European best-mortality model population: a way to identification of potential national improvements in survival

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Introduction

Until the beginning of the pandemic era, there was a general trend towards mortality improvements in developed countries, specifically in Europe. Despite some time-fluctuations in particular countries, the general trend of life expectancy at birth was increasing. There are many ways how the development of mortality could be studied as well as interpreted in relation to potential future improvements. One of the common approaches to evaluation of future opportunities and chances to improvement is a comparison of the studied population with any set goal one or a best one population (e.g., representing the highest value of life expectancy).

In the presented paper, we used the set of national (European countries considered only) age- and sex-specific mortality rates from 1980 until 2019. For each sex and age, the three minimal values were selected and combined to form the European best-mortality model (fictitious) population (hereinafter "*EBMM population*"). In other words, at each age and for each sex, the EBMM population was created as a combination of three national European populations representing the lowest level of mortality.

Aims

The EBMM population could be used for evaluation of mortality disadvantages of any country in a particular year. On the other hand, the EBMM population changes annually according to actual mortality conditions. There are two particular aims of the paper: (1) describe the basic development of the model best-mortality population, (2) evaluate the development of selected European countries in relation to the EBMM population.

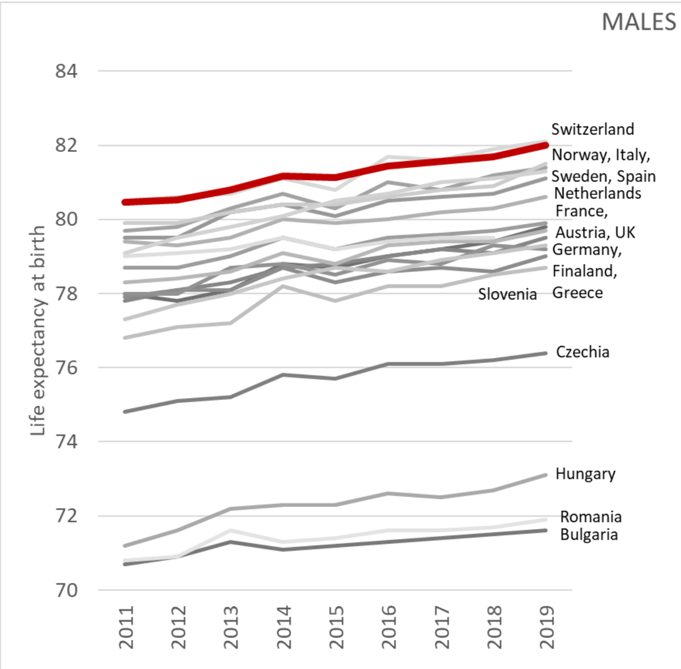
We consider the first aim as a possibility to assess the potential future development of the general mortality trends in Europe or a potential reveal of some life expectancy limit as discussed by many authors in the past (e.g., Oeppen, Vaupel 2002; Dong *et al*. 2016; Fries 1980). The second aim is related to particular countries and their potential future development – if there is a robust trend of the EBMM population development and a relatively stable or constantly changing differences between the studied population and the EBMM population, then it could be used as a support for a mortality forecast. The differences between the EBMM population and particular national populations are expressed using the life expectancy decomposition and age-specific indexes (relation of national age-specific mortality rate and age specific mortality rate from the EBMM population).

Selected results

All the analyses are done for males and females separately. If not stated otherwise, in this extended abstract the results presented are related to males only.

The results revealed that the best-mortality model population for males as well as for females expresses a constant mortality improvements and growth of the model life expectancy until the pandemic years (Figure 1). For all countries, there are differences between the EBMM population life expectancy and the national one. The only exception is Switzerland, where the life expectancy at birth is on average comparable to the EBMM population. However, even in Switzerland, there are age-specific differences between the two compared populations (Figure 2).

Figure 1: *Development of the life expectancy at birth in selected European countries in comparison to the European best-mortality model population*

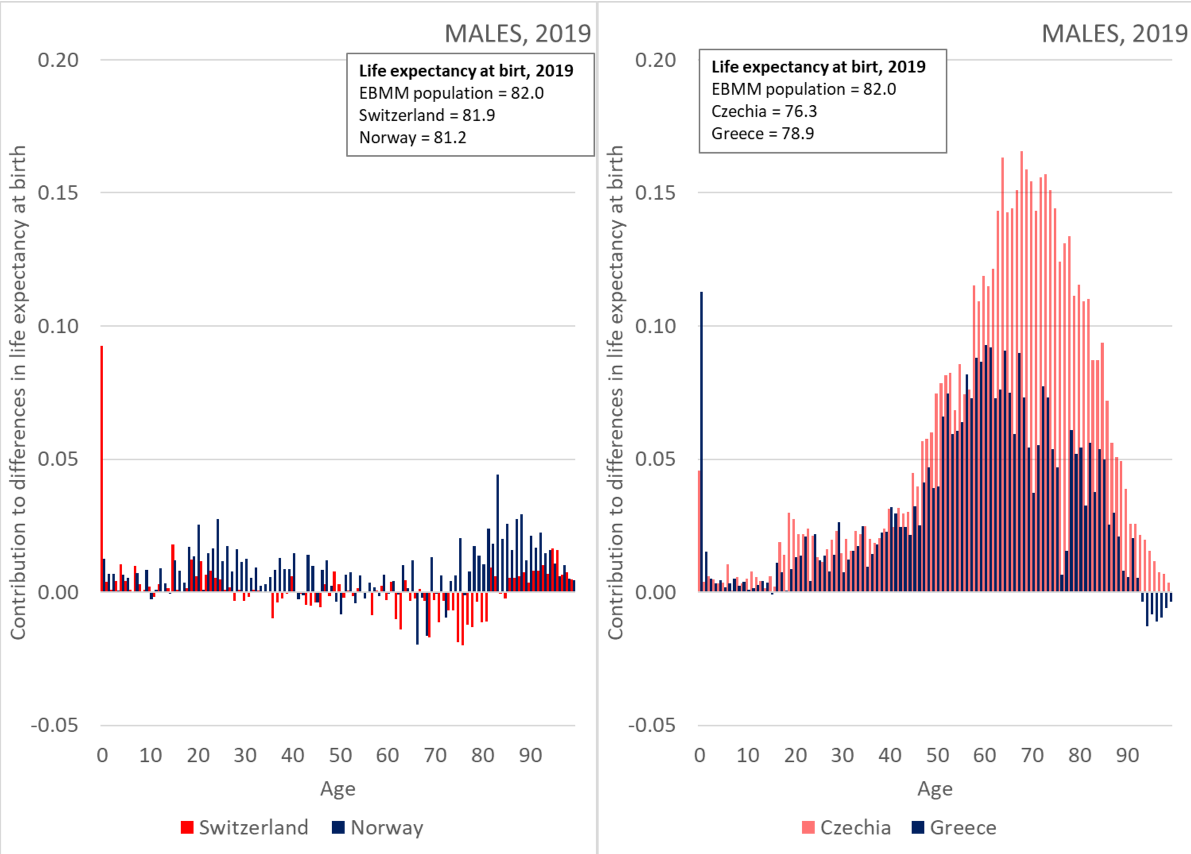


Source of data: Eurostat

Even though, there is only a marginal difference between the life expectancy at birth in Switzerland in in the EBMM population in 2019, clearly, there is a very specific age-pattern. Using the decomposition of the difference, the significant advantage of Switzerland was revealed at ages around 30 to 80. At this age group the age-specific mortality rates are even better in comparison to the EBMM population (the EBMM population is a combination of three the best countries, so it is possible for one to reach better values that the EBMM population). On the other hand, there is a disadvantage of Switzerland's men at the youngest ages and the highest ones. Above all in the first year of life, there Switzerland looses almost a 0.1 year to the EBMM population.

Another country selected for comparison is Norway, where the life expectancy at birth in 2019 was only 0.8 years below the EBMM population (Figure 2). The age-pattern for Norway is clearly different from that one of Switzerland. The age-specific mortality rates in Norway are generally (at almost all ages) slightly higher in comparison to the EBMM population. The biggest difference is located at ages around 80–90 years.

Figure 2: *Decomposition of differences in life expectancy at birth between the European best-mortality model population and Switzerland, Norway (left) and Czechia, Greece (right), males, 2019*

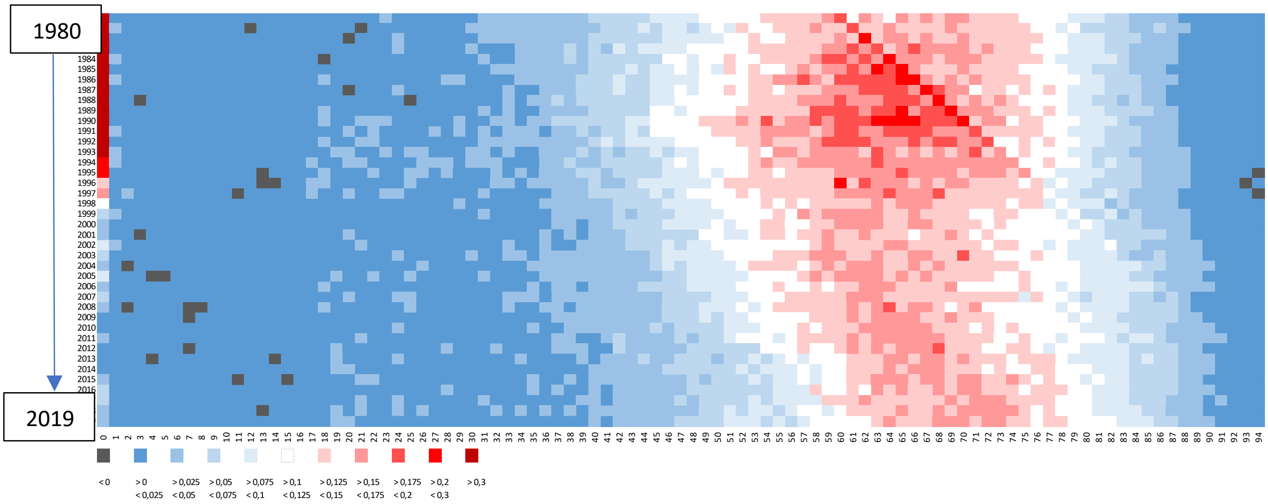


Source of data: Eurostat

On the other hand, in Greece the life expectancy at birth is by 3.1 years below the EBMM population, in Czechia even by 5.7 years. In both the countries the differences are located above all at adult and older ages (45+). There is one interesting exception for Greece, where the registered mortality level at the highest ages (90+) is extremely low, even below the EBMM population at some ages. However, the major Greece's disadvantage in comparison to the EBMM population could be found already in the fist year of life. In Czechia, the infant mortality rate is very close to the EBMM population (Figure 2).

Observing the development of the age-specific contributions to differences in life expectancies in the studied country and the EBMM population (Figure 3), it is possible to estimate the potential future development as well. Clearly the disadvantageous values of mortality (much higher values in comparison to the EBMM population) are moving to higher and higher ages. In Figure 3, the blue values represent contributions to difference in life expectancy that are below 0.1 years. These small values could be observed up to the ages around 60 at the end of the studied period. Around the year 1990 such values were observable already at ages around 45 years. It is clear that cohorts born before 1960 carry a higher difference compared to the EBMM population.

Figure 3: *Decomposition of differences in life expectancy at birth between the European best-mortality model population and Czechia, males, 1980–2019 (vertical axis), according to age (horizontal axis)*



Conclusion and future steps

Decomposition of the differences between the EBMM population and selected national life expectancies revealed specific patterns of potential improvements, in transitional societies (Czechia) supported also by a strong cohort effect. In general, the constructed EBMM population could help to reveal any potential limits to life expectancy values as well as to evaluate the national trends according to national disadvantages and chances of future potential improvements. In most of the countries, there are chances to improvement above all at adult and older ages.

The results are slightly different for females (not included in this abstract). Moreover, a special attention should be paid to development during the pandemic, where not only the particular nations were affected by mortality worsening, but also the EBMM population.

References

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