ANALYSIS OF MORTALITY IN THE CZECH REPUBLIC IN RECENT YEARS

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Abstract

Human life has been extended for several years now. People are living longer thanks to the positive development of medical care. However, if there is a lengtheting in human life, this should be compensated by a sufficient birth rate. If compensation is not sufficient, the population ages. The problem of population aging is a topic discussed more or less in all European countries. How to deal with the aging of the population is being addressed more and more often. In order to make the right decisions, you need, among other things, a good idea of the development of mortality.

This article will focus on the analysis of the mortality of the Czech population. Special attention will be paid to changes in recent years, when the covid 19 pandemic affected this development. The analysis itself will mainly use modal length of life. Furthermore, attention will be focused on the use of the logistic function (also for estimating modal length of life).

The main contribution is the calculation of modal length of life by using the Kannisto's model. A second contribution is the analysis of mortality during a pandemic using modal length of life.

Key words: mortality, mortality models, logistic function, modal length of life

JEL Code: J10, J11, J19

Introduction

The extension of human life, which is not compensated by a sufficient birth rate, has been addressed in most European countries in recent years. The necessary changes, mainly in the social system, are being discussed (Langhamrová, Fiala, 2013).
The best possible analysis of mortality is also related to the correct choice of reforms.

1 Methodology

The paper will focus on the analysis of mortality in recent years. The effort is also to capture the effects of the covid 19 pandemic.

Several available indicators can be used to analyze mortality: number of deaths, specific death rates (differentiated by age and sex) or different types of life tables that can be obtained from mortality tables. Life expectancy, modal length of life and median length of life can be included here (Langhamrová, Arltová, 2014).

A modal length of life was chosen for the processing of this post. Its advantage is that it is a mode-type characteristic and is not so affected by extreme values.

A modal length of life can be thought of as the age at which people most often die (Dotlačilová, 2019 or Fiala, 2002).

In the first part, specific deaths rates will be calculated, which will then be modeled using a logistic function (Kannisto's model) for persons aged 60+.

In order to better link the modeled mortality with the calculation of modal length of life, an estimation formula derived from the Kannisto's model will be used to calculate it (Dotlačilová, 2020).

Kannisto's model

Kannisto's model is a type of logistic function. It is one of the most frequentely used analytical functions for modelling mortality at higher ages. This feature assumes to have a slower increase in mortality (Burcin et al., 2010 or Gavrilov, Gavrilova, 2011).

In this article, Kannisto model was used in shape (Kannisto et al., 1994 or Thatcher et al. 1998 or Boleslawski, Tabeau, 2001)):

$$\mu_x = \frac{ae^{b.x}}{1+ae^{b.x}}, \tag{1}$$

where *a* and *b* are unknown parameters of the model, *x* is the age.

Based on the estimation of the unknown parameters of the Kannisto's model, the modal length of life will be calculated. In deriving the estimation formula, the following formula was used:

$$\mu'(x) - \mu^2(x) = 0,$$

where $\mu(x)$ is the intensity of mortality, which is represented by Kannisto's model (1).

By successive steps, we get an estimation formula that can be used to calculate a modal length of life in the form:

$$x = \frac{ln\, b - ln\, a}{b}, \tag{2}$$

where *a*, *b* are parameters from Kannisto's model and *x* is modal length of life.

2 Results

Data on the mortality of the Czech population in the years 2018 – 2021 were used for the calculations (CZSO, 2023). The first two years were selected as those that have not yet been affected by the covid 19 pandemic, and the last two, on the contrary, as those in which the impact of the pandemic could be noticeable.

The aim is to analyze mortality using modal length of life. This was calculated based on a formula derived from Kannisto's model (Kannisto et al., 1994).

Tab. 1: Males – modal length of life

	2018	2019	2020	2021
mode	82.8	83.1	81.7	81.8

Source: author's calculation, data CZSO (CZSO, 2023)

The first table contains values of modal length of life for males in the Czech Republic. In 2018 and 2019, an increase in values is noticeable. Which corresponds with the assumption of improving mortality. On the contrary, in 2020 there is a noticeable decrease. The decrease is probably due to higher mortality caused by the pandemic.

Tab. 2: Females – modal length of life

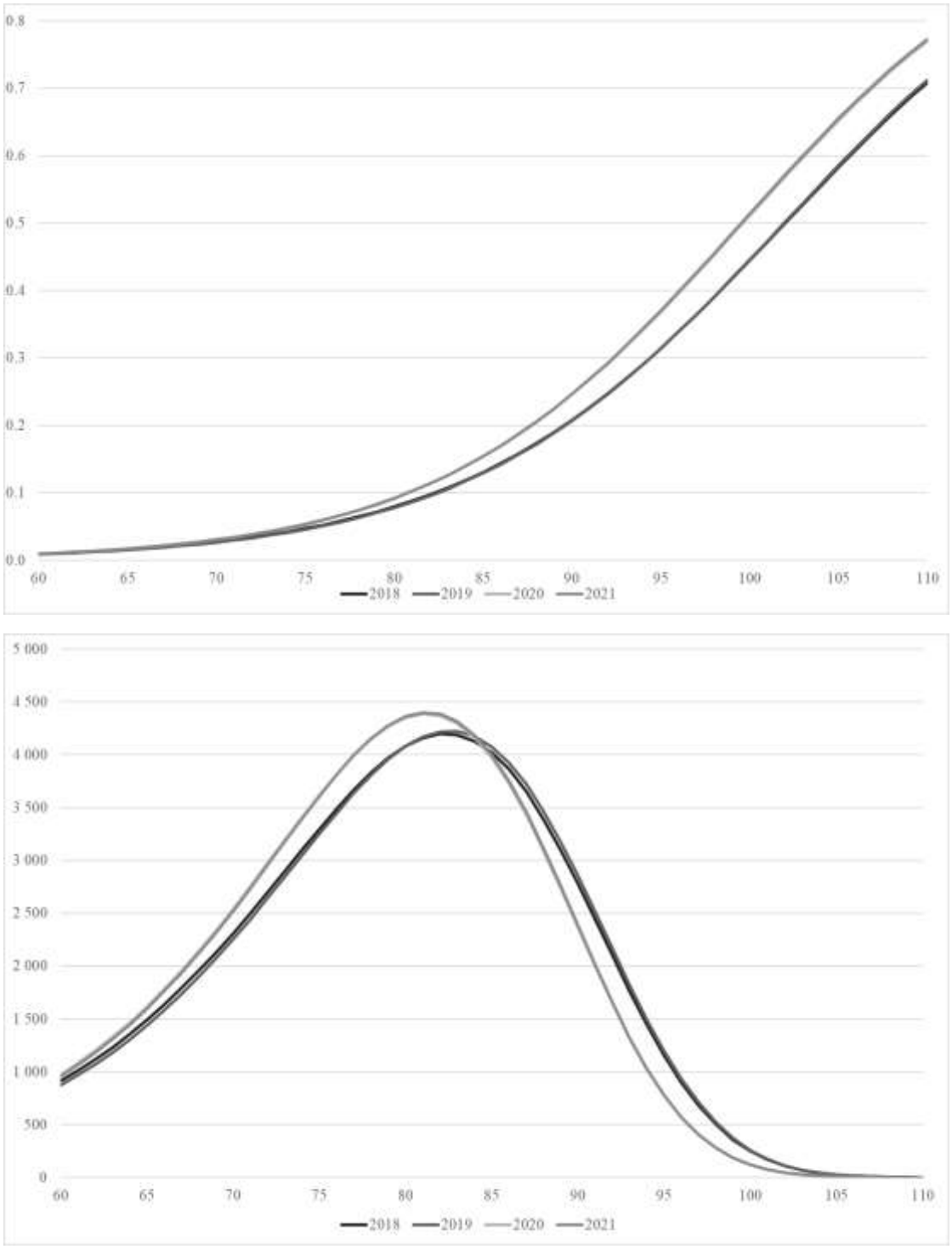
	2018	2019	2020	2021
mode	87.6	87.9	86.9	86.9

Source: author's calculation, data CZSO (CZSO, 2023)

The second table contains the values of the modal length of life for females. Here, too, it is possible to observe a decrease in values in comparison with 2019 and 2020. However, the decrease is not so significant.

To supplement the analysis, the mortality intensity represented by the Kannisto's model was calculated (the figure shows values for persons 60+). Table numbers of deaths were also used as an additional indicator (table numbers of deaths assume stationary population – population that is not increasing). From it, the age at which the (tabular) number of deaths is maximum can be easily traced.

Fig. 1: males – modeled mortality, number of deaths – 2018, 2019, 2020, 2021



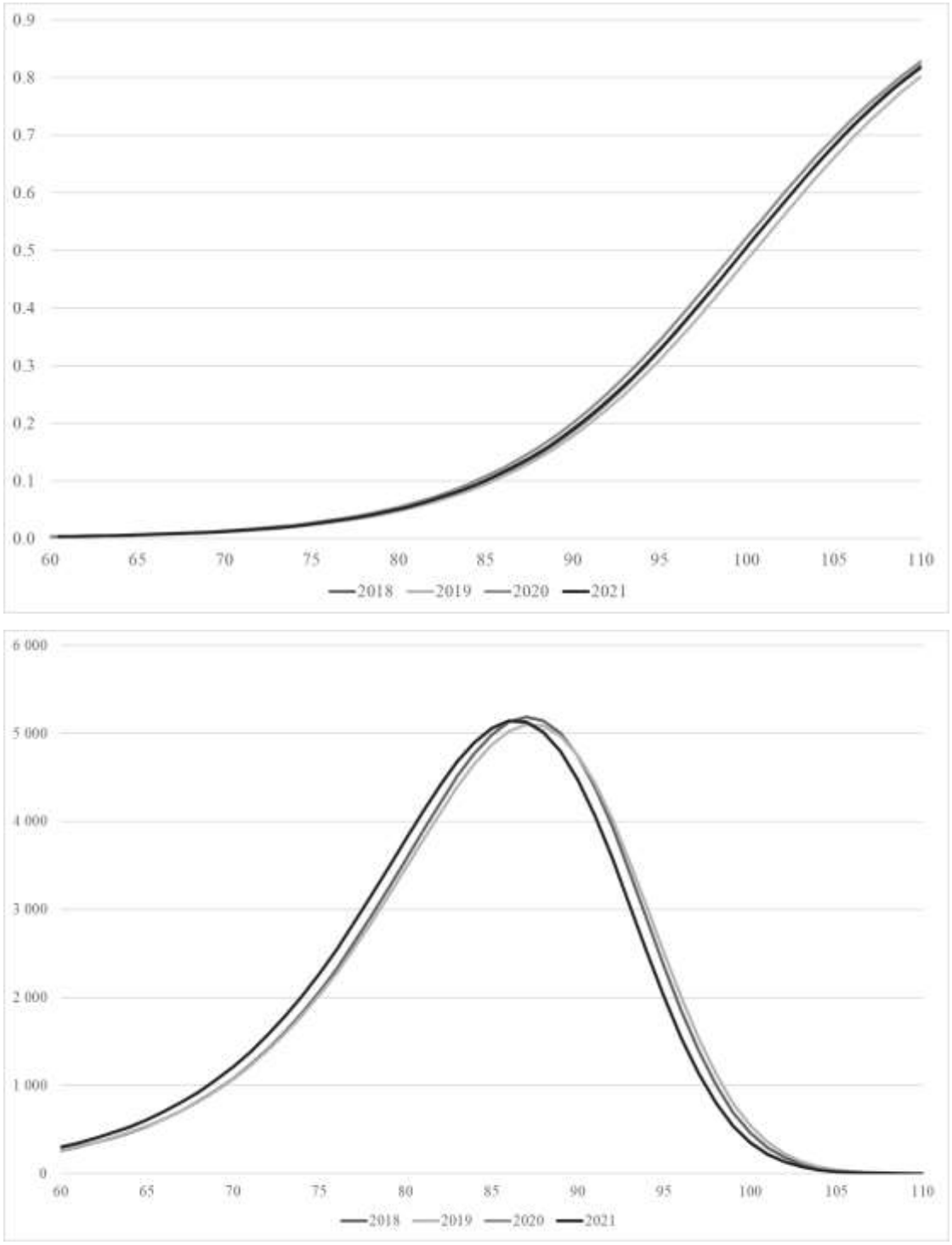
Source: author's calculation, data CZSO (CZSO, 2023)

The figure on the left shows the modeled mortality. Here it is evident at first glance that the death rates was lower in the first two years. The increase only became apparent in 2020 and 2021. This is also evident in the figure of the tabular number of deaths. In 2018 and 2019, the

maximum number of deaths is shifted more to the right. Here, too, it is clear what impact the lower mortality in the first two years has on the number of deaths and on the associated modal length of life.

The following two figures are devoted to the population of females.

Fig. 2: Females – modeled mortality, number of deaths – 2018, 2019, 2020, 2021



Source: author's calculation, data CZSO (CZSO, 2023)

The first figure shows modeled mortality of females in the years 2018 – 2021. For comparison, the years before the pandemic and then after its outbreak were also selected here. At first glance, it is clear that the pandemic did not cause such differences for females as it did for males. Although it is also visible here in 2020 and 2021. Even from the tabulated number of deaths, we can see that there was no significant increase in mortality among females. The age at which the tabular number of deaths is maximum has not decreased as much (the maximum of the curve in 2020 and 2021 is not shifted as much to the left).

Conclusion

The aim of the contribution was to analyze the death rate of the Czech population in recent years using modal length of life. An important part was the calculation of modal length of life using the estimating function obtained using the Kannisto's model (this was also used to model mortality in the 60+). Special attention was paid to the effects of the covid 19 pandemic on mortality.

The calculation of the modal length of life was realized using the derived estimation formula.

In the second part, attention was focused on the effects of the pandemic. From the modeled mortality, it is clear that between 2020 and 2021 there was an increase in the death rate for both males and females. In males, the increase is more noticeable. The same can be observed from the curves of the table number of deaths, where higher mortality was reflected in the shift of the maximum of the curve to the left. The knowledge obtained from the figures can subsequently be seen also in the modal length life. In the years 2018 – 2019, the values of modal length of life confirm the improving trend of mortality in both males and females. On the contrary, during the transition to the years 2020 and 2021, a decrease in values can be seen.

Annex 1 – males – parameters of Kannisto model, values of adjusted R^2 (second table)

	2018		**2019**	
	value	**p-value**	**value**	**p-value**
parameter a	0.000011	0.0000	0.000010	0.0000
parameter b	0.111469	0.0000	0.112708	0.0000
	2020		**2021**	
	value	**p-value**	**value**	**p-value**
parameter a	0.000008	0.0000	0.000008	0.0000
parameter b	0.116627	0.0000	0.117252	0.0000

2018	2019	2020	2021
0.9978	0.9979	0.9987	0.9978

Source: author's calculation, data CZSO (CZSO, 2023)

Annex 2 – females – parameters of Kannisto model, values of adjusted R^2 (second table)

	2018		2019	
	value	p-value	value	p-value
parameter a	0.000000	0.0000	0.000000	0.0000
parameter b	0.149120	0.0000	0.146468	0.0000
	2020		2021	
	value	p-value	value	p-value
parameter a	0.000000	0.0000	0.000000	0.0000
parameter b	0.147219	0.0000	0.147468	0.0000

	2018	2019	2020	2021
R^2 adj. Kannisto	0.9991	0.9991	0.9995	0.9995

Source: author's calculation, data CZSO (CZSO, 2023)

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