava Region (2)
Banská Bystrica Region (6)	Košice Region (8)		

Source: Author's analysis.
Notes: The first group contains regions with above-average initial values and an above-average growth coefficient. The second group comprises the regions with below-average initial values and an above-average growth coefficient. In the fourth group are the regions with above-average initial values and a below-average growth coefficient.

Figure 3 **A correlation diagram of regions in Slovakia**



Source: Author's analysis using Statistica.

coefficient. They show a tendency to move increasingly towards the first group, i.e., into the group of regions that show a trend towards moving away from the other regions. This group includes both regions in Eastern Slovakia and the Žilina Region. In the fourth group are regions with above-average initial values and a below-average growth coefficient. These regions are the ones closest to the capital of Slovakia – the Bratislava Region and the Trnava Region. The trend in these regions is towards increasing convergence with the third group, i.e., the group of regions that tend to lag behind the others.

THE CONVERGENCE OF REGIONS IN THE CZECH REPUBLIC

For the purpose of this analysis the logarithm of the initial values and the logarithm of the average growth coefficient of the ageing index in the CR during the period analysed were calculated and then the parameters of the linear regression expressing the dependence of the logarithm of initial values and the logarithm of the average growth coefficient were estimated using the Statistica program.

The estimated regression coefficient indicates that the linear regression function is decreasing. The determination coefficient is 41.37%. This demonstrates that there is a trend towards regional convergence in the CR. Estimated parameters of the linear regression function are in Table 4.

In the next step, a correlation diagram (Figure 4) was constructed in order to divide the regions into groups. Table 5 presents the groups of regions in the CR. The values in the brackets represent the designation of the regions in Figure 4.

The first group contains the regions with above-average initial values and an above-average growth coefficient. There are Hradec Králové Region, Vysočina Region and Olomouc Region. This region reduces the evidence of convergence. The second group comprises the regions with below-average initial values and an above-average growth coefficient. This group includes the Ústí nad Labem, Liberec, Karlovy Vary, South Bohemia, Pardubice and Moravian--Silesian Region. They show a tendency to move increasingly towards the first group, i.e., the group of regions that are increasingly diverging from the other regions. There is only one region in the third group – Central Bohemia Region. This region shows below-average initial values and a below-average growth coefficient. The Central Bohemia Region tends to lag behind the other regions. In the fourth group are regions with above-average initial values and a below-average growth coefficient. These include the regions of Prague, Plzeň, South Moravian and Zlín. They show a tendency towards increasing convergence with the third group, i.e., the group of regions that tend to lag behind the others. It should be noted, however, that in this group the Zlín Region is on the border between the first and the fourth group.

The most significant changes in the ageing index expressed by the logarithm of the average growth coefficient are in the Karlovy Vary Region. The Karlovy Vary Region had relatively low initial ageing index values. In the period analysed, however, the ageing index increased the most (in this region).

A COMPARISON OF THE CONVERGENCE OF REGIONS IN SLOVAKIA AND THE CZECH REPUBLIC

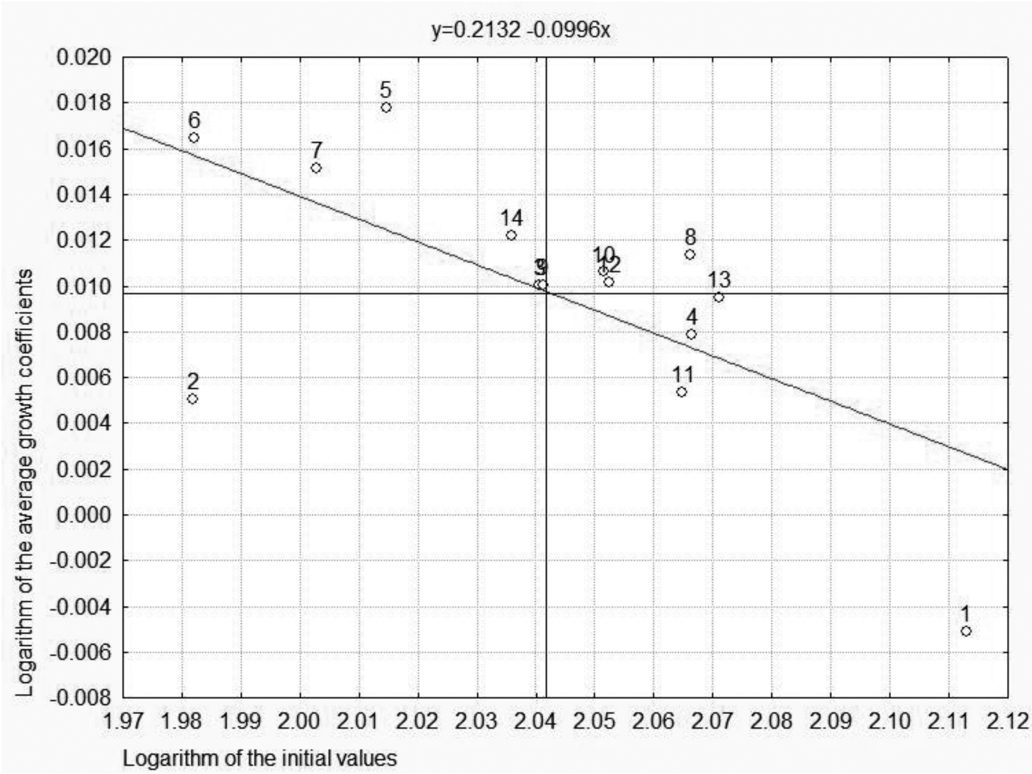
The convergence analysis indicates that there is no evidence of convergence of the ageing index in Slovakia. The trend towards convergence is stronger in CR. There are several factors that, in our opinion, are responsible for the fact that the trend towards convergence in Slovakia wasn´t demonstrated. According to the Statistical Office of the Slovak Republic (2014), the housing and population census in the Slovak Republic

Table 4 Estimated parameters of the linear regression function (regions in the Czech Republic)

	Estimated parameters
Constant	0.2132
Regression coefficient	–0.0996

Source: Author's analysis using Statistica.

Figure 4 A correlation diagram of regions in the Czech Republic



Source: Author's analysis based on data from 'A Comparison of Regions in the Czech Republic' 2015, 'A Comparison of Regions in the Czech Republic' 2016, and the Demographic Yearbook of Regions 2005–2014.

Table 5 Regions by group (in the Czech Republic)

1.	2.	3.	4.
Hradec Králové Region (8)	South Bohemia Region (3)	Central Bohemia Region (2)	Prague Region (1)
Vysočina Region (10)	Karlovy Vary Region (5)		Plzeň Region (4)
Olomouc Region (12)	Ústí nad Labem Region (6)		South Moravian Region (11)
	Liberec Region (7)		Zlín Region (13)
	Pardubice Region (9)		
	Moravian-Silesian Region (14)		

Source: Author's analysis.
Notes: The first group contains the region with above-average initial values and an above-average growth coefficient. The second group comprises the regions with below-average initial values and an above-average growth coefficient. In the third group are the regions with below-average initial values and a below-average growth coefficient. In the fourth group are regions with above-average initial values and a below-average growth coefficient.

in 2011 indicated a large share of the population declare themselves to be religious (only 13.4% do not belong to any particular church/faith) and the majority are Roman Catholics (62%). Religion currently influences the birth rate, but to a lesser extent than it did in the past. There are considerable differences among the regions of the SR in the share of people who claim to be religious. Differences in the population structure by religion can also be a factor behind regional differences in the birth rate. Another important factor is the fact that according to the Statistical Office of the Slovak Republic (2014), the housing and population census in the Slovak Republic indicates that 2% of the total population declared themselves to be members of the Roma population. The majority of Roma live in eastern Slovakia. Their way of life may also be a factor of regional differences in population ageing. Another fact that should not be overlooked is the different economic levels of individual regions. The regions in western Slovakia in particular tend to have a stronger economic performance than the regions in eastern Slovakia.

In Slovakia, the largest number of regions were in the first group, i.e., in the group where the regions tend to move away from the others, and in the second group, where the regions exhibit a tendency towards convergence with the first group. There was no region in the third group. Thus, no region tends to lag behind the others. In the CR, most regions were in the second group. These regions tend to move into the first group.

Understanding regional differences in the state and dynamics of the process of demographic ageing in individual regions of both countries is important in order to meet the goals and implement the measures of an active ageing policy. Such knowledge can be used to determine what specific measures need to be implemented in different regions.

CONCLUSION

As *Káčerová* and *Bleha* note (2007), it is important to question whether the ageing process is irreversible or whether there is some way to influence it. On a global scale, in the coming decades it will definitely be an irreversible process. A simple combination of reduced fertility and high life expectancy will act towards ageing at the base of the age pyramid and at the top.

Based on our research it was possible to draw several crucial conclusions. In both countries, the population structure has been changing, as the ongoing process of ageing shows. In the previous period, demographic ageing was more pronounced in the Czech Republic. This was manifested by the higher ageing index values at the beginning of the period analysed. However, in the period analysed ageing was more dynamic in the SR. This was manifested as a higher average growth coefficient of the ageing index in Slovakia than in the Czech Republic.

In both countries the development and dynamics of the ageing process differ among the regions. The only regions in which the ageing index declined are the regions with the capital cities. These regions have the highest life expectancy and an above-average number of live-born children. In the other regions, the ageing index increased. Of all the regions in Slovakia and in the Czech Republic, the Karlovy Vary Region had the fastest growing ageing index. Large initial values and rapid growth of the ageing index was observed in the Trenčín, Nitra and Banská Bystrica Regions in Slovakia and the Hradec Králové Region, Vysočina Region and Olomouc Region in the CR. When active ageing measures are being implemented in both countries, it will be important to take into account the regional differences. In the regions where the level and dynamics of demographic ageing are highest, the most significant need is to create and implement active ageing measures in different areas of social life.

This analysis confirmed that the trend towards convergence in the process of demographic ageing is stronger in the CR. In the SR, no trend towards convergence or divergence of demographic ageing was confirmed. The factors influencing the fact that there is no convergence of demographic ageing in the SR are probably the regional differences in the population structure in terms of religion, the proportion of Roma in the population (especially in the east of Slovakia), and regional differences in economic performance, etc. These facts have a negative impact on the regions' convergence process.

There are some limitations to this analysis. Population ageing was not addressed in the broader context of changes in life expectancy and birth rates. In further research, it would be advisable to monitor the dynamics of changes, i.e. the dynamics and convergence of the development of the life expectancy and the number of live-born children. Nevertheless, this analysis contributes to the field of study by extending the findings that are not part of statistical surveys.

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ARTICLES

HEALTHY LIFE YEARS IN THE CZECH REPUBLIC: DIFFERENT DATA SOURCES, DIFFERENT FIGURES

Jana Vrabcová[1)] – Šárka Daňková[2)] – Kateřina Faltysová[3)]

ABSTRACT

Healthy Life Years (HLY) may be an important indicator of the potential demand for health and long-term care services, especially for the elder generations of the population. This indicator, unlike the concept of life expectancy, puts emphasis not only on the whole length of life but also on its quality, expressed as the period of life in good health. The European Union's Survey on Income and Living Conditions (EU-SILC) and the European Health Interview Survey (EHIS) could be used as the basic set of indicators for an overall assessment of the state of health. In this article, we compare data on the prevalence of activity limitation in both surveys. The questions used to assess this and their wording are almost the same in both surveys. However, significant differences can be observed in the results of the two surveys. The most important explanation of the difference is probably the overall context of the survey. The EU-SILC is an extensive survey focusing on living conditions and health issues are marginal. The EHIS survey focuses exclusively on health, and there are a number of questions that further inquire about the respondent's health, specific chronic illnesses, visits to the doctor, etc. The second part of the article investigates how these differences in the prevalence of activity limitation are reflected in the HLY indicator.

Keywords: Healthy Life Years, Survey on Income and Living Conditions, European Health Interview Survey, prevalence of activity limitation, Czech Republic

Demografie, 2017, **59: 315–331**

INTRODUCTION

For many years now, much attention has been paid to aggregate health indicators because they can quantify health, which is important not only for health statistics. Indicators of this type contain information about mortality and morbidity.

The ageing of the population in Europe will have far-reaching economic and social consequences and will require changes in the allocation of resources within social and health systems. Health expectancy indicators are constructed from citizens' subjective assessment of their own health and are based on a wide range of health aspects and people's perceptions about their quality of life. That is why health expectancies can be important indicators of the potential demand for health and long-term care services, especially among the older generations of the population. These indicators, unlike the concept of life expectancy, puts

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emphasis not only on the whole length of life but also on its quality, expressed in health.

In 2010, the Czech Demographic Society approved the uniform terminology of aggregate health indicators that is recommended for use in the Czech Republic in order to prevent any ambiguities in translations from the English language (*Hrkal*, 2010: 1). The English terms for aggregate health indicators according to the *Czech Demographic Society* (2010) are used and described below.

Life expectancy indicators based on health make it possible to compare health conditions between subpopulations of a single country and between populations of different countries in terms of the overall cost-effectiveness of the health system or in terms of long-term health trends.

Aggregate health indicators can be divided into three basic groups (*Hrkal – Daňková*, 2005):

- **Life Expectancy (LE);**
- **Health Expectancies (HE);**
- **Health Gaps (HG).**

The types of aggregate health indicators are shown in Figure 1. This paper will not deal with life expectancy and health gaps in more detail due to spatial constraints.

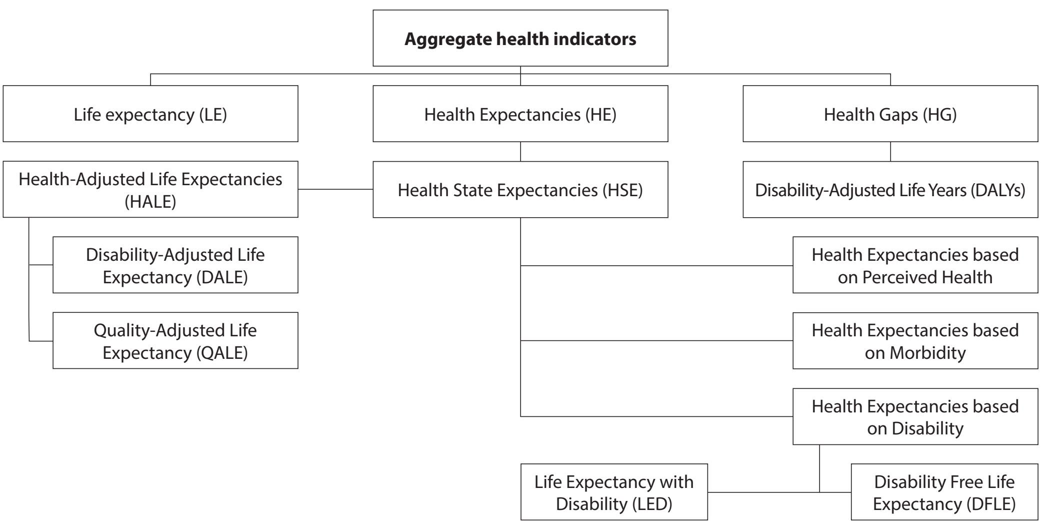
1. HEALTH EXPECTANCIES

'An indicator showing the average number of years that an individual at a certain age is expected to live in a selected state of health' (Czech Demographic Society, 2010).

The idea to create a measure of 'health expectancy'[4] came from a report published in 1969 by the US Department of Health, Education, and Welfare. Consideration of such a measure began because good health and a long life are the basic goals of society. An increase in life expectancy caused worries about the population's future health, and therefore it was necessary to somehow measure these facts (Healthy Life Years: Introduction, [n.y.]).

Health expectancies are an effective tool of interaction between good health, bad health, and death. This term is also often used to monitor

Figure 1 Aggregate health indicators



Source: Czech Demographic Society (2010): English and Czech terms for summary indicators of population health: Basic overview.

4) The division of life expectancy into healthy and non-healthy years of life (disability).

the population's health in relation to increasing longevity (*EHEMU*, 2007).

Health expectancies were first developed to address whether or not longer life is being accompanied by an increase in the time lived in good health (the compression of morbidity scenario) or in bad health (the expansion of morbidity). So, health expectancies divide life expectancy into life spent in different states of health, from, say, good to bad health. In this way, they add a dimension of quality to the quantity of life lived (*EHEMU*, 2014).

Health expectancies based on health can be further divided into:

- Health State Expectancies (HSE);
- Health-Adjusted Life Expectancy (HALE).

Health State Expectancies

'An indicator showing the average number of years that an individual at a certain age is expected to live in a certain state of health' (Czech Demographic Society, 2010).

It is based on the premise that life expectancy (LE) can be broken down into individual time periods in certain states of health. To put it simply, it indicates different states of health that, when added up, equal life expectancy. The equation looks like this (*Hrkal – Daňková*, 2005):

where: $LE = HSE_0 + HSE_1 + HSE_2 + ... + HSE_s$
HSE_0 is considered a state of full health
$HSE_1 - HSE_S$ are considered states worse than full health and are scaled from 1 to s.
Health state expectancies can be further classified as follows (depending on what health characteristics they are based on):

- Health Expectancies based on Perceived Health;
- Health Expectancies based on Morbidity;
- Health Expectancies based on Disability
  - Disability Free Life Expectancy (DFLE);
  - Life Expectancy with Disability (LED).

2. HEALTHY LIFE YEARS AS AN OFFICIAL INDICATOR

Just as there are many ways of assessing health, there are also many healthy life year lifespans. According to the EHEMU reports in 2007, one of the characteristics of healthy life may be healthy life expectancy (HLE). This indicator is constructed on the basis of respondents' answers regarding the evaluation of their own health. The overall health state can be evaluated in several ways that subjectively reflect the actual health of the individual. One of the most commonly used indicators of an individual's health assessment is the General Activity Limitation Indicator (GALI), and the length of life indicator based on this health feature is called Healthy Life Years (HLY).

The Healthy Life Years indicator is currently the one used most frequently from the group of health expectancies across the EU. This indicator is one of the core indicators used to monitor European-wide and national strategies on health. In 2004 it was included among the set of 'structural indicators' introduced for use in the evaluation and monitoring process in relation to the Lisbon strategy in the area of public health (adopted in 2000 by the European Council; *ÚZIS ČR*, 2016).

Monitoring healthy life years helps Member States to assess the health of their population and to find out whether longer life is being lived in good health (morbidity compression) or in bad health (morbidity expansion). Healthy life years are used to highlight health inequalities in individual Member States and to focus on health supporting resources, and are being used more and more to obtain information necessary for the long-term planning of a health, social, and fiscal policy. For instance, the Turner Pensions Commission in Great Britain proposed increasing the retirement age to reflect longer life expectancy, but some professionals point out that healthy life years would be a better indicator because it is health rather than age that determines an individual's ability to work (*EHEMU Reports*, 2007).

The percentage of bad health in a population is often measured by the prevalence of disability, i.e. the percentage of people with a disability. Since our population is ageing more and more and older people are more likely to have a disability, the overall occurrence of disability in the total population can go up without individuals actually being at a higher risk of disability than before. Healthy life years take into account both changes in the length of life lived with a disability and changes in the mortality rate, which are responsible for higher life expectancy. This is why an improvement in the health of the ageing population at any age increases life expectancy without disability, even though the overall disability prevalence is higher due to an ever-increasing number of people at risk. Healthy life years are thus an effective tool for identifying the interaction between health, disease, and mortality (*EHEMU Reports*, 2007).

From a methodological perspective, the indicator falls in the category of Health State Expectancies and specifically Disability Free Life Expectancy (DFLE). The health parameter, which is used to calculate the HLY indicator, is based on a question referred to as the GALI (General Activity Limitation Indicator). This question asks respondents whether or not they were limited in their regular activities for health reasons during the preceding six months.[5)]

To calculate healthy life years, the Sullivan Method is largely used. Since life expectancy is not dependent on the size of the population or the age structure, it is possible to compare European countries. To compute health expectancies with the Sullivan Methods, it is possible to use the calculation guide prepared by experts (*Jagger – Van Oyen – Robine*, 2014).

Years spent with a given health condition can be calculated according the Sullivan Method:

$$DFLE_x = \frac{\sum_{i=x}^{\omega-1} {}_nL_i * prev_i^0}{l_x}$$

where:
${}_nL_x$ is the number of years lived by a population between exact ages x and $x + n$ years;
$prev_i^0$ is the prevalence of the health condition at the age of x;
l_x is the number of survivors up to exact age x;
ω is the age when no one in the population survives.

The advantage of the Sullivan method is the good availability of data (coming mostly from population surveys on health status) and its low computational complexity. The disadvantage of this method is the use of prevalence rates coming from transversal data sources, which reflect, rather than current health risks, past conditions influencing the health of the population (*Hrkal*, 2010).

Eurostat compute HLY indicators for the purpose of formulating and evaluating political strategies. Data on HLY are reported annually in the Eurostat database http://ec.europa.eu/eurostat/data/database. Eurostat annually collects data on morbidity and mortality from Member States and performs the computation of HLY itself.

With the inclusion of HLY among the set of structural indicators, the GALI question was introduced in the Survey on Income and Living Conditions (SILC). This survey is conducted by individual Member States in compliance with the EU's uniform instructions and methodology since 2005. In addition to the GALI question, the survey includes another two health questions, all three questions are referred to as the Minimum European Health Module (MEHM) and are also recommended for surveys other than those that are health-oriented.

Although the MEHM was introduced as a European module with harmonized methodology in all countries, the comparability was not optimal before 2008, as it took time to harmonize all aspects of the instrument used in the national questionnaires. Therefore, we can observe breaks in the series of data before 2008, and only data since 2008 are considered comparable. In the Czech Republic, the GALI question was changed significantly[6)] in 2007 and 2008 in order

5) The exact wording of the question and the category of responses recommended by Eurostat to be used in social surveys in 2017 and earlier are:
For at least the past 6 months, to what extent have you been limited because of a health problem in activities people usually do? Would you say you have been …
1) severely limited, 2) limited but not severely or 3) not limited at all?

6) 2006 wording: *Have you been limited during the last 6 months due to health problems in your activities?*
1) Yes, very limited, 2) Yes, limited, 3) No, not limited
2007 wording: *Have you been long-term limited during the last 6 months due to health problems in your activities?*
1) Yes, very limited, 2) Yes, limited, 3) No, not limited
2008 wording: *Have you been limited due to health problems for previous at least 6 months in activities people usually do?*
1) Yes, very limited, 2) Yes, limited, 3) No, not limited

to be comparable with the recommended standardised concept used in the European Health Interview Survey. Thus we can observe a break in data in these years.

However, the concept behind the GALI question is very complicated as it covers 4 dimensions:

- Presence of a limitation
- Presence of a limitation during the past 6 months
- Severity of the limitation
- Health reasons for this limitation

The exact wording of the question is not mentioned in legislation relating to the SILC survey directly, there is just a list of variables that countries are obliged to provide to Eurostat. Implementing the specific tool into the national questionnaire, its exact wording, and the question(s) used to obtain data for this variable depend on each country. In this situation, it is not easy to compare data across the EU as the question(s) and modes of data collection used in some countries may differ from others. It has been found that the number of questions that respondents are asked in order to collect the data on GALI, the context in which they are asked, and the modes of interviewing are relevant issues that can have an impact on the final results (Cambois, Inserm 2017). Moreover, discussion has begun at the EU level on introducing an 'easier' tool to measure this aspect in the population and the recommended 'GALI question' will probably be changed in the coming year.

Within several European projects the European Health Expectancy Monitoring Unit was set up and the European Health and Life Expectancy Information System (EHLEIS) was developed during 2004–2014. Since 2014 EHLEIS has been a part of the BRIDGE Health project that is working to prepare the transition towards a sustainable and integrated EU health information system within the third EU Health Programme, 2014–2020.

EurOhex (www.eurohex.eu) is a website that provides access to research on health expectancies in Europe. It includes a database on health indicators comprising life expectancies and Healthy Life Years (HLY) for 28 European countries. The method of computation slightly differs from the method used by Eurostat, but the data are almost the same. On the EurOhex webpage one can compute the HLY indicator for different morbidity variables (subjectively perceived health, prevalence of chronic disease, activity limitation) and from different sources (SILC, SHARE – Survey on Health, Ageing and Retirement in Europe). Since 2005 within this information system annual Country Reports are prepared and published on the EHEMU website. Country Reports contain a description of the main purpose of health expectancies and the HLY values for the given country in comparison with an average for the 28 Member States of the European Union(EU28). The HLY values based on the SILC question on long-term activity limitation are presented here, together with health expectancies based on two additional dimensions of health (chronic morbidity and self-perceived health) for the given country.

3. ACTIVITY LIMITATION (THE MORBIDITY DIMENSION OF HEALTHY LIFE YEARS) IN THE CZECH REPUBLIC

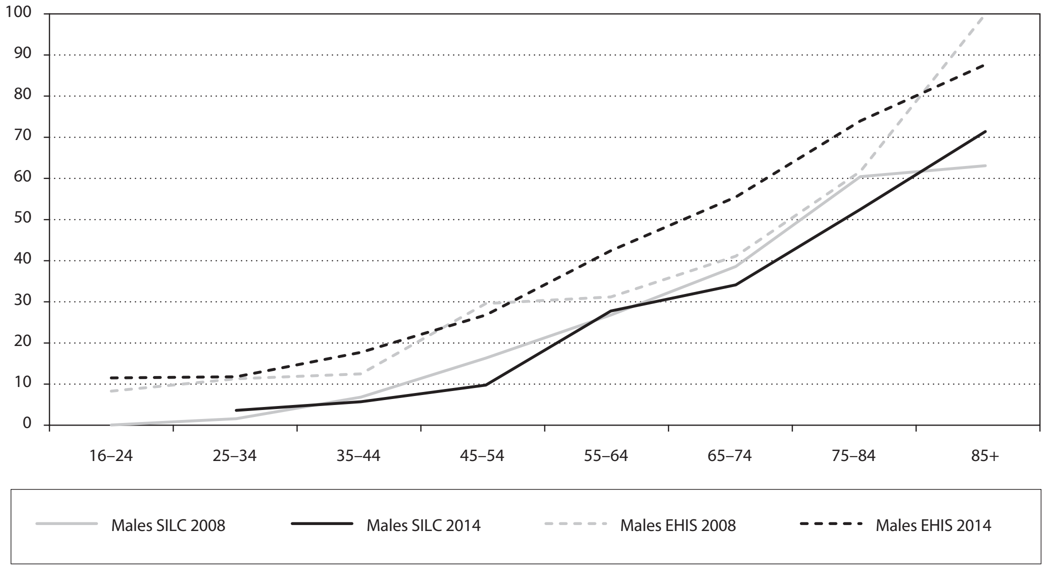
Besides SILC, there is one more detailed source of survey data on health in European countries, which is EHIS. The European Health Interview Survey is a survey that supplements routine health statistics. In 2008 the first wave of this health interview survey took place in the Czech Republic using the harmonised materials for conducting this survey, such as questionnaire, methodological guidelines etc. In 2013 an implementing regulation on the EHIS came into force (Implementing Regulation No. 141/2013 of 19 February 2013 implementing Regulation No. 1338/2008 of the European Parliament and of the Council (EC) on Community statistics on public health and health and safety at work, as regards statistics based on the European Health Interview Survey (EHIS)) and the survey became obligatory in all EU countries. In 2014 the second wave of the survey was conducted in the Czech Republic. The next survey will take place in the Czech Republic in 2019. The relevant legislative framework is currently under preparation.

Both surveys, SILC and EHIS, include MEHM, which can be used as the basic set of indicators for assessing the overall state of health. The questions and the wording of them used in both surveys are almost the same. Significant differences, however, can be observed in the results produced by the two surveys.

The prevalence of limitation in activities according to SILC and EHIS – an overview

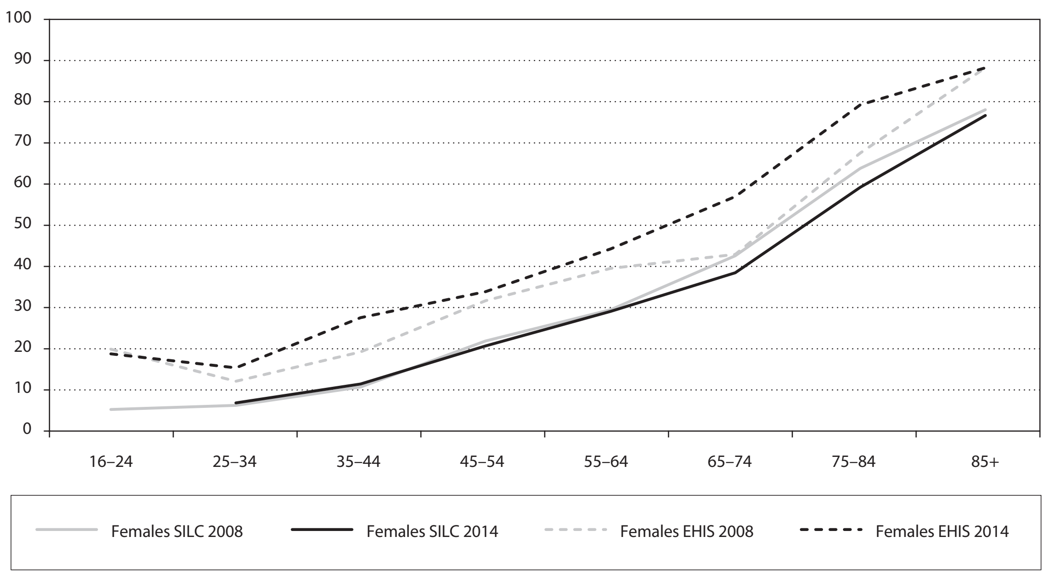
From Figures 2 and 3 it is clear that the two above-mentioned sources differ in their GALI figures.

Figure 2 The prevalence of limitation in usual activities due to health reasons (%), males aged 16+, Czech Republic, 2008, 2014



Source: EHIS 2008, EHIS 2014, SILC 2008, SILC 2014.

Figure 3 The prevalence of limitation in usual activities due to health reasons (%), females aged 16+, Czech Republic, 2008, 2014



Source: EHIS 2008, EHIS 2014, SILC 2008, SILC 2014.

In both surveys, the prevalence of activity limitation increases with age. However, in SILC we can observe lower prevalence of activity limitation across all age groups compared to EHIS and a less rapid increase in the highest age groups. This difference can be observed in both years – 2008 and 2014 – and in both men and women.

Given that the SILC survey monitors only population aged 16 and over, for the purposes of comparison the data for EHIS were re-calculated for this age group. So for a comparison of both data sources, data on population aged 16 and over are presented. When presenting only results of the EHIS survey, data on population aged 15 and over are used.

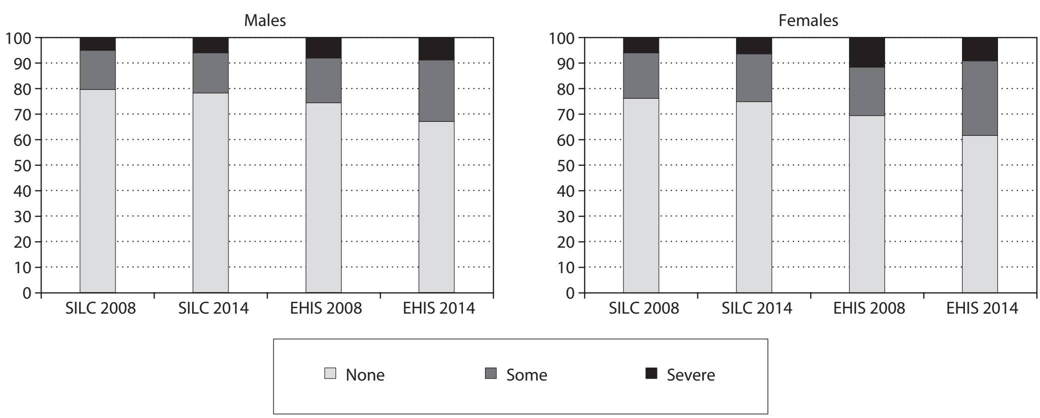
As Table 1 shows, limitations related to health were observed in 20% of men and 24% of women in the SILC survey in 2008, compared with 26% of males and 30% of females with limitations in EHIS 2008. This means that the overall figures in EHIS are 6 percentage points higher compared to SILC. The same pattern can be observed in 2014: according to SILC data the prevalence of persons with limitations

Table 1 Share of persons limited in usual activities due to health reasons (%), males and females aged 16+, Czech Republic, 2008, 2014

	Males		Females		Males		Females	
Age group	SILC 2008	SILC 2014	SILC 2008	SILC 2014	EHIS 2008	EHIS 2014	EHIS 2008	EHIS 2014
16-24	4.4	NA	5.6	NA	12.3	15.3	20.3	19.1
25-34	5.9	7.8	6.6	7.2	15.2	15.7	12.5	15.7
35-44	10.9	9.8	11.1	11.8	16.3	21.3	19.6	27.9
45-54	20.0	13.7	22.3	21.1	32.7	30.0	32.1	34.3
55-64	30.0	30.9	29.9	29.5	34.2	44.9	40.0	44.7
65-74	41.3	37.0	43.1	38.9	43.7	57.4	43.4	57.5
75-84	62.2	54.6	64.4	59.8	63.4	75.1	68.1	79.9
85+	64.7	72.7	78.7	77.3	100.0	88.2	88.9	88.9
Total	20.4	21.8	23.8	25.1	25.8	32.9	30.6	38.4

Source: EHIS 2008, EHIS 2014, SILC 2008, SILC 2014.

Figure 4 The prevalence of limitation in usual activities by severity (%), males and females aged 16+, Czech Republic, 2008, 2014

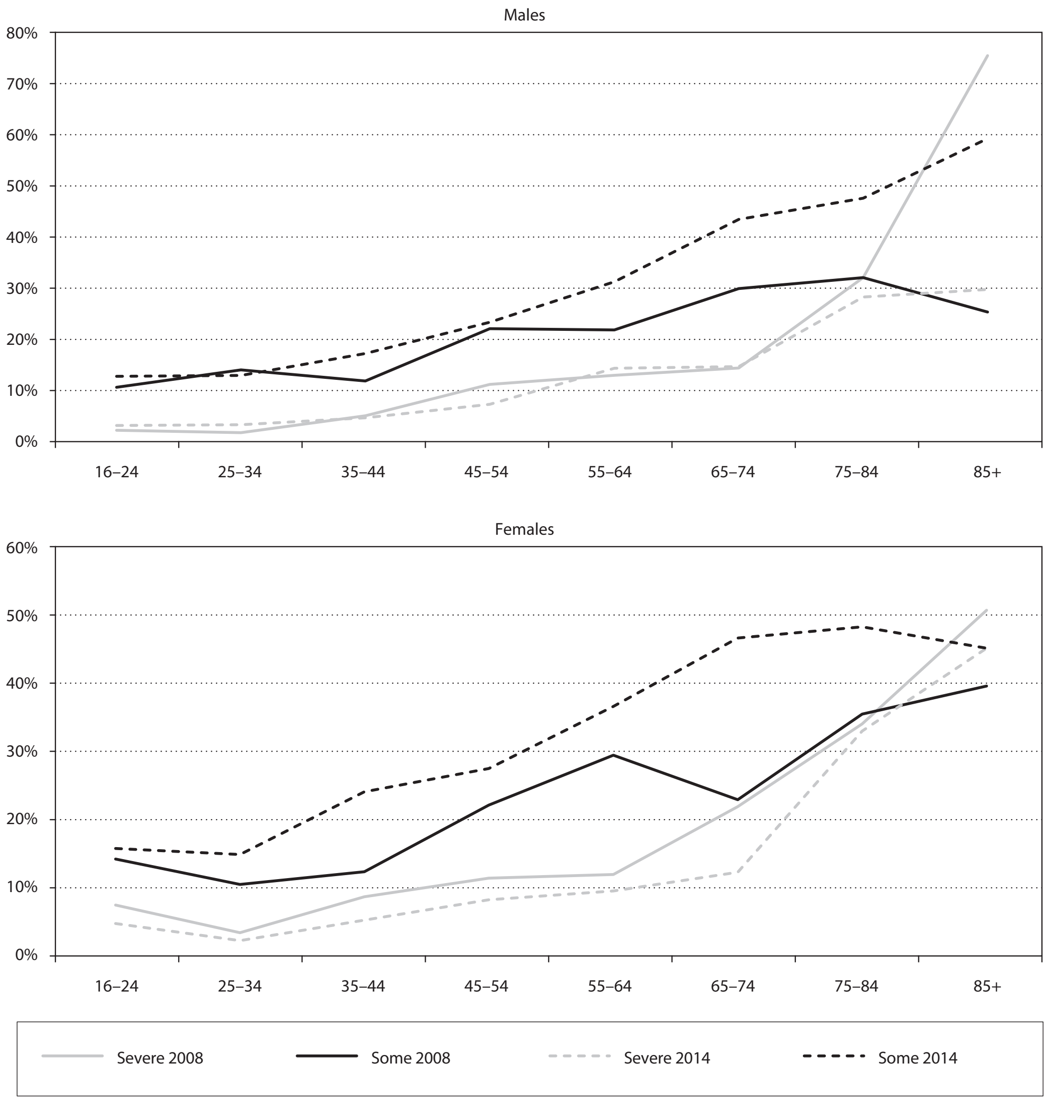


Source: EHIS 2008, EHIS 2014, SILC 2008, SILC 2014.

was 22% for males and 25% for females, according to EHIS data the figures were 33% for males and 38% for females, which means that the difference between the two sources increased during the 6 years. According to both data sources, the prevalence of limitations increased, but the increase was greater in EHIS data than in SILC data.

If we observe separately the severity of limitations (see Figure 4), we can see in 2008 a huge difference in the share of women and the share of men who answered that they are limited severely in usual activities. These figures are much higher in EHIS than in SILC, while the share of people who have some limitations

Figure 5 The prevalence of limitation in activities by severity according to age (%), males and females aged 16+, Czech Republic, 2008, 2014



Source: EHIS 2008, EHIS 2014.

is more or less the same in both surveys. If we assess 2014 data, we can see an enormous increase in the prevalence of persons with 'some' activity limitation in the EHIS data, which resulted in the large difference between both sources.

The huge increase in the prevalence of some limitations observed in EHIS data has a different age pattern for men and women (see Figure 5). While in men this increase was lower, it was not accompanied by a decrease in the prevalence of severe limitations and was observed especially among older people, in women the increase of prevalence of some limitations was observed in almost all age groups and it was accompanied by a decrease in the prevalence of severe limitations in several age groups.

The prevalence of activity limitation in SILC and EHIS – the causes and consequences of the differences

What are the reasons for this difference between SILC and EHIS data?

We could start by comparing the question's wording, but we can see that it is almost the same in both data sources. Only a very minor difference can be found in the question itself: in SILC[7)] the reference period for the duration of the health limitations is defined as 'the previous 6 months' while in EHIS[8)] it is defined as 'the last 6 months'.

More significant differences can be found in response categories. SILC uses the following response categories: 1) Yes, very limited, 2) Yes, limited, 3) No, not limited, while in EHIS the exact wording slightly differs (1) Yes, severely limited, 2) Yes, limited, but not severely, 3) No, not limited). Unfortunately, no cognitive testing has been performed that could explain any difference the wording of the response categories might cause.

More important and problematic issues could be found in other methodological aspects related to the question. In the interviewer's manual for the SILC questionnaire there is just a short note explaining that any limitation has to have lasted at least 6 months in order for the respondent to answer 'yes'. In the EHIS manual for interviewers, there is about half a page of instructions explaining the concept behind the question and it describes in details all four parts of the question. For instance, it explains the reference period (any limitation has to be present at the time of the interview and has to have lasted at least 6 months) and interviewers are provided with a detailed description of what 'activities people usually do'.

However, the most important difference is probably the overall context of the survey (*Daňková*, 2010). The points above refer to some methodological differences between the two surveys.

Although the maximum degree of harmonisation was achieved and the questionnaire used is the same, the contexts of the two surveys are nonetheless significantly different. EU SILC is an extensive survey focusing on living conditions (material, financial, working conditions, etc.), while health issues are dealt with only marginally. The EHIS survey, by contrast, focuses exclusively on health, and MEHM is followed by a number of questions that question respondents further on their health, specific chronic illnesses, visits to the doctor, etc. This can be expected to have a psychological effect on respondents, as they will concentrate more on the state and aspects of their health (*Šprocha*, 2016). The process of going through a questionnaire that investigates the respondents health in detail could also create a situation where respondents modify their original response during the interview.

There may also be other factors that are not easy to describe now and will probably surface in the next survey periods, factors such as the structure of interviewers, modes of interviewing, hidden proxy answers etc.

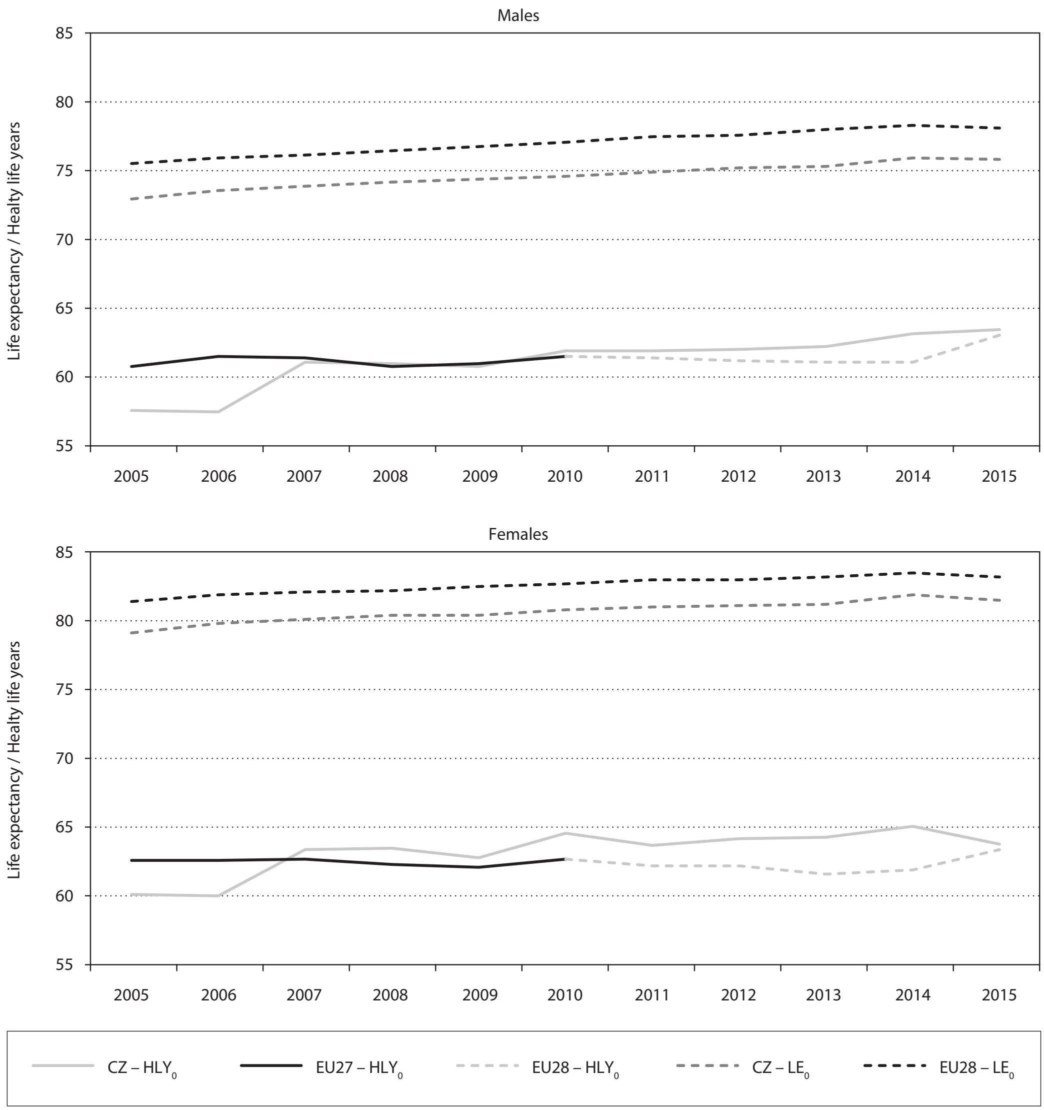
The implications of identifying these different population structures according to health in the EHIS and SILC surveys are crucial. 'Healthy life years' is a very important indicator of the health of the population and has great significance. Benchmarking based

7) *Have you been limited due to health problems for previous at least 6 months in activities people usually do?*
1) Yes, very limited, 2) Yes, limited, 3) No, not limited

8) *Have you been limited due to health problems for previous at least 6 months in activities people usually do?*
1) Yes, severely limited, 2) Yes, limited, but not severely, 3) No, not limited

on this indicator is often used to assess the situation in a given country for various policy purposes and strategies. It is often used to formulate strategies, with the main goal specified as extending the share of life experienced in a state of health (i.e. share of HLY to LE) or for comparing countries with the highest HLY. For this reason, it is necessary to address not only the number of 'healthy years', but also the development of the indicator. Equally important is the methodical background (the wording of the question, the context, the manner of questioning), which vary between countries and can vary over time, etc.

Figure 6 Life expectancies at birth (LE_0) and Healthy Life Years (HLY_0), males and females, Czech Republic and EU (27 or 28 countries of EU), 2005–2015



Source: Eurostat database.

We must keep in mind that this indicator is based on a subjective evaluation of health, which is assessed by respondents themselves and may be influenced not only by their real health state, but also by other determinants (political situation, cultural differences etc.).

4. HEALTHY LIFE YEARS IN THE CZECH REPUBLIC

European context

Figure 6 shows the development of life expectancy at birth (LE_0) and Healthy Life Years (HLY_0) for the Czech Republic and the European Union for both genders in 2005–2015. From these results, it is clear that in terms of life expectancy the Czech Republic is in all years below the EU level (data from 28 countries). The difference between the Czech Republic and the EU is around 2 years for women and 2.5 years for men.

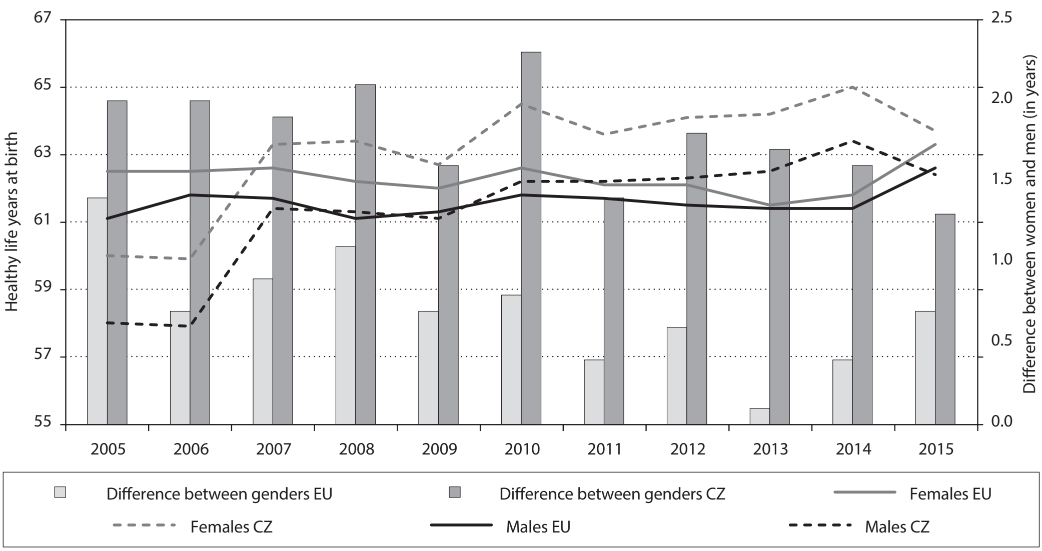
Table 2 presents the concrete values of life expectancy and healthy life years at birth for each gender in the Czech Republic as well as the percentage of life that an individual born in a certain year is to live in good health. Some may say that while life expectancy is a quantitative parameter that uses exact values

Table 2 Life expectancies at birth (LE_0), Healthy Life Years at birth (HLY_0) and the percentage of life spent in good health, males and females, Czech Republic, 2008–2015

		2008	2009	2010	2011	2012	2013	2014	2015
Females	HLY_0	63.4	62.7	64.5	63.6	64.1	64.2	65.0	63.7
	LE_0	80.5	80.5	80.9	81.1	81.2	81.3	82.0	81.6
	HLY_0 / LE_0 (%)	78.8%	77.8%	79.7%	78.5%	78.9%	79.0%	79.2%	78.1%
Males	HLY_0	61.3	61.1	62.2	62.2	62.3	62.5	63.4	62.4
	LE_0	74.1	74.3	74.5	74.8	75.1	75.2	75.8	75.7
	HLY_0 / LE_0 (%)	82.7%	82.3%	83.5%	83.1%	83.0%	83.1%	83.6%	82.4%

Source: Eurostat database.

Figure 7 Difference in healthy life years between females and males, Czech Republic and EU, 2005–2015



Source: Eurostat database.

concerning the entire population based on life tables, healthy life years are a qualitative parameter that reflects the results from sample surveys. Unfortunately, for now we do not have any other health parameter that would be better for such a comparison. If we disregard the 'disadvantages' of each parameter, the data clearly show that during the entire monitored period, men are expected to live a bigger part of life in relatively good health than women (the difference is approximately 4 percentage points).

In the Czech Republic the share of healthy life years out of life expectancy is relatively large. In 2015 the share of healthy life years was 78.0% for females and 82.4% for males, while in the EU28 it is about 2 percentage points lower. In the long term it has a rather stable trend, in 2015 the percentage decreased slightly year-on-year in both sexes.

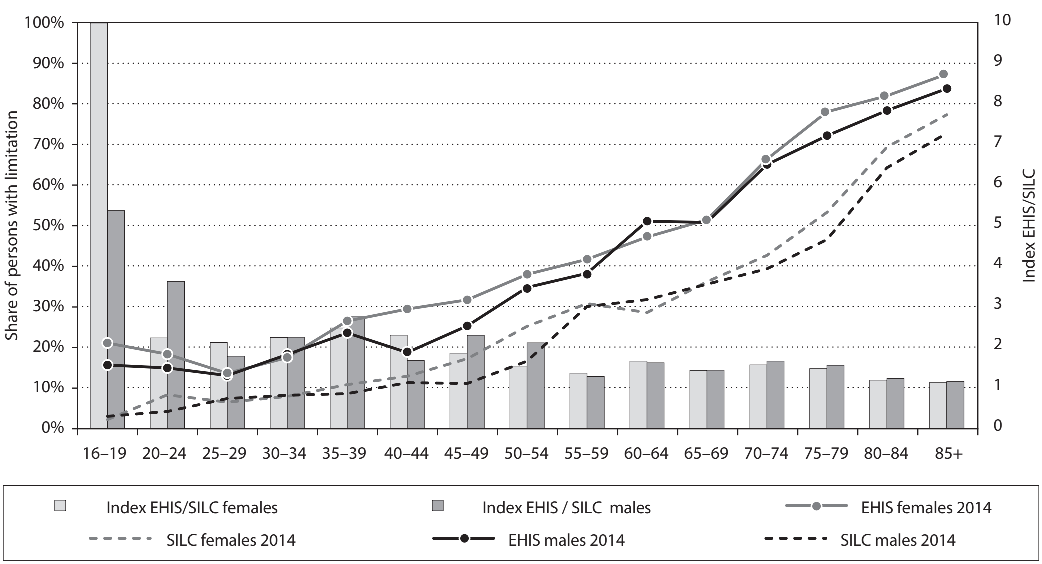
Figure 7 shows the development of the differences in HLY between females and males over the period 2005–2015. The figure shows that the gender gap in the Czech Republic is bigger than in the EU. The difference in HLY at birth between females and males was 1.3 years, which is 0.6 years more than in the EU on average. The Czech Republic ranks among the countries in the EU with above-average figures. From 2007 the HLY indicator had a rising trend (an increase between 2007 and 2014 of 2 years for males and 1.7 years for females), and only declined in 2015. However, there was a reduction in the gender gap, which was the smallest in 2015.

Healthy life years in the Czech Republic – two different sources of health data

As shown above, two important sources of data in the Czech Republic indicate significantly different results for the prevalence of activity limitation for health reasons. In order to show the effect of the different results on health expectancy, we computed values of HLY using data from these two data sources. The computation was done using Sullivan's Method, and life tables downloaded from the EHEMU database (Eurostat method of computation) were used.

Unfortunately, for 2008 the EHIS sample size was relatively small (1,955 respondents) and the prevalence of activity limitation varies considerably across the 5-year age groups that should be used in the computation in order to obtain valid results. Thus, the HLY indicator was computed only for 2014, and only for ages 16+, as we do not have data on the prevalence of activity limitation in younger age groups.

Figure 8 The prevalence of activity limitation by age and sex, Czech Republic, 2014



Source: EHIS 2014, SILC 2014.

Figure 8 presents a comparison of the prevalence of activity limitation by 5-year age groups in the SILC and EHIS 2014 surveys for men and women. We can see that EHIS indicates a much higher prevalence of limitation across all age groups, but extreme differences can be observed in younger age groups 16–19 and 20–24. The prevalence of limitation is 10 times higher in EHIS than in SILC for females aged 16–19 years, and more than 5 times higher for males of the same age. At the age of 85+ the EHIS prevalence of activity limitation is just 12–15% higher if compared to SILC, which, however, is then a difference of 10–11 percentage points in the prevalence of activity limitation. While 87% of women have activity limitation according to EHIS, in SILC it is only 77%, and for men it is 84% according to EHIS and 73% according to SILC data.

The HLY indicators computed with data from SILC, which are used as the official European figures, are 48.4 years for men and 49.5 years for women at age 16 years. If we use data from EHIS, the figures are much lower, at 40.1 for men and 39.8 for women.

At age 65 the HLY indicator according to SILC data is 9 years for males, while only 5.7 if data from EHIS are used. Similarly, for females, the figure is 9.3 for SILC and 5.8 for EHIS data.

It is clear that the relative difference in the HLY indicators between both surveys increases with age and the maximum difference was observed at the age of 75, when the HLY figures based on SILC data were almost twice as high as the figures based on EHIS data.

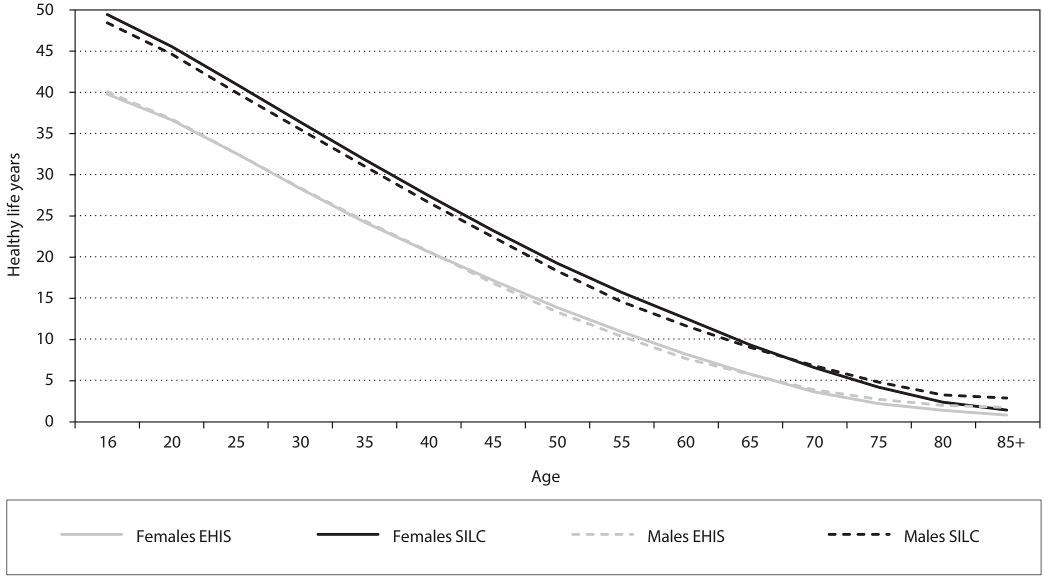
The difference in HLY between males and females is 1.1 years if data from SILC are used and 0.3 if data from EHIS are used at the age of 16. According to EHIS data, the HLY indicator at age 16 was 0.3 years higher for males than females, while SILC data show a higher figure for females than males and the difference is 1.1 years. The HLY indicators based on EHIS data show only a small difference between both males and females across all age groups. A slightly bigger difference can be observed at age 45–60, where women have higher HLY indicators than men, and in the oldest age groups, when, on the contrary, men's HLY indicators are higher. However, a similar profile can be observed in the SILC data, and the difference between both sexes is greater than the difference observed using EHIS data for people under the age of 65 and relatively lower for persons aged 70+.

Table 3 **Healthy Life Years computed using GALI data from both data sources – SILC and EHIS, Czech Republic, 2014**

	HLY Males		HLY Females		Sex difference (absolute) HLY females – HLY males		Females / males ratio	
Age	**EHIS**	**SILC**	**EHIS**	**SILC**	**EHIS**	**SILC**	**EHIS**	**SILC**
16	40.1	48.4	39.8	49.5	-0.28	1.01	0.993	1.021
20	36.8	44.6	36.6	45.6	-0.11	0.92	0.997	1.021
25	32.6	40.0	32.6	41.0	-0.02	1.03	0.999	1.026
30	28.4	35.5	28.3	36.4	-0.07	0.89	0.998	1.025
35	24.4	31.0	24.2	31.8	-0.16	0.80	0.993	1.026
40	20.7	26.6	20.6	27.4	-0.09	0.83	0.996	1.031
45	16.8	22.4	17.2	23.2	0.35	0.78	1.021	1.035
50	13.3	18.3	13.9	19.2	0.56	0.93	1.042	1.051
55	10.3	14.5	10.9	15.7	0.56	1.15	1.054	1.079
60	7.6	11.6	8.2	12.5	0.53	0.89	1.069	1.077
65	5.7	9.0	5.8	9.3	0.05	0.30	1.009	1.033
70	3.8	6.8	3.6	6.5	-0.25	-0.21	0.935	0.968
75	2.7	4.8	2.2	4.2	-0.52	-0.62	0.806	0.871
80	1.9	3.2	1.3	2.3	-0.59	-0.89	0.693	0.724
85+	1.7	2.8	0.8	1.4	-0.93	-1.47	0.450	0.480

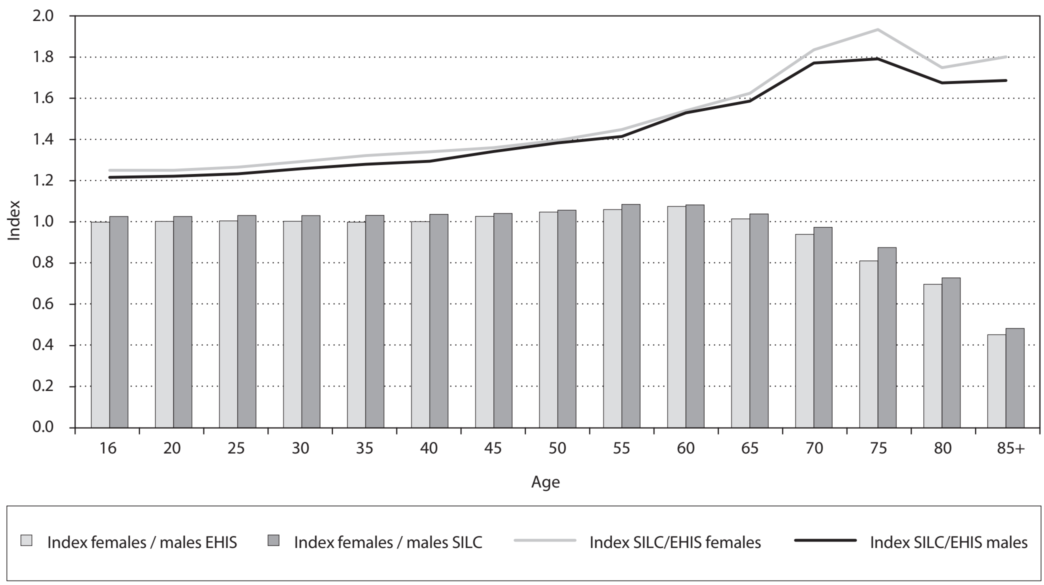
Source: EHIS 2014, SILC 2014, EHEMU database; authors' calculations.

Figure 9 Healthy Life Years (life expectancy without disability based on GALI) computed from EHIS and SILC data, Czech Republic, 2014



Source: EHEMU, SILC 2014, EHIS 2014; authors' calculations.

Figure 10 Indexes related to HLY computed on the basis of EHIS and SILC data, Czech Republic, 2014



Source: EHEMU, SILC 2014, EHIS 2014; authors' calculations.

5. CONCLUSION

With longer life expectancy, health expectancies are becoming increasingly important, because they are able to quantify, at least approximately, how the years of life will be spent, in what quality of life and in what health. There are several indicators of health expectancies, but the one most commonly used is the HLY indicator.

The HLY indicator is increasingly a part of policy concepts and their evaluations at the national, international, and regional levels. In the Czech Republic, there is no more detailed breakdown available of the data (i.e. on the NUTS 2 or NUTS 3 level), but we believe that in the future it will be possible to publish this indicator regularly for regions.

The methodology for calculating this indicator is relatively simple. The indicator as such has two main components: mortality and morbidity. The calculation, usually performed using the Sullivan Method, is based on including the proportion of people limited in the activities people usually do due to health problems by age into the calculation of life expectancy in the form of life tables. The morbidity characteristic used for this purpose is the General Activity Limitation Indicator (GALI). Information on GALI used by Eurostat to calculate the HLY indicator comes from the EU-SILC sample survey, which is obligatory in all EU countries and provides comparable data on the living conditions of the population since 2008. Although this is a harmonised survey with a uniform methodology, specific aspects connected with the collection of data on GALI may vary across countries. The resulting figures are then dependent not only on the precise wording of the question, but also on the way the interview is conducted.

Another possible source of data on the proportion of people with activity limitation for health reasons is the European Health Interview Survey (EHIS). This survey is conducted according to the European Commission's Legislative Decree; in the Czech Republic, the most recent survey took place in 2014 on a sample of more than 6,500 respondents. This is a survey that focuses mainly on the health of an individual, but also monitors the use of health care and selected aspects of lifestyle that are risky for health.

By comparing the results of the SILC and EHIS surveys in 2008 and 2014, we find that the prevalence of persons reporting restrictions on routine activities for health reasons is underestimated in the SILC survey compared to EHIS, both for males and for females. The underestimation applies to all age groups and is larger in 2014 than in 2008. The reasons for this difference in the results of both surveys could be the methodological aspects of both surveys (wording, questionnaire guidelines, etc.), but in our opinion the most important role is played by the context in which the GALI question is placed in the survey. While in the SILC survey the question is posed at the end of the interview as a supplement to other questions relating, in particular, to income, household equipment, etc., in the EHIS survey it is among the first questions asked and is subsequently supplemented by a number of questions focusing on the particular health problems the respondent is struggling with.

The HLY indicator, calculated and presented by Eurostat based on the GALI question (from SILC), reached 62.4 years in males and 63.7 years in females in 2015. The share of HLY out of life expectancy was approximately 82% for males and 78% for females. Compared to the EU-28 average, life expectancy in the Czech Republic is lower by about 2.5 years for men and 2 years for women, but the length of HLY in the Czech Republic is comparable to the values observed in the EU as a whole and therefore there is also a higher proportion of HLY out of the total life expectancy. Relatively high levels of inequality between the sexes are observed in the Czech Republic. The difference in life expectancy between males and females is around 6 years. If we monitor HLY, there is a difference of less than 1.3 years, but still higher than the EU average.

It is difficult to say which of the GALI figures is closer to the real situation in the Czech population, whether the figure obtained from the EHIS or the SILC survey. In addition, in 2014 the difference between the two surveys in the prevalence of this indicator was significant. To demonstrate the effect of possible distortion, an HLY calculation using EHIS data was performed.

HLY computed with data from SILC, which are used as official European values, is 48.4 years for men and 49.5 years for women at age 16 years. If we use data from EHIS, the figures are much lower – 40.1 for men and 39.8 for women. The difference is therefore huge. It can thus be concluded that the actual HLY figure in the Czech Republic is probably lower than the calculation performed here on SILC data. And it is clear that the figures for the HLY indicator obtained by the calculation using the EHIS survey data give a more insightful view of the health status of the population. Unfortunately, the trend of the HLY indicator is unlikely to be monitored by EHIS. However, for this purpose it is possible to use the data from the SILC survey, which is comparable since 2008, because the survey is still carried out in the same way.

The last question is to what extent the data presented by Eurostat for the HLY indicator is comparable across the countries. A very important role is played by the way in which the GALI variable is specifically identified in a given country, by methodological factors, and by the circumstances of the survey. Currently, the wording of the GALI question is being changed in some countries, which significantly distorts comparisons. In the future, it can be expected the question recommended by Eurostat for the GALI survey will change, which will certainly be reflected in further inconsistencies between countries.

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THE DEVELOPMENT OF REGIONAL MORTALITY DISPARITIES IN THE CZECH REPUBLIC IN THE PERIOD 1991–2015

Dan Kašpar[1)] – Klára Hulíková Tesárková[2)] – Boris Burcin[3)]

ABSTRACT

Convergence analysis represents a distinct stream of research in demography and its findings have both theoretical and practical implications. This article focuses on an analysis of mortality convergence of Czech districts over the years between 1991 and 2015. Selected methods that can be used in this kind of analysis are introduced. The results mainly point to the significant influence of age (especially in relation to the differences in mortality in the oldest age groups) on the process of mortality convergence and the effect of specific regional factors (e.g. some districts lag behind others in mortality).

Keywords: mortality, convergence, divergence, Gini coefficient, districts, Czech Republic

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1. INTRODUCTION

The study of mortality convergence (and divergence) is a developing branch of research in demography today. It focuses mainly on the international level, although many studies also stress the importance of observing developments on the regional level (*Burcin – Kučera*, 2008; *Janssen et al.*, 2016; *Vallin*, 2013). Analysis of mortality convergence between regions provides a deeper insight into changes observed on the national level (*Odoi – Busingye*, 2014), but above all it can contribute to the discussion of the theoretical and practical issues connected with regional disparities in demographic processes, their practical significance, and their trends over time.

First of all, a regional analysis of convergence can be used to verify the assumption included in some theoretical concepts – that mortality conditions are converging (e.g. the demographic revolution, the epidemiological transition, the health transition, etc.; *Kibele – Klüsener – Scholz*, 2015; *Vallin – Meslé*, 2004).

Governments also seek (explicitly or implicitly) not just to improve mortality in the population (*Coleman*, 2002) but also to reduce (regional and other) differences in the level of mortality within the state. Inequality in death is viewed by society as 'more inequitable than other' (*Vallin*, 2013: 139) inequalities in human well-being. As *Vallin* (2013) has pointed out, while it is probably impossible to achieve total mortality equity, it is still the aim to reduce inequalities as much as possible. Understanding regional differences in mortality and their development may thus also

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determine how financial resources in the state budget are distributed in selected regions in an effort to reduce these inequalities (*Janssen et al.*, 2016).

Last but not least, it is possible to note that there is often an assumption in population forecasts about the future convergence of regions in terms of intensity of mortality, both at the international level (see, e.g., *European Commission, Economic Policy Committee*, 2014) and at the regional level (see, e.g., *Bleha – Šprocha – Vaňo*, 2014; *Czech Statistical Office*, 2014; *Fiala – Langhamrová – Hulík*, 2009). To verify such assumptions, first it is necessary to learn more about past mortality trends.

Janssen et al. (2016) note that the results of studies focusing on regional mortality convergence and divergence differ from the viewpoint of the various trends observed, even when the attention is solely devoted to the total level of mortality in advanced countries. If we are concerned only with European states and regions, there is a relatively large body of literature devoted to regional mortality differences (overall or by causes of death) that offers examples of countries and regions in which current trends indicate convergence, while stagnation or even growing differences have also been recorded. While some studies have been pointing to regional convergence in mortality in France since the 1950s (*Vallin*, 2013), in Germany since the 1990s (*Kibele*, 2012), or in the European Union since the start of the new millennium (*Jaworska*, 2014), no change in mortality conditions was observed in 1988–2009 in the Netherlands (*Janssen et al.* 2016), and a tendency towards mortality divergence has been observed between regions in, for example, Belarus since the early 1990s (*Grigoriev – Doblhammer-Reiter – Shkolnikov*, 2013) and in Scotland between 1981 and 2001 (*Boyle – Exeter – Flowerdew*, 2004). Although there are some studies that have also looked at mortality trends in regions in the Czech Republic (see e.g. *Burcin – Kučera,* 2000; *Burcin – Kučera*, 2008; *Dzúrová*, 2000), none of them focused primarily on analysing convergence tendencies. Therefore, with a view to the questions noted above, the main goal of this article is to analyse mortality convergence at the regional level in the Czech Republic since 1990.

2. DATA AND METHODS

The indicators used in this study were constructed from data drawn from the standard records of population change maintained and processed by the Czech Statistical Office (*Czech Statistical Office*, 2017). Our analysis looks at mortality trends on the level of districts within the Czech Republic (76 district units + the Capital of Prague), analysing them separately for men and women, using selected indicators characterising intensity of mortality over the course of life and at age intervals that reflect the specific character of mortality. We divided the total age interval into three age groups (defined as the ranges of exact age 0–50, 50–70 and 70 years and over), which represent age groups in which level of mortality and the possible trend in mortality are relatively distinct from each other. The 0–50 age group is characterised by generally low mortality with already small potential for its further decrease. Conversely, the oldest age group, 70 and over, is currently characterised by a significant decrease in mortality but also by its still high level. The middle age interval, aged 50–70 years, represents a kind of transition between low and high mortality, with large differences between sexes. To express the level of mortality we used the temporary life expectancy in the first two age groups, and we used life expectancy at the exact age 70 for the 70+ age group.

We calculated the temporary life expectancy between exact ages x and $x+i$ (expressed as ${}_ie_x$) according to the Arriaga (1984) as:

$$ {}_ie_x = \frac{T_x - T_{x+i}}{l_x} $$

where T_x and T_{x+i} are the total number of person-years lived after reaching the exact age x, or $x+i$ (i is the length of the age interval) and l_x is the life table survival function (i.e. number of survivors to the exact age x).

In order to calculate these indicators, we used the DeRaS software application (*Burcin – Hulíková Tesárková – Kománek*, 2017) producing detailed life tables, which are smoothed in older age, using the Kannisto model. Based on the Akaike information criterion, this model was evaluated as the most suitable one for the used data of all mortality models (Gompertz, Gompertz-Makeham, Coale-Kisker, Heligman-Pollard, Thatcher and Kannisto) offered by the application DeRaS. The model parameters were estimated using the nonlinear regression method by minimising the weighted least squares. To reduce random fluctuations resulting from the small number of events, we constructed the tables and subsequently the indicators defined above for five-year periods – 1991–1995, 1996–2000, 2001–2005, 2006–2010 and 2011–2015 – representing the time frame of our analysis.

There is an array of analytical approaches in demography and other fields of study that can be used to study changes in regional disparities (see, e.g. *Cowell*, 2011).[4] This broad range of options using different indicators and including different hierarchical levels undermines the comparability of studies focusing on regional convergence (*Janssen et al.*, 2016; *Netrdová – Nosek*, 2009; *Novotný*, 2007).

One way of differentiating between approaches to the analysis of (regional) inequalities is the distinction of beta convergence and sigma convergence (*Barro – Sala-i-Martin*, 1992; *Janssen et al.*, 2016). Beta convergence is based on regression models and is used primarily to determine whether in regions where the situation is less favourable in terms of mortality, its improvement (mortality decrease) is faster than in 'more advanced' regions. However, this method of measuring convergence does not answer the question of whether inequalities are decreasing over time within the given group of regions as a whole. This question is addressed by the second approach, sigma convergence (Novotný, 2010; Rey – Janikas, 2005).[5] Considering the aim of our analysis, attention is devoted to the analytical tools that are used in the study of sigma convergence. It can be explored more deeply using numerous indicators, most often the Gini coefficient and the Theil index (*Netrdová – Nosek*, 2009; *Novotný*, 2010), but also using basic statistical characteristics of variability such as standard deviation (*Coleman*, 2002; *Janssen et al.*, 2016). The advantages of the Gini coefficient and the Theil index compared to the majority of these basic characteristics are their independence from the average, their non-dimensionality, and their explanatory nature (*Netrdová – Nosek*, 2009; *Novotný*, 2010).

We used cartograms to create an initial idea of the regional trends in mortality differentiation in the Czech Republic, and to evaluate regional convergence tendencies we used the Gini coefficient in its unweighted form and in a form weighted for the population size of the districts.[6] The unweighted Gini coefficients reflect the inter-regional differences in the phenomenon under observation (each region has the same weight in the formula; *Firebaugh*, 1999). They are also easier to interpret than the results obtained using the weighted formula (*Janssen et al.*, 2016). On the other hand, the weighted formula reflects the differences between individuals (each individual is assigned the same weight; *Firebaugh*, 1999), which in our analysis makes it possible to observe the trends in mortality inequalities between inhabitants of the Czech Republic.

The Gini coefficient (marked as G in its unweighted form and G_w in the form weighted for population size), which is derived from the Lorenz curve (particularly used in economics, for instance, to illustrate the inequalities in the distribution of wealth or income in the population), was calculated according to *Novotný – Nosek – Jelínek* (2014) as:

$$G = \frac{1}{k^2}\frac{1}{2y}\sum_{i=1}^{k}\sum_{j=1}^{k}(|y_i - y_j|)$$

$$G_w = \frac{1}{2y}\sum_{i=1}^{k}\sum_{j=1}^{k}(\frac{n_i}{n}\frac{n_j}{n}|y_i - y_j|)$$

where k is the number of districts, y indicates the mean of the values of (overall or temporary) life expectancy (in the case of the weighted form the weighted average is used), y_i and y_j indicate the levels of (overall or temporary) life expectancy in district

4) It is also possible to encounter the opinion that 'there is no one ideal measure of inequality due to its multidimensionality' (*Novotný*, 2004: 57).

5) It might at first glance seem that when beta convergence occurs then sigma convergence also automatically occurs, but this is not the case. It has been shown that even when beta convergence is observed it is possible for the differences between the defined population units or groups to grow (*Barro – Sala-i-Martin*, 1992; *Young – Higgins – Levy*, 2008).

6) EasyStat statistical software was used to calculate the Gini coefficients (*Novotný – Nosek – Jelínek*, 2014). As noted above, it is also possible to use other statistics that characterise regional differences, such as the coefficient of variation and the Theil index. However, as these analytical tools revealed similar trends in regional inequalities as the Gini coefficients, only the results of the latter are presented in this article.

i and *j*, *n* represents the total number of inhabitants, and n_i and n_j indicate the number of inhabitants in districts *i* and *j*. The Gini coefficient can reach values from 0 to 1, and the lower the value observed, the lower the inequality of the given indicator (*Baštová – Hubáčková – Frantál*, 2011).

For above mentioned mortality indicators we also constructed the empirical distribution functions. This graphical representation of data offers an opportunity to examine in-depth mortality convergence tendencies observed on an aggregate level using the Gini coefficient.

The empirical distribution function can be defined for value *r* (that is, at point *r*) as the relative number of values less than or equal to this value (it thus determines the share of observations of values smaller or equal to the value of *r*), that is

$$F(r) = \frac{(number\ of\ y_i \leq r)}{k}$$

where y_i indicates the observations for individual districts ($i = 1, ..., k$) and *k* is the total number of observations (*Hendl*, 2009), i.e. the total number of districts. The distribution function can reach the values from 0 to 1, where the value of 1 reflects a situation in which all observed values are less than or equal to *r* and the value of 0 means none of the observed values is less than or equal to *r*.

3. REGIONAL PATTERNS OF MORTALITY IN THE CZECH REPUBLIC: 1991–2015

Between the 1991–1995 and 2011–2015 periods life expectancy at birth in the Czech Republic rose by 6.2 years for men (from 69.0 to 75.2 years) and by 4.8 years for women (from 76.4 to 81.2 years). Although the decline in mortality in the observed units was a universal process for both men and women, not all of them shared the tempo or increase in life expectancy development, and it is possible to detect significant regional differences (Figure 1).

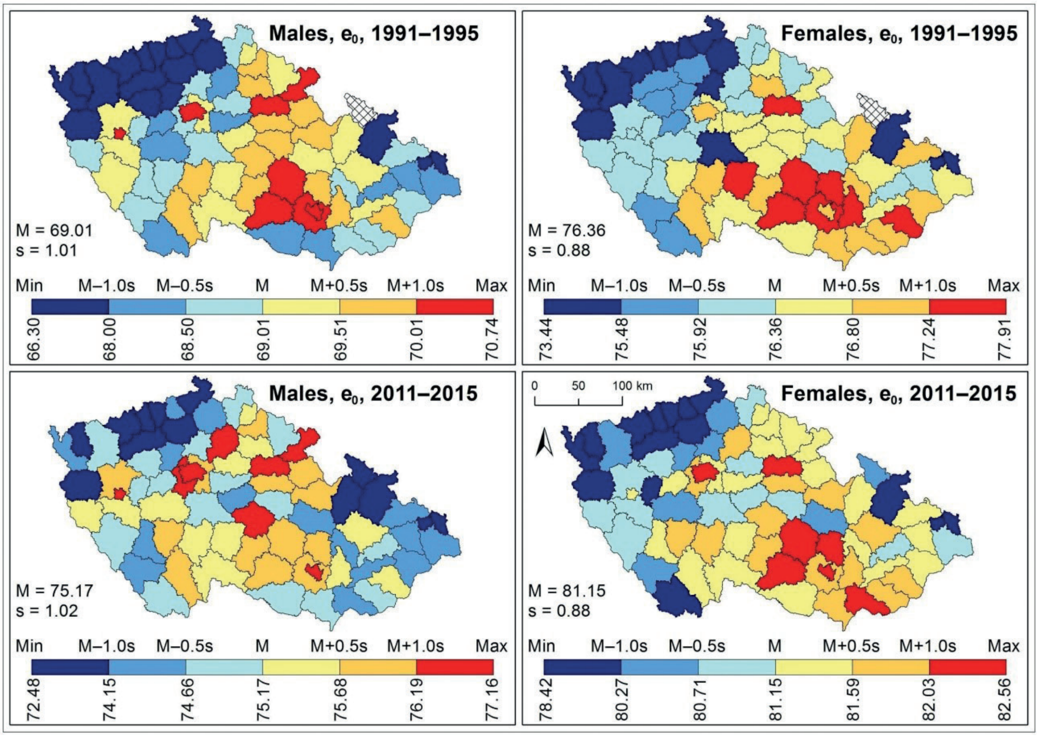
The least favourable mortality conditions across districts for both men and women throughout the analysed period reigned in the northwest of the country (especially districts in the Ústí nad Labem Region and the Karlovy Vary Region)[7] and mainly in the case of men also in districts in the Moravian-Silesian Region. For example, in the districts of Děčín, Chomutov, Most, Teplice, Tachov, Bruntál and Karviná, life expectancy at birth for men and women at both the start and the end of the observed period was lower than the national average by more than one unit of standard deviation (see the note below Figure 1). There are a number of interrelated factors behind why the highest mortality rates have typically been found in these districts. Possible factors include the lower socioeconomic status of inhabitants in these districts, the worse educational structure, the higher unemployment rate, and the less favourable impact of the economic transformation in these districts (*Baštová – Hubáčková – Frantál*, 2011; *Burcin – Kučera*, 2000). Conversely, the most favourable mortality conditions were recorded in some large cities (Prague, Brno, and also Pilsen for men), all the districts in the Vysočina Region, and most districts in the Hradec Králové Region and the Pardubice Region.

Significant mortality differences between men and women were found mainly in the south-eastern part of the Czech Republic. While women's life expectancy at birth in, for example, the districts of Břeclav, Hodonín, Uherské Hradiště and Vsetín was rather high, men in these districts reached relatively low values of life expectancy at birth. This could be due to the lifestyle of the population in the area and types of local economy and economic sectors that are most common in the area, all of which are, in general, less favourable for males. On the contrary, the lowest differences in women's and men's mortality were recorded in some large cities (namely, the Capital of Prague and Pilsen) and their suburban areas.

Looking at the transformation of regional differentiation in mortality within the state, it is apparent that the regional pattern changed little over the course of the period analysed (Figure 1). It is, however, possible to notice some exceptions to this. For example, in the first period analysed, 57 districts surpassed the district of Mladá Boleslav in terms of male life expectancy at birth, but in the recent period there were

7) A map showing the names of the districts and regions is included in Appendix 1.

Figure 1 Male and female life expectancy at birth in the districts of the Czech Republic, 1991–1995 and 2011–2015



Notes: The boundaries between intervals were determined based on multiples of the standard deviation of life expectancy at birth in the given period for the studied sample of districts (s) and their distance from the average life expectancy at birth in the given period for the Czech Republic as a whole (M). Intervals are right restricted, i.e. if a district reaches displayed threshold value, it belongs to the interval with lower life expectancy. Hatched area represents unavailability of data (in district Jeseník, which was established in 1996, in period 1991–1995).
Source: Czech Statistical Office, 2017; authors' calculations.

only 7 such districts. The extraordinary improvement in mortality that is represented by this dramatic shift in the hierarchy of Czech districts in terms of attained life expectancy at birth was primarily caused by the swift expansion of the automobile industry in the area (Škoda car maker and its suppliers) and the related improvement in the socioeconomic conditions of the population in the region. Conversely, the peripheral district of Šumperk ranked 24th in male life expectancy at birth in the 1991–1995 period, but in the 2011–2015 period it ranked 66th.

4. RESULTS

The following analysis of mortality convergence tendencies at the district level in the Czech Republic in the 1991–2015 period is divided into two parts: subchapters 4.1 and 4.2. The first explores changes in regional differentiation, and it does so using statistics that do not take into consideration the population size of districts. The results obtained using this unweighted approach can be a source of valuable information – for instance for policymakers who are interested in learning whether regional mortality differences are decreasing (*Janssen et al.*, 2016).

The observed convergence (or divergence) expressed by a Gini coefficient that does not take into consideration the population size does not, however, necessarily reflect the real decrease or increase in differences within the given population, that is, differences at the individual level. An example would be a situation where in a given state, on the one hand,

Table 1 Characteristics of regional differences in overall and temporary life expectancies in Czech districts by sex, 1991–1995, 1996–2000, 2001–2005, 2006–2010 and 2011–2015

Indicator	Statistic	1991–1995	1996–2000	2001–2005	2006–2010	2011–2015
				Males		
e_0	G	0.00827	0.00795	0.00838	0.00854	0.00766
	G_w	0.00931	0.00937	0.00994	0.01017	0.00939
$_{50}e_0$	G	0.00212	0.00172	0.00169	0.00170	0.00133
	G_w	0.00208	0.00167	0.00173	0.00179	0.00143
$_{20}e_{50}$	G	0.00941	0.00851	0.00828	0.00823	0.00722
	G_w	0.01071	0.00978	0.00912	0.00914	0.00839
e_{70}	G	0.02466	0.02385	0.02590	0.02360	0.02152
	G_w	0.02559	0.02752	0.03126	0.02803	0.02611
				Females		
e_0	G	0.00638	0.00617	0.00607	0.00560	0.00597
	G_w	0.00617	0.00599	0.00602	0.00580	0.00626
$_{50}e_0$	G	0.00176	0.00137	0.00104	0.00104	0.00095
	G_w	0.00160	0.00130	0.00099	0.00095	0.00092
$_{20}e_{50}$	G	0.00467	0.00445	0.00420	0.00359	0.00359
	G_w	0.00448	0.00399	0.00401	0.00347	0.00353
e_{70}	G	0.02005	0.02054	0.02060	0.01804	0.02009
	G_w	0.01995	0.02039	0.02092	0.02005	0.02109

Source: Czech Statistical Office, 2017; authors' calculations.

a few regions with large populations showed strong convergence of mortality towards a low level while, on the other hand, there were a large number of regions with smaller populations in which mortality characteristics were stagnating at a high level. In this case, it may happen that indicators that do not include population size will signal a slight divergence caused by the large number of regions lagging behind. On the other hand, statistics weighted for population size will indicate that mortality conditions are converging, which is caused by the larger share of population in a few large converging districts. Therefore, in assessing trends in regional differences in mortality it is useful to always consider both approaches in harmony with the objective of the particular study. While the results in the first subchapter focus on the unweighted measures, characterising the districts as a whole, the second is devoted to an analysis of mortality conditions that reflects the population size of individual districts. This is an analysis of convergence within the population.

4.1 Convergence of mortality in the Czech districts in the 1991–2015 period: unweighted measures

The first step in our analysis involves assessing regional mortality trends from the perspective of decreasing or increasing inequalities between districts. The starting point for identifying these trends is to look at changes in the unweighted Gini coefficients over time (Table 1).

When it comes to men, the regional differences in life expectancy at birth decreased between the first and the last of the periods analysed, but the decrease was not a gradual one. While between the 1991–1995 period and the 1996–2000 period there was only a slight decrease in the differences between districts, during the first decade of the new millennium mortality conditions diverged. There was greater variability in male mortality conditions in the 2006–2010 period than in the 1991–1995 period. The mortality convergence observed in the overall period of analysis can therefore be ascribed to the convergence of the values of life expectancy at birth in the 2011–2015 period.

This mortality trend warrants a closer analysis. As well as the trend in life expectancy at birth, which expresses intensity of mortality across the whole lifespan, it is also possible to trace changes in regional differences for the measure that characterises the level of mortality in selected age intervals (Table 1).

With regard to temporary life expectancy of men between exact ages 0 and 50, what is first noticeable when compared to life expectancy at birth is the small level of regional differences. This is mainly because in this age interval mortality was already low during the period of analysis and had little potential to decrease further. A pronounced decline in regional differences occurred between the 1991–1995 and 1996–2000 periods, due mainly to the rapid improvement of mortality measures caused by improving health-care parameters (*Burcin*, 2008). Unlike life expectancy at birth, temporary life expectancy stagnated until the 2006–2010 period (Table 1). Greater mortality variability was observed in the 2011–2015 period compared to the preceding period. The increase in regional differences observed until the 2006–2010 period in terms of overall mortality thus cannot be ascribed to the trend in this age category.

In the temporary life expectancy of men between exact ages 50 and 70 it was possible to observe the homogenisation of districts more or less across the entire period of analysis. A decrease in the pace of convergence is apparent in the period from 2006 to 2010 (compared to preceding periods), but after 2010 the convergence trend continued again. Again, it can be confirmed that this age group did not contribute to the increase in the differences between districts in terms of overall life expectancy at birth recorded in the first decade of the 21st century.

Logically it is mortality in the oldest age group, measured as life expectancy at exact age 70, that has the biggest influence on the trend towards the convergence of districts in life expectancy at birth. Mortality in the oldest age group also exhibits the biggest regional differences. The Gini coefficients stagnated in the 1990s, so there were no fundamental changes in the variations between districts in terms of mortality in the oldest age group. After the turn of the millennium differences between districts grew and the greatest variations were observed in the 2001–2005 period. Given that this period is also characterised by changes at the level of old-age mortality, it can be assumed that the differences increased mainly between those districts with better access to health care, better living conditions, and where the population has a better lifestyle, and those districts that tend to have the opposite characteristics. This assumption will be tested in further sections of the analysis. The end of the period of analysis was marked by a return to mortality convergence.

There was less variation in mortality between districts among women than men in every period and for each of the indicators considered here (Table 1). In this respect, the biggest difference between the sexes was observed for temporary life expectancy between exact ages 50 and 70, where the Gini coefficient for women was roughly half that for men. This is fully consistent with the above-mentioned continued differences in mortality rates and the trend towards declining mortality differentiated by sex.

As in the case of men, among women variations in life expectancy at birth between districts decreased over the course of the period of analysis, but followed a different course of development over time. Among women the life expectancy at birth in districts was converging up until 2006–2010. However, more recently there has been a slight increase in the variation in mortality between districts. Variations between districts in temporary life expectancy among women in age intervals 0–50 and 50–70 grew smaller over the observed period and the start of the 21st century showed a stagnating trend.

Again, it is possible to state that the observed increase in variation between districts at the end of the studied period can primarily be ascribed to variations between districts in mortality in the oldest group of women. Variations in life expectancy among women at exact age 70 were the only of the unweighted statistics that did not decrease between the first and the last periods analysed. Until the 2001–2005 period the differences between districts actually grew, and while these differences did decrease in the 2006–2010 period, this was only a temporary deviation. In the final period analysed regional differentiation was again comparable to what was observed in the 1991–1995 period. However, it is again necessary to use other possible tools of analysis to explain the observed course of development as those tools could better specify whether the variation changed only at the level of districts or whether within the population overall. And above all it will then be possible to identify the districts that were the main contributors to the changes in variation observed over time. The weighted versions of the Gini coefficient will be used for this purpose, along with an analysis based on the distribution functions.

4.2 Convergence of mortality in the Czech districts in the 1991–2015 period: weighted measures

This subchapter presents an analysis of mortality convergence in the Czech population using mortality indicators, like in the preceding section, but it also takes into consideration the population size (weight) of individual districts.[8] The weighted Gini coefficients on which the analysis of developmental trends is based are shown in Table 1. Although districts in the Czech Republic do not have the same population sizes (in this article the Capital of Prague is analysed alongside districts), in terms of the convergence and divergence tendencies in mortality there are no great differences between the weighted and unweighted statistics during the studied period (Table 1). Therefore, the basic developmental trends in mortality variations are not discussed in detail below, and the comments instead focus on the specific features by which the results of the weighted and unweighted formulas differ.

Among men the observed regional disparities are higher when the weighted measures are used than when the population size is not taken into consideration. Exceptions were the 1991–1995 and 1996–2010 periods regarding the temporary life expectancy between exact ages 0 and 50, where, however, the differences between districts are very small. As far as women are concerned, the differences between the results produced by each of the two versions of the formula were not too pronounced. The greater variation observed among men when population weights are included is primarily caused by the population size of the capital city. When using the weighted version of the formula, Prague has a weight of more than 10%, and throughout the studied period it had one of the best male mortality rates. The mortality rate of women in Prague was also lower than in most other districts, but the difference was not as pronounced as among men.

Generally, it can be stated that the variation between districts in the total life expectancy of men increased over most of the studied period in the case of the weighted form of the Gini coefficient (the exception being in the most recent period between 2011 and 2015). The biggest contribution to this increase in variation again comes from the trend in variation in the oldest age group, as differences between districts in the case of the younger age groups of men decreased or stagnated over time.

When it comes to women, the variation between districts in total life expectancy fluctuated, with a rather more noticeable increase in variation observed at the end of the studied period, that is, after 2010. This was primarily due to the trend in the variation of mortality among the oldest age group. To the contrary, particularly noteworthy is the rapid decrease from already low values among population below the age of 50.

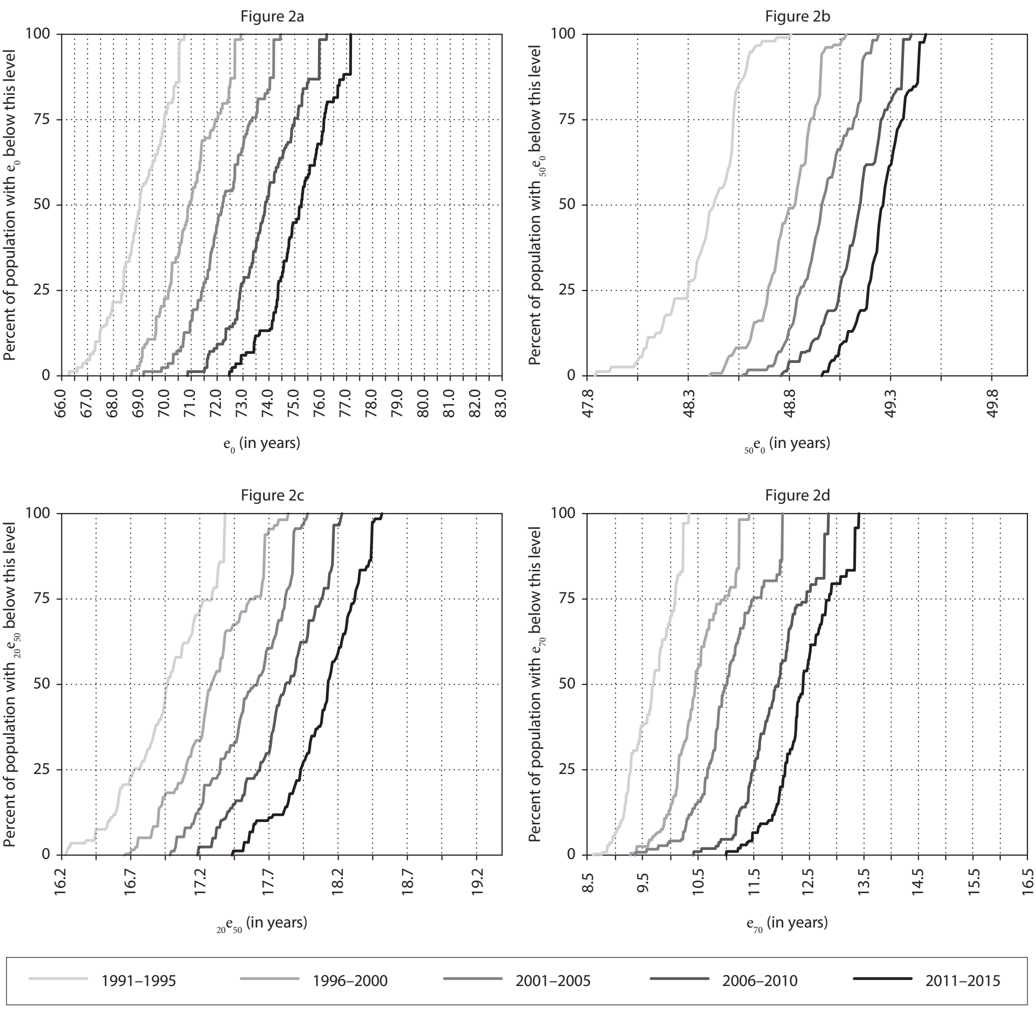
Deeper insight into the observed aggregate trends is provided by the curve of the distribution functions, which shows the share of the population of Czech districts by attained (total or temporary) life expectancy (Figure 2a–d, 3a–d). In these figures, there are two important points to focus on. First, it is possible to trace what changes occurred in attained mortality rates. If mortality improves in the population over time, the curve shifts to the right towards higher life expectancies. Second, it is possible to examine the variation in mortality. When there is a decrease in the lifespan differences between district populations, the curve straightens. If, for example, the value of a particular indicator in the analysis was in some period the same in all the districts, the curve would represent this as a straight vertical line.

When explaining the above-described divergent trends in mortality among men, the curve representing the 2001–2005 period can be illustrative (Figure 2a).

8) It is important to remember that the same mortality is assumed to apply to all the inhabitants of a given district, so this is not an analysis based on individual data.

The increase in the variation in mortality can mainly be attributed to districts with small populations, which had the worst values of the mortality indicator used. These were mainly industrial districts (e.g. Děčín, Chomutov, Most, Teplice, Louny, and Sokolov in the Ústí nad Labem Region, and Karviná and Bruntál in the Moravian-Silesian Region), which were heavily impacted by the economic transformation, and are also areas with environmental damage. In most districts in the Czech Republic, mortality in the 2001–2005 period saw a decrease from the preceding period, and consequently the corresponding curve shifted to higher values for life expectancy at birth. By contrast, in the group of districts cited above, with the lowest life expectancies at birth, there was a relatively smaller decrease in intensity of mortality. This is why the shift in this part of the distribution curve towards higher values is less noticeable (Figure 2a). This intensification

Figure 2a–d Relative cumulative distribution of the population of the Czech Republic by overall and temporary life expectancies, males, 1991–1995, 1996–2000, 2001–2005, 2006–2010 and 2011–2015

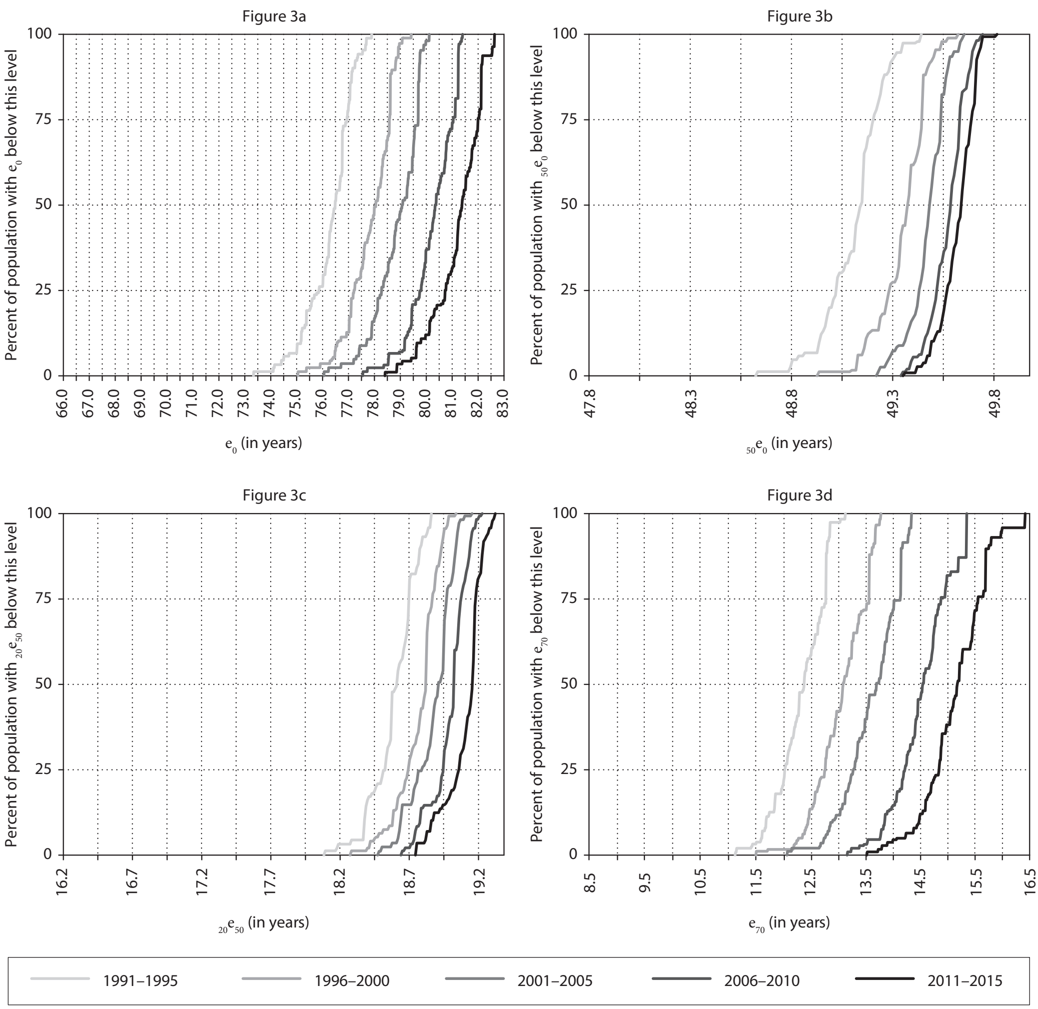


Source: Czech Statistical Office, 2017; authors' calculations.

of the degree to which the districts with the highest mortality are lagging behind led to the increase in the total variation of the indicators. Moreover, this continued in the next period analysed and it was only after 2010 that the variation between the populations of Czech districts in terms of total mortality decreased again. This is visible in the figure (Figure 2a) from the steeper curve of the distribution function.

As well as looking at the overall distribution curve, it is also possible to analyse the development of the values of the interquartile range of the observed indicator, which is defined as the difference between the values of the temporary and overall life expectancies attained by 75% and 25% of the populations of the Czech districts. It is also possible to trace the variation in the upper and lower quartiles of the population separately – i.e. the variation in the one-quarter

Figure 3a–d Relative cumulative distribution of the population of the Czech Republic by overall and temporary life expectancies, females, 1991–1995, 1996–2000, 2001–2005, 2006–2010 and 2011–2015



Source: Czech Statistical Office, 2017; authors' calculations.

of the population living in the districts with the highest and the lowest mortality rates (Table 2).

In the case of overall mortality among men, the value of the interquartile range increased from the original 1.6 years until the 2006–2010 period, when it reached almost 2.1 years. In the last period, it then decreased to 1.8 years (Table 2). This indicates rather an increase in variation in the middle half of the population in terms of attained intensity of mortality. In Figure 2a this is apparent in the change in the angle of the overall distribution curve, which grew steeper only in the last period of the analysis. This also confirms the observed trend in the weighted form of the Gini coefficient for overall life expectancy at birth.

If the analysis focuses on the 25% of the male population living in districts with the best mortality conditions (the upper quartile of the curves in Figure 2a), it is clear that life expectancies at birth in this group of the population increased during the period studied and also that they were concentrated within a relatively narrow interval, which in none of the periods rose above 1.3 years. There was also an increase in the range of values for life expectancy at birth corresponding to this upper quartile, which continued until the 2006–2010 period, while in the last period in the analysis the values became more concentrated again (Table 2). This can be interpreted as growing differences between the districts with the best mortality rates. In the majority of periods in the analysis the reason lay in the relatively more pronounced distance of those districts that had the very highest life expectancies (Hradec Králové or Prague). Conversely, the life expectancies at birth among the 25% of the male population with the highest mortality showed relatively high variation not just compared to the upper but also compared to the other quartiles. This supports the above-mentioned observation about the districts with the worst mortality lagging behind the others, which contributed to the increase in overall variation. In the 2001–2005 period, when the biggest differences are observed in the least favourable quartile, this much lower value of life expectancy is found in the districts of Chomutov and Most, and in the next period it was mainly in the district of Teplice.

When it comes to the temporary life expectancy of men between exact ages 0 and 50 it is possible to note that the dynamics of the changes in mortality are decreasing in time as the potential for a further decrease in mortality in this age group is gradually exhausted (Figure 2b). With the exception of the 2001–2005 period, the value of the interquartile range for this age group was around 0.2 years (Table 2). In other words, one half of the population of the Czech Republic was living in districts with almost the same rate of mortality. The homogenisation of districts in terms of mortality in this age interval over the period studied was primarily the result of the decrease in differences in mortality among the population in the first and fourth quartiles – that is, a decrease in the distance of the best districts and also a decrease in how much the districts with the shortest lifespan were lagging behind.

In the case of the temporary life expectancy of men between exact ages 50 and 70 the shape of the distribution function did not fundamentally change, nor did the pace of their shift in the direction of higher temporary life expectancies. This corresponds to the just relatively slight decrease in the Gini coefficients for men in this age interval (see above). At the same time, the values of the interquartile range decreased from 0.6 years in the first period to 0.4 years in the last period (Table 2). The mortality rates in the middle half of the population were thus very similar, with very little potential for a further decrease in differences. However, regional differentiation was influenced by an increase in the variation of the values of this indicator among the 25% of the population with the best mortality in the last period analysed owing to the positive distance in values for the district of Hradec Králové, and also for the 25% of the population with the worst mortality, especially in the last two periods analysed, owing to the effect of the lagging districts of Teplice and Most (Figure 2c).

The distribution function curves for male life expectancy at exact age 70 confirm that this age group is key to the overall development of the variation in mortality between districts in the Czech Republic (Figure 2d). Moreover, it is the developments in the districts with the best and worst mortality rates that are causing the changes in the overall variation in mortality in this age group. The variation in mortality, expressed as the value of the interquartile range, remained almost unchanged (except for the 2006–2010 period) and hovered at a level just slightly above

Table 2 Range of values of the upper and lower quartiles and the interquartile range for the relative cumulative distribution of the population of the Czech Republic by overall and temporary life expectancies by sex. 1991–1995. 1996–2000. 2001–2005. 2006–2010 and 2011–2015

Indicator	Statistic	1991–1995	1996–2000	2001–2005	2006–2010	2011–2015
				Males		
e_0	$Q_{0.25}$–MIN	2.06	1.48	2.27	2.04	1.88
	IQR	1.61	1.76	1.92	2.08	1.77
	MAX–$Q_{0.75}$	0.77	0.99	1.09	1.24	1.03
$_{50}e_0$	$Q_{0.25}$–MIN	0.44	0.28	0.28	0.28	0.22
	IQR	0.22	0.21	0.26	0.21	0.17
	MAX–$Q_{0.75}$	0.29	0.17	0.12	0.14	0.11
$_{20}e_{50}$	$Q_{0.25}$–MIN	0.49	0.44	0.36	0.45	0.49
	IQR	0.57	0.50	0.47	0.45	0.40
	MAX–$Q_{0.75}$	0.09	0.24	0.16	0.14	0.19
e_{70}	$Q_{0.25}$–MIN	0.66	0.87	1.30	1.09	1.06
	IQR	0.81	0.83	0.83	0.94	0.80
	MAX–$Q_{0.75}$	0.24	0.44	0.52	0.39	0.53
				Females		
e_0	$Q_{0.25}$–MIN	2.48	2.12	2.18	2.21	2.27
	IQR	1.06	1.34	1.39	1.21	1.25
	MAX–$Q_{0.75}$	0.93	0.83	0.41	0.35	0.62
$_{50}e_0$	$Q_{0.25}$–MIN	0.39	0.35	0.20	0.17	0.21
	IQR	0.18	0.16	0.11	0.11	0.12
	MAX–$Q_{0.75}$	0.23	0.17	0.11	0.11	0.12
$_{20}e_{50}$	$Q_{0.25}$–MIN	0.42	0.40	0.30	0.29	0.29
	IQR	0.16	0.16	0.17	0.12	0.12
	MAX–$Q_{0.75}$	0.15	0.16	0.17	0.14	0.13
e_{70}	$Q_{0.25}$–MIN	0.91	1.27	1.21	1.05	1.32
	IQR	0.75	0.80	0.86	0.66	0.71
	MAX–$Q_{0.75}$	0.35	0.21	0.20	0.47	0.86

Notes: The difference in values between the minimum (MIN) and the boundary of the lower quartile ($Q_{0.25}$) describes the range of values falling within the lower quartile; the difference in values between the boundary of the upper quartile ($Q_{0.75}$) and the maximum (MAX) denotes the range of values in the upper quartile. The interquartile range as the difference between the boundary of the upper ($Q_{0.75}$) and lower quartiles ($Q_{0.25}$) is indicated by the abbreviation IQR.
Source: Czech Statistical Office. 2017; authors' calculations.

0.8 years (Table 2). By contrast, primarily until the 2001–2005 period there was an expansion of the interval in which life expectancies at exact age 70 in the upper and lower quartiles ranged. While in 1996–2000 in the quarter of the population with the shortest lifespan these values reached a range of 0.9 years, in the 2001–2005 period the figure was 1.3 years. In districts with the lowest mortality rates the increasing variation was mainly caused by how far ahead Prague, Brno-město, and Hradec Králové were above the others. In the graph, there is also apparent the lagging of approximately 4% of the population with the very lowest life expectancies at exact age 70 (this was the population in the districts of Chomutov, Louny, Most, Teplice, and Sokolov).

Women's life expectancy at birth saw a more gradual increase than men's, which is reflected in the smaller differences between the curves (Figure 3a).

While the trend in the Gini coefficients indicated decreasing regional differences in women's mortality up to the 2006–2010 period, in the interquartile range the values in the first three periods increased (from 1.1 years in the 1991–1995 period to 1.4 years in the 2001–2005 period; Table 2). In the 2006–2010 period, life expectancies at birth in this 50% of the population of Czech districts then grew closer and the interquartile range reached 1.2 years, while in the next period there was again a slight increase in variation.

One question that can be asked is what segment of the population in terms of attained life expectancy at birth caused the drift towards the mortality convergence that was revealed using the Gini coefficients. The shape of the curves indicates that up until the 2006–2010 period women's mortality was converging because of the decreasing variation among the quarter of the population of the lowest overall intensity of mortality. In the 1991–1995 period, life expectancies at birth in this segment of the population were in the range of 0.9 years. The subsequent convergence only stopped in the 2006–2010 period, when the difference between the values in the upper quartile fell to 0.4 years (Table 2). The increase in the range of values to 0.6 years in the 2011–2015 period can be attributed mainly to the populations in the districts of Třebíč, Hradec Králové and Brno-město, which had life expectancies at birth 0.4 years higher than the other districts (Figure 3a).

With regard to the 25% of the population of women with the highest mortality, the range of values of life expectancy at birth is clearly greater than in the other quartiles (Figure 3a, Table 2). The interval of life expectancies at birth attained within the lower quartile narrowed from 2.5 years to 2.1 years in the 1996–2000 period (Table 2). After that, however, the differences increased again and in the last period in the analysis the values of the indicator hovered around the level of 2.3 years. Among the 25% of the population with the lowest values of life expectancy at birth mortality figures came to be concentrated within a wider interval than in the case of the remaining 75% of the population (Table 2). It can be inferred from this therefore that regional inequalities among the female population were mainly influenced by the variation in mortality in the quarter of the population with the highest mortality. The decrease in regional variation in the 2006–2010 period and the subsequent increase after 2010 were conversely supported by the trend in the variation within the quarter of the population living in districts with the lowest mortality rates.

As far as the indicators that express mortality in the defined age intervals are concerned, greater variation was also found within the 25% of the population of women with the worst mortality compared to the one-quarter of the population living in districts with the lowest mortality rates (Figure 3b–d). In particular the temporary life expectancies in the quartile with the worst mortality throughout the period studied hovered within an interval of the same width as the 75% of the population with the better mortality (Figure 3b–c, Table 2). However, it should be added that with regard to temporary life expectancies we can observe among women a strong tendency towards an end to the decrease in mortality and overall towards little variation in mortality between districts. The potential for a further decrease has in the case of some districts almost been exhausted. It is therefore possible to assume that in the near future the variation in these two indicators between districts will probably progress to the homogenisation of districts, as long as it becomes possible to improve the mortality situation in the districts with the very highest mortality rates (these are mainly the districts of Teplice, Most, Sokolov, and Chomutov).

The tendencies in the interquartile range of values of life expectancy among women at exact age 70 are comparable to those expressed by the Gini coefficient, that is, divergence up until the 2001–2005 period, followed by decreasing variation in the 2006–2010 period, and then by an increase again in the 2011–2015 period (Table 2). Among the population of women aged 70 and over with the worst mortality, it is possible to see in the 1996–2000 and 2001–2005 periods in particular approximately 2% of the population that is lagging behind. In the 1996–2000 period this 2% was represented by the population in the districts of Teplice and Rakovník, and in the 2001–2005 period it was the districts of Teplice and Most (Figure 3d). Conversely, in the 2011–2015 period in the upper quartile, the district of Brno-město had a life expectancy at exact age 70 more than 0.4 years higher than the other districts. It is thus possible to say that in this age group of women the slight increase in variation to 2005 was primarily caused by the districts with the highest mortality lagging further behind (especially in the 1996–2000 period), but also by the increasing variation of values in the middle half of the population expressed through an increase in the values of the interquartile range. The decrease in the inter-district differences in the mortality of the oldest group of women in the 2006–2010 period was then supported both by the decreasing differences within the middle half of the population and by the decrease in the lagging of the districts with the lowest life expectancy. Conversely, the districts with the lowest mortality increased their distance from the others in this period. In the last period analysed an increase in variation revealed by the Gini coefficient was caused by the increase in variation in all the quartiles, and especially by the increased distance of the districts with the very best mortality from the others.

5. CONCLUSION AND DISCUSSION

This article focuses on the trend in inequalities in mortality between Czech districts observed in five-year periods between 1991 and 2015. Gini coefficients and the curves of distribution functions for the individual periods were used to analyse trends in regional differences in life expectancy at birth and also the degree of convergence for indicators representing mortality in three successive age groups. For this purpose we used the temporary life expectancies between exact ages 0 and 50 and between exact ages 50 and 70 and at exact age 70.[9] As noted above, this study was motivated by a theoretical question, specifically the assumption contained in selected theories that mortality rates are converging. There were also practical questions that demography is currently dealing with in connection with the convergence and divergence of mortality. This is exemplified by formulating hypotheses about the development of inequality as part of regional forecasts or the preparation of materials designed to help decision-makers adopt effective measures towards reducing the differences between regions within the state. The article thus produced several findings from the perspective of research on regional inequalities that are discussed in more detail below.

First, using current data the stability of the regional pattern of mortality in the Czech Republic indicated in previous studies was confirmed (*Burcin – Kučera*, 2000; 2008; *Dzúrová*, 2000). The highest intensity of mortality was observed during the period studied in the north-western and eastern parts of the Czech Republic. By contrast, the districts with the best mortality rates were mainly found in the Vysočina Region, the Hradec Králové Region, and the Pardubice Region. Low mortality was also observed in some large towns. In reference to observed inequalities in mortality the above-mentioned studies highlighted the influence of differences in the education levels and socioeconomic structure of the population, access to health care, and unemployment rates.

The analysis of convergence revealed that although between the first and last periods in the analysis there was a decrease in inequalities between districts among both sexes in terms of overall mortality according to the Gini coefficients, the decrease in variations was not however continuous for either males or females. Among men inequalities increased between the 1996–2000 and 2006–2010 periods and convergence only appeared in the last period in the analysis, when the values of the Gini coefficients decreased significantly. By contrast, among women districts grew closer in terms of attained life expectancies at birth until the 2006–2010 period, but in the years, that followed those figures increased slightly from the preceding period.

When the Gini coefficients weighted for the populations were used we found similar trends in the development of differences in mortality between districts. The different sizes of the districts did not therefore have a significant influence on the above-described convergence and divergence tendencies.

It was possible to analyse the observed trends in a detailed perspective from two points of view – from the perspective of age groups and from a regional perspective. The first perspective, analysed using temporary life expectancies, helped to reveal which age groups had the biggest influence on the overall development of mortality convergence (divergence). Given the potential for further changes in mortality

9) It should be noted that the age intervals could have been defined in a different way, but the aim here was to distinguish between different mortality patterns and the differing potential for a further decrease in mortality.

in the defined age intervals it could be assumed that a key role was played by the development of mortality among the oldest group aged 70 and over. The regional perspective helped in the search for a response to the question of which districts are the ones most responsible for the observed convergence trends: whether it is the districts with the shortest life expectancies lagging behind the others, the districts with the lowest mortality rates becoming increasingly more distant from the other districts, or whether changes in variation are occurring across all districts.

The analysis confirmed that within the frame of the overall variation in life expectancy at birth a key role was played by the oldest age group. The fastest decrease in mortality in this age group occurred among both men and women between the third (2001–2005) and fourth (2006–2010) periods. The start of the 21st century was also a period in which this age group showed the biggest differences in mortality, especially in the case of men. An analysis of the distribution curves showed that the increase in the variation in mortality (especially up until 2005) in this age group was primarily caused by the lagging districts with the highest mortality rates (Chomutov, Louny, Most, Teplice, and Sokolov), but also by the increase in how far ahead the districts with the longest life expectancy became (Prague, Brno-město, Hradec Králové). Similar trends were observed for both men and women. Younger age groups, and especially the youngest one, played a much smaller role in the overall variation in mortality. There is very little potential at those ages for a further decline in mortality and this manifests itself as a decrease in the pace of mortality decline observed over time. This is especially true with regard to women, where mortality is already very low.

The biggest differences between sexes in terms of mortality were apparent in the 50 to 70 age group – the variation in mortality of men was roughly twice as great as in case of women's mortality. This confirms the assumption about continuing differences in mortality rates from the perspective of sex in this age group. The decrease in mortality in this age group is relatively stable over time for both sexes, but when it comes to women it is very gradual. However, this decrease was mainly due to the average districts growing more even, while the districts with the worst mortality acted against a further decrease in variation. The effect of the lagging districts with the highest mortality rates manifested itself most in the case of men (Teplice, Most).

The analysis of the distribution functions for individual indicators confirmed the fundamental effect the lagging districts have on the overall level of variation in regional mortality which is particularly evident in the case of women. As far as life expectancy at birth (and in some cases also in the defined age groups) among women is concerned the 25% of the population with the highest mortality even had (with the exception of the 1996–2000 period, when the values were almost even) a greater range of values than the other 75% of women.

In terms of the practical application of the results it should be noted how the observed trends contrast with the assumption about an expected decrease in regional differences in mortality that is often inherent within population prognoses (see, e.g., *Bleha – Šprocha – Vaňo*, 2014; *Czech Statistical Office*, 2014; *Fiala – Langhamrová – Hulík*, 2009). As shown above, the decrease in the variation in mortality was apparent among Czech districts only for the younger age groups (up to the age of 70), but this decrease was also held back by the lagging districts with the highest mortality rates (Chomutov, Most, Teplice, Louny, and Sokolov). For the oldest age group, which had the biggest influence on the variation of overall mortality, no clear trend towards decreasing variation was identified.

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Appendix

Appendix 1 Regions and districts in the Czech Republic, 1. 1. 2015

THE VIENNA YEARBOOK OF POPULATION RESEARCH 2015[1)]

Martina Miskolczi

The Vienna Yearbook of Population Research by the Vienna Institute of Demography for the year 2015, titled **'Demographic Differential Vulnerability to Climate-related Disasters'**, focuses on the link between demography and other social science disciplines to pay higher attention to demographic differential vulnerability. This yearbook contains a selection of 15 papers that were presented at the IUSSP conference, 'Demographic Differential Vulnerability to Natural Disasters in the Context of Climate Change Adaptation', which was co-organised by the Vienna Institute of Demography of the Austrian Academy of Sciences and held in Thailand in April 2014.

The empirical analysis of the vulnerability of people to recent natural disasters is probably the best way to get an analytical handle on estimating the levels of human vulnerability that could result from the intensifying consequences of climate change in the future. This empirical approach is based on the underlying assumption that vulnerability to past climate-related disasters, such as flooding, storms, and droughts, is isomorphic in relation to the likely future vulnerability to climate change. While the risks and the exposure levels of human populations to extreme weather events may change across regions as climate systems shift, it is also evident that not all people who are living in the same region that is affected by a natural disaster are equally vulnerable to disaster-related mortality or injury. As is the case for other mortality risks, **people tend to be differentially vulnerable according to their age, gender, level of education, occupation, and other social and economic variables.**

THE DEMOGRAPHIC DEBATE SECTION

This section comprises six articles by distinguished demographers from different continents. The study of environmental change has yet to become popular among demographers. Here demographers therefore address the following question: Why are so few demographers working on population and climate change? The reasons are:

- The complexity of climate science and the limitations of data and methods for integrating the environmental and climate context into the microdata commonly used by demographers. With a focus on empirical science, it takes a longer time for demographers to address new research questions such as climate change if the appropriate data are not available (authors: *Hayes; Hunter and Menken*).
- The lack of interdisciplinary collaboration, despite the interconnectedness of the issues of population and climate change. This results in climate models being inadequate for accounting for social and demographic components (authors: *Gage; Hayes; Hunter and Menken; Peng and Zhu*).
- The discomfort with addressing population and environmental issues given the historical involvement of demographers in the controversial debates during the late 1960s and 1970s on the limits to population growth, which were triggered by concerns about the limits of natural resources. As these debates raised complex and sensitive policy questions, demographers have become reluctant to engage with climate change and environmental issues (authors: *Gage; McDonald; Peng and Zhu)*.
- The research topics surrounding climate change, such as production and consumption and disaster vulnerability, are more directly related to other social

1) Crespo Cuaresma, J. – Lutz, W. (ed.). 2016. *Vienna Yearbook of Population Research 2015.* Volume 13. Vienna: Vienna Institute of Demography, Austrian Academy of Science. Avalable at: <https://www.oeaw.ac.at/vid/publications/serial-publications/vienna-yearbook-of-population-research/vienna-yearbook-of-population-research-2015-vol-13/>. ISBN-13: 978-3-7001-8007-4 ISBN-13 Online: 978-3-7001-8041-8.

science disciplines (e.g. economics, political science, geography) than demography. As anthropogenic climate change is a 'social problem' inherently related to human values, demographers are required to go beyond merely emphasising empirical relationships between population and climate systems when investigating this issue (authors: *Hayes; Peng and Zhu*).

- Limitations in funding, especially because funders of climate change research tend to value natural science approaches more than social science approaches (authors: *Peng and Zhu*).

The following nine original research articles presented in this special issue highlight how scholars of population studies and other relevant disciplines can contribute to the understanding of population and climate change interactions. These articles address the issue of demographic differential vulnerability from different perspectives on vulnerability, drawing upon case studies from across the globe based on unique data and innovative methodologies. This collection of research articles offers both empirical studies and forecasts of future vulnerability based on national- and global-level evidence.

THE SECTION ON DIFFERENTIAL MORTALITY FROM EXTREME CLIMATE EVENTS

Zagheni et al. and *Zhao et al.* explicitly investigated mortality risks from climate extremes, such as hydrological hazards (flood and storm) and extreme temperatures, which are likely to be further aggravated by climate change. The findings on age-sex differentials in mortality risks from different types of natural disasters have important implications for designing appropriate policy responses to address the differential vulnerability of different demographic subgroups. Focusing on mortality from extreme temperatures in Taiwan in the 1970s, *Zhao et al.*, in their article **'Daily Mortality Changes in Taiwan in the 1970s: An Examination of the Relationship between Temperature and Mortality'**, showed that both unusually cold temperatures in winter and unusually hot temperatures in summer were associated with higher mortality. However, the mortality patterns differed by age group and cause of death, with older people being more likely to die from cardiovascular disease during extreme cold episodes, and children and young adults being more likely to die from drowning during hot spells. These mortality patterns have changed in recent decades due to socioeconomic developments in Taiwan, which brought about improvements in health care, living environments, safety management, and disease prevention practices. Similarly, the analysis of cause-of-death data for 63 countries in the years 1995–2011 by *Zagheni et al.* in **'Differential Mortality Patterns from Hydro-meteorological Disasters: Evidence from Cause-of-death Data by Age and Sex'** found that mortality from hydro-meteorological disasters declined over this period as a result of improvements in human development. Contradicting the common belief that women are more vulnerable to natural disasters than men, Zagheni et al. found that in the case of mortality risks from floods and storms, men, and especially young adult men, had much higher mortality levels than women.

THE SECTION ON SPATIAL PATTERNS OF SOCIAL VULNERABILITY TO WEATHER AND CLIMATE EXTREMES

The articles in the next section contribute spatial perspectives to the analysis of differential vulnerability. The two articles address the important question of whether the subgroups of the population who are socioeconomically disadvantaged – for example, people who have low incomes, low levels of education, or high unemployment rates, or people who are members of ethnic minority groups – are also more likely to live in areas with higher levels of exposure to natural hazards. In geography, this question is often approached by developing an index of social vulnerability or a composite measure of various demographic and socioeconomic characteristics of a geographical unit.

De Sherbinin and Bardy, in their article titled **'Social Vulnerability to Floods in Two Coastal Megacities: New York City and Mumbai'**, employed census data to develop social vulnerability indices of New York City and Mumbai, which are considered to be among the top 10 port cities most exposed to coastal flooding. Exploiting the events of Hurricane Sandy in 2012 for NYC and of the Maharashtra floods in 2005 for Mumbai, the article investigated whether the areas with higher social vulnerability scores were also more likely to be inundated. This was found to be the case for Mumbai, but not for New York City. While these findings may be attributable in part to data limitations and the different spatial resolutions used, the two cities may also differ in terms of settlement preferences, with, for instance, wealthy households in New York preferring to live along the coastline.

The findings from the case study of tropical storm Washi flood in the southern Philippines in 2011 by *Ignacio et al.* in their article **'Assessing the Effectiveness of a Social Vulnerability Index in Predicting Heterogeneity in the Impacts of Natural Hazards: Case study of the Tropical Storm Washi Flood in the Philippines'** suggest that the areas along the riverbanks most prone to severe flooding were predominantly inhabited by the middle class. In addition, authors broke down the vulnerability indices in order to determine which demographic and socioeconomic factors contributed to disaster vulnerability. They found that physical characteristics that determine exposure to flooding, such as elevation from the coast and slope, explained the losses and the damages better than the sociodemographic characteristics of the areas. Given the extreme nature of the flood event, exposure was an important determinant of vulnerability.

THE SECTION ON DIFFERENTIAL RISK PERCEPTIONS AND CLIMATE ACTIONS

Risk perceptions, attitudes toward climate change, and climate-related behaviours vary considerably by demographic and socioeconomic characteristics. Understanding public attitudes and perceptions is essential not only for formulating education and communication strategies, but for successfully implementing risk reduction or adaptation strategies.

The article by *Meijer-Irons* titled **'Who Perceives What? A Demographic Analysis of Subjective Perception in Rural Thailand'** offers a unique analysis of panel surveys from rural Thailand that compared subjective assessments of environmental risks with objective measures of environmental and climate conditions, such as the vegetation health index. In particular, the author showed that subjective perceptions of environmental risks depend on household characteristics and economic activities. Households that, relative to the average, were large, had a high level of involvement in agriculture, and had a large number of members were more likely to report that their income losses were due to environmental shocks. This finding implies that policies aiming to address the impacts of environmental change should take into account the issues that are most crucial to different subgroups of people who are vulnerable to environmental shocks.

The article by *Muttarak* and *Chankrajang*, **'Who Is Concerned about and Takes Action on Climate Change? Gender and Education Divides among Thais'**, investigated the relationships between climate change perceptions and climate-relevant behaviours, i.e. the actions individuals take to minimise the problem of global warming (mitigation actions) in Thailand. Their results showed that while concerns about global warming were associated with climate -relevant behaviours, this association applied to actions that involved making technical and behavioural changes (e.g. using energy-efficient electrical devices, using a cloth bag instead of a plastic bag, and planting trees), but not to actions that involved saving electricity and water (e.g. turning off unused lights and turning off the tap while brushing teeth). Similarly, educational differences were found for the former set of behaviours, but not for the latter. The findings further showed that achieving technical and behavioural changes generally involved making consistent efforts to change behaviour, knowing what actions to take; whereas saving electricity and water was undertaken for economic reasons. Educational differentials in climate actions thus depend on the motivations for carrying out the action.

THE SECTION ON FORECASTING FUTURE SOCIETIES' VULNERABILITY AND ADAPTIVE CAPACITY THROUGH THE LENS OF HUMAN CAPITAL

The final three articles in the special issue offer a forecast of the future vulnerability and adaptive capacities of societies through the lens of human capital based on a multi-dimensional population projection exercise and the application of the newly developed Shared Socioeconomic Pathways (SSPs), following the five scenarios as defined by the SSPs. The SSP narratives described alternative socioeconomic development pathways that influence population dynamics and human capital formation for different world regions.

Based on the estimation of disaster mortality for the years 1970–2010 covering 174 countries, *Striessnig* and *Loichinger*, in their article titled **'Future Differential Vulnerability to Natural Disasters by Level of Education'**, confirmed that countries with a higher proportion of women with at least secondary education experienced far fewer deaths due to climate-related extreme natural events. The results were then translated into the predicted number of deaths, and the future fatalities were projected according to changes in the educational composition of population derived from the five SSPs scenarios. They found that future disaster deaths vary considerably in the SSP scenarios, especially for Latin America and the Caribbean, Asia, and Africa, where room for educational expansion is greater than it is in other regions.

Similarly, *Crespo Cuaresma* and *Lutz* further extended our understanding of future societies' adaptive capacity in the article **'The Demography of Human Development and Climate Change Vulnerability: A Projection exercise'** by projecting how the Human Development Index (HDI) varies under different SSP scenarios. Previous studies have shown that each of the three components of HDI (income, educational attainment, and life expectancy) is a key determinant of vulnerability to natural disasters (*Striessnig et al.*, 2013; *Patt et al.*, 2010). Indeed, the article by *Zagheni et al.* in this issue demonstrated that disaster-related mortality steadily declines as a country's HDI level increases. Exploiting the new life expectancy and educational attainment projections by the Wittgenstein Centre for Demography and Global Human Capital (*Lutz et al.*, 2014), projections of income per capita growth by Crespo Cuaresma (2015) under the five SSP scenarios, the authors were able to produce HDI projections for 154 countries up to the end of this century. The HDI projection exercise found that the degree of vulnerability to climate change varies based on different development trajectories.

In the article **'A Four-dimensional Population Module for the Analysis of Future Adaptive Capacity in the Phang Nga Province of Thailand'** by *Loichinger*, *KC*, and *Lutz*, multi-dimensional population projections are innovatively applied to forecast future adaptive capacities at the sub-national level based on data from Phang Nga province located in the south of Thailand, which was severely affected by the Indian Ocean tsunami in 2004. The projection is prepared by age, sex, level of education, and labour force participation. This four-dimensional module made it possible to forecast the level of the province's adaptive capacity using a relatively comprehensive understanding of population dynamics and future changes in distribution and composition of the population. Having shown that individuals with higher education were better prepared for disasters (*Muttarak and Pothisiri*, 2013; *Hoffmann and Muttarak*, 2015), the shift in the educational composition of the province's labour force toward higher levels means that it is possible to assume that the population will have higher levels of disaster preparedness in the future.

The articles presented in this volume extend our understanding of different dimensions of demographic differential vulnerability in various geographical contexts and demonstrate how demographic methodological tools and data can be applied to the study of vulnerability. In particular, the application of demographic knowledge in investigating and forecasting demographic differential vulnerability is a key contribution of demographers to the vulnerability research community. There is considerable potential for the further development of climate change research in demography.

THE HISTORICAL POPULATION ATLAS OF THE CZECH LANDS[1)]

Jaroslav Maryáš

The Historical Population Atlas of the Czech Lands is one of the main outcomes of a project titled 'Providing Access to Historical Spatial and Statistical Data in a GIS Environment' (DF12P01OVV033), which was conducted in 2012-2015 under the NAKI programme (Applied Research and Development on National and Cultural Identity) by a research team in the Urban and Regional Geography Laboratory in the Department of Social Geography and Regional Development at the Faculty of Sciences, Charles University in Prague, in cooperation with other researchers.

The atlas is a remarkable piece of work that contains more than 330 cartograms and cartodiagrams (55 at a scale of 1:2 mil., 46 at a scale of 1:3 mil., and 224 at a scale of 1:5 mil.), accompanied by figures, tables, and age pyramids, distributed across twelve chapters. The first two introductory chapters are devoted to the methods used to create the atlas and territorial-administrative divisions. The ten analytical chapters contain 42 map sheets, most of them on population-related phenomena and processes, such as the distribution and demographic structure of the population and other processes addressed in separate chapters that include mortality and migration, the economic and cultural structure, social status (this covers a wide range of topics, from education levels to household facilities), crime, and voting behaviour. The final chapter is devoted to a subject of prominent interest to the Department of Social Geography and Regional Development, namely, the settlement structure, and it also includes all of professor Martin Hampl's sociogeographic regionalisations of the Czech Republic.

The Atlas uses time series for a number of basic population statistics drawing on population census data from 1921 up to 2011, population registers from the post-war years, and other statistical sources covering periods of time. Almost all of the maps contain data covering a period from 1921 to 2011, or 2013 in the case of election results, and usually also in reference to the time horizons when important political changes occurred – 1946/47, 1970, and 1991. The territorial detail of the indicators represented extends to the district level – judicial districts in the interwar period, administrative in the post-war period, and from 1960 the districts that currently exist. The last chapter is an exception, as it contains analyses at the lower territorial level of municipalities and settlements.

The maps are unfortunately not accompanied by text, but this shortcoming is partly made up for by the description of methods in the first part of the publication and the thematic sections of the atlas and by the references to data sources that accompany the maps.

The map's chosen scale, 1:2 mil., 1:3 mil., and 1:5 mil., usually corresponds to its content, although in some cases a smaller scale could have been used to present the particular phenomenon – e.g. maps at a scale of 1:3 mil. for ethnic minorities, 1:2 mil. for years of school attendance, or 1:2 mil. for areas of maximal population density (in the case of the latter the map sheet also includes Korčák's map of areas of maximal population density from the Atlas of the Czechoslovak Socialist Republic dating from 1966, which clearly presents them using a scale of 1:5 mil.).

The use of certain colours to mark administrative borders (black for regions and white for districts) probably decreased production costs, but another result is that indicators represented using very light colours (especially light yellow or light green) cannot

1) Ouředníček, Martin – Jíchová, Jana – Pospíšilová, Lucie (eds.) 2017. *Historický atlas obyvatelstva českých zemí* (Historical Population Atlas of the Czech Lands). Prague: Karolinum, 2017. 131 pp. ISBN 978-80-246-3577-4.

be clearly distinguished territorially and the impression of the final map is of an unfinished piece of work. This applies, for example, to the cartodiagrams and some cartograms showing the old-age index, mortality, economic activity, nationality and educational structure, election results, and others. Apart from this small shortcoming, the colour differentiations are good, with a few exceptions, such as the cartodiagram for 'The Religious by Region' in 1921 or 'The Municipality Statute and Urbanisation Rate' for municipalities with more than 1,000 inhabitants, where districts with a level of urbanisation lower than 65% show through the municipalities with a smaller population size.

The Atlas is one of the first works in almost half a century to assess the country's spatial features with an unusually wide thematic focus, while some topics, such as crime, are presented here for the time in such a scope. An important contribution also is that the Atlas captures trends in the spatial differentiation of the selected indicators using the same legend for individual time intervals. The databases used to create the Atlas are publicly accessible at: www.atlasobyvatelstva.cz/cs/historie.

Ansley Coale (1917–2002)

Ansley Johnson Coale, one of the leading word demographers, was born in Baltimore, Maryland, on 14 November 1917. He attended a public high school in the state capital of Annapolis, graduating in 1934. That same year he enrolled in Princeton University, but he was not accepted because the College Entrance Board deemed his knowledge of Latin not good enough for admission. He spent one year at Mercersburg Academy on a scholarship for boys from low-income families in order to improve his language deficiency. He graduated successfully from Princeton University in the fall of 1935. He not only obtained his entire education at this university, but he spent his whole life there.

He obtained his bachelor degree (BA) in 1939 and his master's degree (MA) in 1941. When the United States entered World War II he served in the Navy. He was an able mathematician and so he served as a radar officer in the US Naval service and taught radar at the Massachusetts Institute of Technology. It was because of this that he did not receive his doctoral degree (PhD) until 1947, after which he joined the Office of Population Research.

His career was wholly and continuously associated with the Office of Population Research at the very prestigious Princeton University, which usually has a very high academic ranking (it was 4th in 2017 Forbes college rankings) and the Office of Population Research has without any doubt played a role in this. The Office of Population Research was founded in 1936 by its first director Frank Wallace Notestein (1902–1983), who helped to establish demography as an independent scientific discipline in the United States with his book on population projections for Europe and the Soviet Union 1940–1970 (1944) and started the discussion about the demographic revolution / transition, and he was also the first director of the UN Population Division (1946–1948).

Ansley Coale started working in the Office of Population Research as an assistant professor in 1947. He was promoted to associate professor in 1954 and to full professor in 1959. He was named the William Church Osborne Professor of Public Affairs in 1964. He served as assistant director of the Office from 1954 to 1959 and when Frank Notestein left to become the director of the Population Council, Ansley was named as a director of the Office of Population Research in 1959, a post he continued to hold until 1975, after which he became an associate director until 1986. After that he became a senior research demographer until he retired in 2000.

He served as the president of the **Population Association of America in 1967–1968 and as the president of the International Union for the Scientific Study of Population from 1977 to 1981.** He was a member of the National Academy of Sciences, the American Academy of Arts and Science, and the American Philosophical Society. He was a corresponding fellow of the British Academy and he was awarded honorary degrees by the University of Louvain, the University of Liège, the University of Pennsylvania, and Princeton University. He received many other honorary awards, including being named an honorary member of the Czech (former Czechoslovak) Demographic Society. President John F. Kennedy appointed him to represent the United States on the Population Commission of the United Nations Economics and Social Council (1961–1967).

He was a very prolific author. He published more than 125 books and articles (most of them with one or more co-authors). He was also an excellent teacher. He continued the policy of Frank Notestein and Irene Barnes Tauber (1906–1979), a close associate of Notestein's and editor (1936–1974) of the office's journal *Population Index*, which was to try to make the Office of Population Research the most important academic centre of population studies in the world. He invited professors and postgraduate students from other universities all over the world. He was the official supervisor of 35 doctoral dissertations and more than 90 research papers by visiting graduate students who earned the certificate in demography offered by the Office of Population Research. The key to Coale's success as a teacher lay in his character to create a collective of students and professors, and his enthusiasm for demography, which he was able to pass on to his students and colleagues.

Some of former students and colleagues thought back and published their memories of Coale in a biographical memoir three years after his death in 2005.[1)] The students considered the courses demography that Coale taught to be fascinating, especially remembered Coale's infectious enthusiasm for the subject. They claim that he was a man of extraordinary brilliance and insight, but most of all a man of integrity. He always had new ideas and this made for an exciting intellectual atmosphere at the Office for Population Research. He was very precise in his calculations, and when he found an error he did not regret the time needed to recalculate everything. This trait was known among his students. who learned from his example to behave in the same way, saying to themselves: 'Because Ansley would have done so' (James Trussell).

He had a strong competitive streak, not only in research, but also in sports activities. He enjoyed playing tennis, squash, bridge, softball and riding his bicycle. He kept a weight chart in his office and was proud of the fact that over the course of many years it seldom deviated by more than a pound from a perfectly flat trend line. He was very friendly to everyone in the office and did not distinguish between professors and students. He loved to argue, especially about politics, about which he was very stubborn. However, he was very sociable, and he liked good jokes, Italian restaurants (he learned Italian so he could order meals in this language and impress the staff) and good wine. He used to invite students and colleagues to restaurants and in a family style he always ordered for the whole table.

I do not want to evaluate his contribution to demographic knowledge. It was enormous and concerned not only all aspects of demography but also the neighbouring disciplines represented among the staff of the office. He was very good at demographic methodology (e.g. the Coale indexes for the analysis of fertility or model life tables) but also at demographic theory. I cannot go into detail in this short commemoration, the aim of which is rather to remember the eminent figure of Ansley Coale 100 years after his birth. However it seems to me that his most significant scientific contribution was the theory of the demographic revolution. He headed the European Fertility Project, which started in 1963, analysing the changes in fertility in 700 provinces in Europe in the 19th and 20th centuries. The results were published in nine books and finally summarised in a book published in 1986.[2)] Coale presented some of the results from this project at the IUSSP conference in Belgium (Liège)[3)] in 1973.

I first met Ansley Coale in 1963 in Prague, when he was travelling around Europe looking for available data for his fertility project, and then met him again many times at different conferences. It was a great honour for me that Ansley and Norman B. Ryder attended my lecture for postgraduate students at Princeton in 1971 and I especially remember the lovely discussion I had with them the whole afternoon at Ansley's home. Our main topic was the demographic revolution and I argued for this term, as a transition can be anything and these changes in demographic reproduction are really revolutionary and unique in the evolution of mankind (from the extensive type of reproduction to the intensive type, the transition from unplanned parenthood to planned parenthood). They are comparable to the revolutionary changes in industry that arrived with new technology (the term 'industrial revolution' is well accepted). I did not succeed, but up to the present day I have been using the demographic revolution as an important part of the global revolution of the modern era (I am probably the only demographer in the world to do so, with the exception of some of my students). We also of course discussed other issues, and not just demographic ones. Ansley was interested in the political situation in Czechoslovakia after the Soviet invasion in 1968.

Ansley Johnson Coale passed away just nine days before his 85 birthday on 5 November 2002 at Pennswood retirement village in Newton, Pennsylvania The cause of death was heart failure, after several years with Parkinson's disease. Ansley was survived by his charming wife Sue, whom I met in Princeton, and by two sons, Ansley Jr. and Robert.

Zdeněk Pavlík

1) Bibliographical Memoirs: Volume 87, Washington, DC, The National Academies Press, 2005.

2) Coale A. J. and S. C. Watkins (eds.) The Decline of Fertility in Europe: The Revised Proceedings of a Conference on the Princeton European Fertility Project, Princeton University Press, Princeton, NJ, 1986, 522 pp.

3) Coale A. J. The Demographic Transition, Proceedings of the IUSSP Conference I, pp. 53–71, Liège, 1973.

160 Years since the First Census on the Territory of the Czech Republic

The end of October (31 October 2017) marked exactly 160 years since the first population census took place in the Czech lands, which in its overall concept and goals was fundamentally different from the population rolls that had been carried out prior to that. This census was identified as a point of transition from the population rolls to the modern population census.

Unlike the population rolls, the primary objective of which was to obtain information necessary for military or taxation purposes, the census in 1857 was different in that:

- it was carried out uniformly across the territory of the Austrian Monarchy;
- it was carried out in reference to a single date;
- it covered the entire domestic population (belonging to a particular community), both those present on the day of the survey and even anyone absent on that day, and foreigners were also included in the census;
- it was conducted by a single body (political bodies at the level of municipalities and the newly introduced district level) without the participation of any others;
- as well as the population, domestic livestock were also counted;
- analysis of the results produced detailed and complete information on the size and composition of the population in the Czech lands.

The results of the census in 1857 were summarised manually and published in *Tafeln zur Statistik der österreichischen Monarchie* and were also published separately in book form under the title *Statistische Übersichten über die Bevölkerung und den Viehstand von Österrreich nach der Zählung wom 31. October 1857,* Vienna 1859.

More information on the census in 1857 will be published in *Demografie* 1/2018.

Johann Peter Süssmilch (1707–1767) – His Life and Contributions

This year marks three hundred and ten years since the great scholar Johann Peter Süssmilch was born. Süssmilch's work earned him a unique place in the historical development of population statistics and ranks him among the leading scientists of the 18th century.

Süssmilch's family had its roots in north-eastern Bohemia, where in 1513 Maximilian I granted it the hereditary judgeship of the Lusatian stronghold of Tollenstein, situated about three miles from Zittau. Johann Peter's father, John Elias, married Marie Blell and established himself in Berlin as a grain dealer and the owner of a brewery. Johann Peter Süssmilch was the eldest son in the family. He was born on 3 September 1707 in Zehlendorf. His early youth was spent in the village of Brandenburg with his grandparents, the Blells, who had a strong influence on Süssmilch's education.

In 1716 he entered the College of Berlin where he studied for six years. Like many other young men, Süssmilch seems to have experienced great difficulty in deciding on a profession. In his early days at Berlin College, he showed a strong liking for natural history, but in 1724 he began attending the Anatomical Institute that had just been founded in Berlin. He was then determined to become a physician. Deferring to his parents' wishes, he left Berlin to study law at a Latin school in Halle. There he developed an interest in theology. This field was one his parents also agreed with and Süssmilch devoted himself to it intensely. Halle was moreover considered a centre of Pietism,[1)] the movement that would influence Süssmilch throughout his life.

For a short period of two-and-a-half years he went to Jena where Süssmilch studied theology and philosophy and even aspired to obtain a university chair. His parents, however, would not agree with this idea, and his college career ended when, in 1733, he defended his thesis, *Dissertatio de cohaesione et attractione corporum*, written at Jena under the direction of a medical doctor, Georg Erhard Hamberger. After the First Silesian War, in which Süssmilch did his military service in the ministerial function of chaplain of the Kalckstein regiment, he took up a position in the Church of St Peter in Berlin. There he soon acquired a great reputation as a preacher and a scholar. By this time, in the year 1734, Süssmilch started collecting facts and empirical data and wrote the preface to his masterpiece, the first edition of *Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts, aus der Geburt, dem Tode und der Fortpflanzung desselben* (The Divine Order in the Changes of the Human Race, from Birth, to Death, and Reproduction).

At the age of 30 Süssmilch married 16-year-old Charlotte Dorothy Lieberkühn, the youngest daughter of the Royal goldsmith. Their marriage produced ten children, all but one of whom survived, which was rare in those days. He spent the spare moments of his life writing, revising, extending, and defending this statistical work. Never tired of data, Süssmilch continued to gather more and published ever larger editions of his work in 1761–62 and 1775–76. All the editions are vast compendiums of demographic data and socio-economic analyses.

Süssmilch died from an attack of apoplexy on 22 March 1767 at the age of 60. During his life Süssmilch was in contact with Gotthold Ephraim Lessing (German writer and philosopher) and Immanuel Kant (German philosopher). Süssmilch's work was cited extensively by Robert Malthus. Having briefly sketched the life of Süssmilch, we shall now look at the content of his principal literary work and his contribution to science and especially demography.

J. P. SÜSSMILCH'S MAIN CONTRIBUTIONS TO DEMOGRAPHY

Johann Peter Süssmilch is regarded as the pioneer of scientific statistics and demography. His great

1) Pietism was a reform movement in the German Lutheran Church during the 17th and 18th centuries that was designed to restore the devotional ideal of Protestantism.

contribution to these fields was that he gathered and described the statistical methods that existed in his time and his analysis was based on empirical records – for example, of the Breslau (today Wroclaw) priest Kaspar Neumann, who maintained parish registers on births, marriages, and deaths by age and cause of death. Süssmilch worked on life tables before anyone else. It can be said that he put together the most extensive collection of available data of his time.

By this time the conflict had arisen between his turning away from religion and towards science, and Süssmilch was engaged as a statistician and demographer working with statistical data of the time, which made him unique. On one hand, there were the ideals of Christianity which Süssmilch was required to follow; on the other hand, there was empirical data, which Süssmilch used as the basis of studies. Süssmilch combined the natural order and the divine order with political economy and empirical data in response to secularisation developments during the 17th century.

Süssmilch assessed the sex birth ratio of 100 girls to 105 boys and discovered that the sex ratio is compensated for draws even at the age of marriage. He showed that the reason for this was the higher rate of mortality among younger boys. Süssmilch searched for the medical reasons for this higher mortality and reasoned that it is the visible expression of the Lord's will regarding monogamy.

Johan Peter Süssmilch is best known for his remarkable work on population connecting natural law to 'political arithmetic'. Süssmilch sought to show the 'natural" constancy of population patterns and classes over time. His capable use of the 'law of large numbers' to analyse demographic statistics has led him to be considered one of the forefathers of statistics and econometrics.

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Veronika Svobodová

At deep sorrow we shall notice to all friends, colleagues, and the public that

prof. Ing. Iva Ritschelová CSc.,

President of the Czech Statistical Office

passed away.

She deceased after a severe illness in late evening of 3 December aged 53 years.

Prof. Ing. Iva Ritschelová CSc. was appointed to the title of the President of the Czech Statistical Office by the President of the Czech Republic, upon a proposal of the Government of the Czech Republic, on 1 September 2010. In her term of office, she promoted significant modernisation of statistics production processes, including the transition to the electronic data collection. She reduced total administrative burden onrespondents by statistical surveys by over 35%. She also encouraged raising of statistical literacy of the general public.

As an active member of academic community she dealt with education and enlightenment. She had ample work experience in abroad. She was an author of tens of professional publications focused on environmental economy and environmental policy.

The 9th Conference of 'Young Demographers' Will Take Place in February 2018

The Conference of Young Demographers traditionally provides demographers with an exceptional opportunity to spend two days discussing current demographic issues and students and young scientists in particular with an occasion to learn and hear the opinions and advice of their more experienced counterparts, colleagues, and teachers from all Europe or even the world. The 9th annual Conference of Young Demographers will take place on **15 and 16 February 2018** in Prague at the Faculty of Science (Albertov 6, Prague 2). The traditional topic of the conference, 'Actual Demographic Research of Young Demographers (not only) in Europe', is as broad as possible in order to ensure that the conference is open to demographers and scientists with various research interests and specialisations.

The event is supported by the Department of Demography and Geodemography, the Institute of Geography (Faculty of Science, Charles University), and the Czech Statistical Office.

All participants in the conference will have an opportunity to present their current research and discuss it with colleagues from other countries or fields of study. Although the conference is primarily intended for Ph.D. students of demography, all young (or slightly older) researchers (and not just demographers) are welcome to attend. The working language of the conference is English.

At the end of the conference the SAS Institute of the Czech Republic and the Institute of Sociology of the Czech Academy of Sciences, partners of the conference, will hand out an award for the best presentation to have used SAS software and the best presentation with a social context.

This year there will again be a session for researchers who are not demographers. This session will be devoted to topics on which demographers may share common scientific ground with researchers from other fields and to possibly developing new areas of cooperation.

The programme of the conference will be released in January 2018. More information about the conference can be found online (http://www.demografove.estranky.cz/en) or you can follow us on Facebook (http://www.facebook.com/young.demographers) or Google+ (http://plus.google.com/u/0/102665514822224781605/posts).

In the case of any questions please feel free to contact us at: yd.demographers@gmail.com.

We are looking forward to meeting you in Prague! On behalf of the Organising Committee, Klára Hulíková, Olga Kurtinová, Dan Kašpar, Barbora Kuprová, Jitka Slabá.

BK

Fifty Years since the Foundation of the Commission for Historical Demography

Historical demography, a field that established itself first in France and Great Britain after the Second World War, began to receive growing attention in Czechoslovakia and other countries starting in the 1960s, which was accompanied by the formation of various national commissions. When efforts by Prof. V. Husa at the Faculty of Arts, Charles University in Prague, to establish a Czech centre of work in this field were halted by his death in 1965, J. Macek, the director of the Institute of History of the Czechoslovak Academy of Sciences, started a new initiative, which in March 1967 led to the foundation of the Commission for Historical Demography under the Institute of History. The Commission for Historical Demography brought together representatives of the main institutions that were working in this field in Czechoslovakia at that time: the Institute of History of the Czechoslovak Academy of Sciences in Prague (P. Horská – chair of the commission) and the branch of the institute in Brno (J. Mezník), the Faculty of Arts in Prague (E. Maur – commission secretary), the faculties of education in Ostrava and Plzeň (M. Myška, A. Zeman), the Czechoslovak Demographic Society of the Czechoslovak Academy of Sciences in Prague (V. Srb, Z. Pavlík), as well as representatives of archives (J. Křivka, J. Hanzal) and secondary schools (J. Kalserová). Slovak colleagues were represented by Ján Sirácky, who a short time later was replaced by Anton Špiesz (both from the Institute of History of the Slovak Academy of Sciences in Bratislava). The commission from the outset worked very closely with the Working Group in Historical Demography at Charles University's Faculty of Arts, which after the death of Václav Husa focused with a new body of staff on methodological discussions, primarily among those interested in the field who were working in archives. Primary credit for advancing the work of the Commission for Historical Demography without question belongs to Pavla Horská, the indefatigable head of the commission, who maintained ties with the International Commission for Historical Demography and was constantly introducing new impulses into the commission's work.

The commission strove mainly to acquaint Czech researchers with methods in historical demography used abroad and to advance work on assessing suitable source materials. To this end the commission and the Working Group in Historical Demography organised two seminars: Sources in Historical Demography in Times before Statistics, in 1970; and the Development of Surnames in the Czech Lands, in 1972. Papers from the Working Group's seminars and discussion sessions along with other papers, mainly by colleagues in Ostrava, were published in the *Historical Demography* yearbook (*Historická demografie*). The commission also annually published a bibliography of Czech historical demography and reviews of the most important publications abroad and new domestic publications. A selected bibliography was then sent to the editorial office of Bibliographie internationale de la démographie historique in Paris.

The successful progress in the commission's work was abruptly interrupted by the onset of 'normalisation'. The commission came under the management of the History Collegium of the Czechoslovak Academy of Sciences, and several members, 'troublesome' in the eyes of the regime, P. Horská foremost among them, were stripped of their membership, new members were added who had prior to that worked in historical demography only marginally or not at all, and a new chair and secretary were appointed. The commission's work, including publication of the yearbook, de facto came to a halt for a decade. Pavla Horská, however, tireless in her efforts, managed to find a new organisational base for the field in the Czechoslovak Demographic Society and to incorporate historical-demographic research into the state plan for the Faculty of Sciences. In connection with this, a new Working Group for Historical Demography was founded as part of the Archive Administration under the Czechoslovak Ministry of the Interior. In 1983 the *Historical Demography* yearbook (*Historická demografie*) finally began to be published again, thanks to the initiative of a new member of the institute's staff, Ludmila Fialová, a demographer by training. L. Fialová established close ties with some of the commission's 'old' members, in particular P. Horská, which helped to secure a good quality circle of authors to contribute to the yearbook and to renew the yearbook's original focus. In 1987 it became possible to organise a two-day academic meeting called Population Development in the Czech Lands (up to 1914).

In 1990 P. Horská returned as the head of the commission and the yearbook, and I again took up the position of secretary. The commission acquired new members, this time people with a genuine interest in the field. In 1992 the commission moved (as did P. Horská and L. Fialová) under a new name, the Commission for Historical and Social Demography, to the Institute of Sociology of the Czech Academy of Sciences, which oversaw the publication of *Historical Demography*. After the revolution, international cooperative ties were successfully established, including cooperation with CEFRES in Prague, both by organising and co-organising seminars with international participants (1992: Czech-French Dialogue on the Family; 1996: Life-Cycle/Domestic Servants in European in the 16th to 20th Centuries; 2000: Czech-French Dialogue on the History of the Family; 2005: The History of Migration in the Czech Lands in the Early Modern Age; 2007: Families and Households from the 16th to the 20th Centuries), and by inviting top international experts to give lectures and the publish papers in the yearbook (e.g. J. N. Biraben, J. P. Poussou, A. Sulerot, A. Fauve-Chamoux, T. Jaworski, K. Arnold, H. Zeitlhofer, and Sathoshi Murayama). Several issues of Historical Demography also presented readers with the results of an important international research project titled 'Social Structures in Bohemia in the 16th-19th Centuries'.

Another change came in 2009. The new management of the Institute of Sociology no longer wished to be the administrative base for the commission and for the yearbook's publication. The Institute of Ethnology of the Czech Academy of Science was happy to assume publication of *Historical Demography* (which since 2015 it has been doing in cooperation with the Faculty of the Humanities, Charles University), and it became a journal published twice a year, but was no longer an organ of the commission. The active core members of the yearbook nevertheless became part of a wider editorial board that is made up of representatives of all the main Czech institutions working in historical demography and colleagues from Slovakia. The loss of the commission's coordinating role, however, has been felt palpably – it was useful, for example, in assigning university and doctoral dissertations – as has the demise of the regular professional meetings. It would therefore be desirable to see the work of the commission renewed.

Eduard Maur

Population and vital statistics of the Czech Republic: 2016, cohesion regions and regions

Cohesion region (NUTS 2), region (NUTS 3)	Population 1 July	Population 31 December	Marriages	Divorces	Live births	Abortions	Deaths: Total	Deaths: Under 1 year	Deaths: Neonatal deaths	Increase (decrease): Natural	Increase (decrease): Net migration	Increase (decrease): Total	Marriages per 1,000 inhabitants	Divorces per 1,000 inhabitants	Live births per 1,000 inhabitants	Deaths per 1,000 inhabitants	Total increase per 1,000 inhabitants
Česká republika	10,565,284	10,578,820	50,768	24,996	112,663	35,921	107,750	317	192	4,913	20,064	24,977	4.8	2.4	10.7	10.2	2.4
Praha	1,272,732	1,280,508	6,415	2,715	14,929	4,358	12,141	30	18	2,788	10,271	13,059	5.0	2.1	11.7	9.5	10.3
Střední Čechy	1,333,249	1,338,982	6,154	3,524	14,748	4,722	12,695	42	27	2,053	10,072	12,125	4.6	2.6	11.1	9.5	9.1
Jihozápad	1,215,945	1,217,411	6,032	2,912	12,687	4,224	12,596	37	24	91	2,851	2,942	5.0	2.4	10.4	10.4	2.4
Severozápad	1,119,617	1,118,126	5,227	2,984	11,078	4,697	12,225	55	29	−1,147	−1,381	−2,528	4.7	2.7	9.9	10.9	−2.3
Severovýchod	1,507,909	1,508,527	7,163	3,573	16,109	5,203	15,300	41	33	809	509	1,318	4.8	2.4	10.7	10.1	0.9
Jihovýchod	1,686,159	1,687,764	8,282	3,703	18,500	4,921	16,735	39	22	1,765	1,501	3,266	4.9	2.2	11.0	9.9	1.9
Střední Morava	1,218,236	1,217,623	5,727	2,660	12,560	3,950	12,925	32	21	−365	−1,408	−1,773	4.7	2.2	10.3	10.6	−1.5
Moravskoslezsko	1,211,437	1,209,879	5,768	2,925	12,052	3,846	13,133	41	18	−1,081	−2,351	−3,432	4.8	2.4	9.9	10.8	−2.8
Hlavní město Praha	1,272,732	1,280,508	6,415	2,715	14,929	4,358	12,141	30	18	2,788	10,271	13,059	5.0	2.1	11.7	9.5	10.3
Středočeský kraj	1,333,249	1,338,982	6,154	3,524	14,748	4,722	12,695	42	27	2,053	10,072	12,125	4.6	2.6	11.1	9.5	9.1
Jihočeský kraj	638,307	638,782	3,175	1,532	6,747	2,377	6,443	24	17	304	644	948	5.0	2.4	10.6	10.1	1.5
Plzeňský kraj	577,638	578,629	2,857	1,380	5,940	1,847	6,153	13	7	−213	2,207	1,994	4.9	2.4	10.3	10.7	3.5
Karlovarský kraj	297,317	296,749	1,504	739	2,815	1,086	3,167	12	6	−352	−703	−1,055	5.1	2.5	9.5	10.7	−3.5
Ústecký kraj	822,300	821,377	3,723	2,245	8,263	3,611	9,058	43	23	−795	−678	−1,473	4.5	2.7	10.0	11.0	−1.8
Liberecký kraj	440,179	440,636	2,126	1,102	4,960	1,842	4,385	13	12	575	422	997	4.8	2.5	11.3	10.0	2.3
Královéhradecký kraj	551,177	550,804	2,565	1,300	5,616	1,855	5,681	18	14	−65	−552	−617	4.7	2.4	10.2	10.3	−1.1
Pardubický kraj	516,553	517,087	2,472	1,171	5,533	1,506	5,234	10	7	299	639	938	4.8	2.3	10.7	10.1	1.8
Kraj Vysočina	509,187	508,952	2,445	945	5,307	1,508	4,997	12	6	310	−833	−523	4.8	1.9	10.4	9.8	−1.0
Jihomoravský kraj	1,176,972	1,178,812	5,837	2,758	13,193	3,413	11,738	27	16	1,455	2,334	3,789	5.0	2.3	11.2	10.0	3.2
Olomoucký kraj	634,081	633,925	2,925	1,432	6,697	2,151	6,731	19	13	−34	−761	−795	4.6	2.3	10.6	10.6	−1.3
Zlínský kraj	584,155	583,698	2,802	1,228	5,863	1,799	6,194	13	8	−331	−647	−978	4.8	2.1	10.0	10.6	−1.7
Moravskoslezský kraj	1,211,437	1,209,879	5,768	2,925	12,052	3,846	13,133	41	18	−1,081	−2,351	−3,432	4.8	2.4	9.9	10.8	−2.8

Radek Havel

Population and vital statistics of the Czech Republic 2016: towns with more than 50,000 inhabitants

Town	Population 1 July	Population 31 December	Marriages	Divorces	Live births	Abortions	Deaths	Increase (decrease)			Marriages	Divorces	Live births	Deaths	Total increase
								Natural	Net migration	Total	per 1,000 inhabitants				
Praha	1,272,732	1,280,508	6,415	2,715	14,929	4,358	12,141	2,788	10,271	13,059	5.0	2.1	11.7	9.5	10.3
Brno	377,413	377,973	1,967	935	4,563	1,257	3,938	625	320	945	5.2	2.5	12.1	10.4	2.5
Ostrava	292,167	291,634	1,376	770	3,019	944	3,374	–355	–692	–1,047	4.7	2.6	10.3	11.5	–3.6
Plzeň	170,119	170,548	873	421	1,798	481	1,852	–54	744	690	5.1	2.5	10.6	10.9	4.1
Liberec	103,572	103,853	523	294	1,246	493	1,001	245	320	565	5.0	2.8	12.0	9.7	5.5
Olomouc	100,265	100,378	481	274	1,255	413	986	269	–45	224	4.8	2.7	12.5	9.8	2.2
České Budějovice	93,503	93,470	480	242	1,078	391	993	85	–128	–43	5.1	2.6	11.5	10.6	–0.5
Ústí nad Labem	93,117	92,984	452	316	1,078	427	972	106	–370	–264	4.9	3.4	11.6	10.4	–2.8
Hradec Králové	92,875	92,929	470	224	978	290	997	–19	57	38	5.1	2.4	10.5	10.7	0.4
Pardubice	89,865	90,044	431	254	994	283	926	68	338	406	4.8	2.8	11.1	10.3	4.5
Zlín	75,125	75,117	369	177	797	247	803	–6	–48	–54	4.9	2.4	10.6	10.7	–0.7
Havířov	73,629	73,274	373	191	677	284	869	–192	–635	–827	5.1	2.6	9.2	11.8	–11.2
Kladno	68,553	68,660	299	181	771	382	738	33	161	194	4.4	2.6	11.2	10.8	2.8
Most	66,997	66,768	292	159	673	333	737	–64	–170	–234	4.4	2.4	10.0	11.0	–3.5
Opava	57,531	57,387	262	123	577	215	572	5	–294	–289	4.6	2.1	10.0	9.9	–5.0
Frýdek-Místek	56,800	56,719	262	176	603	224	540	63	–223	–160	4.6	3.1	10.6	9.5	–2.8
Karviná	54,695	54,413	259	134	485	206	700	–215	–535	–750	4.7	2.4	8.9	12.8	–13.7
Jihlava	50,617	50,559	258	119	560	177	470	90	–245	–155	5.1	2.4	11.1	9.3	–3.1

Radek Havel

Abstracts of Articles Published in the Journal Demografie in 2017 (Nos. 1–3)

Sylva Höhne

CHANGES IN PARENTAL ALLOWANCE TAKE-UP IN A DEMOGRAPHIC CONTEXT

The article analyses data on parental allowance recipients in the last 15 years, during which eligibility criteria and the system of payments considerably changed. It points out changes in the structure of recipients in demographic and other contexts (e.g. labour market, childcare). It is evident that the period of parental allowance uptake is getting shorter; however, there continues to be an interest in using it up to the time a child reaches the age of 3. The outcomes could contribute to the family policy discussion, which is currently underway.

Keywords: parental allowance, legislative changes, birth rate, childcare, family policy **Demografie,** 2017, **59: 5–22**

Jan Fojtík – Tomáš Karel – Martin Matějka – Pavel Zimmermann

MODELLING THE MORTALITY OF OLDER PEOPLE IN THE CZECH REPUBLIC BASED ON COHORT DATA FROM SURROUNDING COUNTRIES

The article presents one possible way in which to reduce uncertainty in modelling the mortality of older age groups. The lack of reliable data is usually one of the most important problems of old-age mortality modelling. The uncertainty of the estimates is reduced in this article by using multiple sources of mortality data and using the credibility approach to mixing data from several countries. For the oldest age, the extinct cohort method is applied to increase the reliability of the population data. Using Czech data mixed with data from surrounding countries, results in narrower confidence intervals of estimates and consequently more accurate predictions than when only Czech data were used.

Keywords: old-age mortality, credibility data model, multi-population mortality models **Demografie,** 2017, **59: 23–32**

Ladislav Průša

THE EFFECTS OF CHANGES IN THE POPULATION AGE STRUCTURE ON THE COSTS OF PROVIDING HEALTH CARE

This paper attempts to quantify the effects of changes in the population age structure on the costs of health-insurance companies for the provision of health care. Based on a population projection for the Czech Republic and data on health-insurance companies' expenditures on health care by gender and age, the expected development costs of health-insurance companies in 2030 are quantified and the possibilities of financing the health- insurance system, including proposed changes to some parameters of the system, are assessed.

Keywords: projection of the population of the Czech Republic, health care, health insurance, health-insurance companies, incomes and expenditures of the health-insurance system **Demografie,** 2017, **59: 33–48**

Martina Šimková – Jitka Langhamrová

THE QUALITATIVE FACTORS OF POPULATION AGEING

Although the ageing of the population has become a much discussed issue in the Czech Republic, these discussions are often limited to the quantitative consequences of population ageing for the economy. However, the impacts of population ageing are also qualitative and concern ageing safely and with dignity and the appropriate living standards in old age. This article focuses on the qualitative aspects of population ageing.

Keywords: ageing of the population, living standards, retirement age, social and health care **Demografie,** 2017, **59: 49–64**

Martin Furmanik

THE NATIONAL AND SOCIO-ECONOMIC STRUCTURE OF THE SPIŠ REGION IN THE FIRST TWO DECADES OF THE 20TH CENTURY ACCORDING TO THE POPULATION CENSUSES IN 1910, 1919 AND 1921

This paper analyses the national and social structure of Spiš County in Slovakia in the early 20th century. It is mainly based on the published results of the population census in the years 1910, 1919, and 1921. The paper also looks at looks at the literacy rate, the degree of urbanisation, and the religious structure of Spiš and Slovakia in the observed period. Analysis of these factors is important for understanding the complex development of society in the early 20th century and in followed period.

Keywords: Spiš, Slovakia, national structure, socio-economic structure, census **Demografie,** 2017, **59: 99–117**

Branislav Šprocha

THE ROMA POPULATION IN SLOVAKIA AND THE COHORT FERTILITY OF ROMA WOMEN ACCORDING TO THE 2011 POPULATION AND HOUSING CENSUS

Romanies in Slovakia are in many ways specific populations. Owing to their ethnicity and especially a degree of isolation from the majority, it is still possible to identify many differences in reproductive behaviour in the Roma population. Probably the one mentioned most is the fertility of Roma women. The paper analyses fertility from a cohort perspective in the population of women of Roma nationality based on data from the 2011 Population and Housing Census. It focuses on the development of cohort fertility, women by parity, and parity progression ratios. The paper also points to possible differences in the cohort fertility of Roma women by marital status, educational attainment, economic activity, and place of residence.

Keywords: Roma women, cohort fertility, 2011 Population and Housing Census, marital status, education, economic activity, Slovakia

Demografie, 2017, **59: 118–131**

Kateřina Podolská – Jitka Rychtaříková

IMPACT OF COSMIC-ORIGIN BACKGROUND RADIATION ON HUMAN SURVIVAL IN THE CZECH REPUBLIC

We evaluate the lifetime attributable risks induced by an increasing concentration of cosmic radiation and cosmogenic radionuclides during periods of low solar activity for the specific conditions in the Czech Republic. The concentration of cosmic radiation and cosmogenic radionuclides reaches its highest values during the solar minima when the Earth's magnetosphere is more penetrable. The computed estimate of lifetime attributable risks from solid neoplasms (colon, lung, and stomach) induced by doses of natural background radiation is higher for the period of low activity in solar cycle No. 24 than for the forced solar activity in the previous solar cycle Nos. 19 – 23. We estimated the lifetime attributable risks induced by the annual dose of natural background radiation by sex for the Czech Republic and the USA. In addition, three different scenarios based on dose radiation level were explored. The cosmogenic radionuclides in our environment may thus play a greater role than in the last decades.

Keywords: mortality, incidence, solid cancer, lifetime attributable risk, age at exposure, solar activity, natural background radiation dose

Demografie, 2017, **59: 132–149**

Jana Křesťanová – Roman Kurkin – Michaela Němečková

POPULATION DEVELOPMENT IN THE CZECH REPUBLIC IN 2016

This analysis describes the demographic situation in the Czech Republic in 2016 and demographic trends in the past decade based on demographic statistics from the Czech Statistical Office. The article evaluates changes in sex-age and marital status structure, nuptiality, the divorce rate, fertility, the abortion rate, mortality and international migration. In 2016 the population of the Czech Republic rose as a result of positive international migration and natural increase. The total fertility rate was above 1.6 children per woman and life expectancy at birth increased to 76.2 years for males and 82.1 years for females. The total first marriage rate for both men and women also rose. Conversely, the total divorce rate declined.

Keywords: demographic development, population, age structure, nuptiality, divorce, fertility, abortion, mortality, migration, Czech Republic

Demografie, 2017, **59: 187–206**

Anna Šťastná – Jitka Slabá – Jiřina Kocourková

THE PLANNING, TIMING, AND FACTORS BEHIND THE POSTPONEMENT OF FIRST BIRTHS IN THE CZECH REPUBLIC

The transition to childbearing at a later age is one of the most striking features of demographic change in recent years. Employing both vital statistics and survey data, the paper analyses the causes and consequences of fertility postponement in the Czech Republic. The authors focus on the planned age of childbearing and on the reasons why women fail to fulfil their plans and postponing childbearing for a much longer period than originally planned.

Keywords: first birth, fertility postponement, fertility planning, Czech Republic **Demografie,** 2017, **59: 207–223**

Branislav Šprocha – Pavol Ďurček

COHORT FERTILITY AND THE CONCENTRATION OF REPRODUCTION OF WOMEN IN CZECHIA AND SLOVAKIA BY EDUCATIONAL ATTAINMENT

Educational attainment is one of the most important features of differential fertility. The aim of this paper is to analyse the development of cohort fertility in Czechia and Slovakia by level of education, to identify changes in the structure of women by the number of births and education, and to highlight the development of parity progression ratios across educational groups in a cohort perspective. The paper also focuses on trends in the concentration of reproduction by education and selected characteristics of reproduction. The results of the analysis clearly confirm the significant impact of education on cohort fertility, family size, and the variability of reproduction and redistribution.

Keywords: cohort fertility, concentration of reproduction, educational attainment, Czechia, Slovakia **Demografie,** 2017, **59: 224–241**


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– *Potraty*. 2005. Prague: Ústav zdravotnických informací a statistiky.

Articles in periodicals

– Bakalář, E. and Kovařík, J. 2000. 'Fathers, Fatherhood in the Czech Republic.' *Demografie*, 42, pp. 266–272.

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Syrovátka, A. 1962b. 'Child Mortality from Automobile Accidents in the Czech Lands.' *Czech Medical Journal*, 101, pp. 1513–1517.

In-text references

(*Srb*, 2004); (*Srb*, 2004: pp. 36–37); (*Syrovátka et al.*, 1984).

Table and figure headings

Table 1: Population and vital statistics, 1990–2010

Figure 1: Relative age distribution of foreigners and total population of CR, 31 Dec 2009

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