A radically simple way to monitor life expectancy

Ilya Kashnitsky[1], Alexey Raksha[x], José Manuel Aburto[1,2,3], Jonas Schöley[1], James Vaupel[1]

Affiliations:
[1] Interdisciplinary Centre on Population Dynamics, University of Southern Denmark, Odense 5000, Denmark.
[2] Leverhulme Centre for Demographic Science and Department of Sociology, University of Oxford, 42-43 Park End Street, OX1 1JD Oxford, UK.
[3] Nuffield College, New Rd, OX1 1NF Oxford, UK .

Correspondence to:
Ilya Kashnitsky
Interdisciplinary Centre on Population Dynamics, Odense 5000, Denmark
Email: ikashnitsky@sdu.dk
ORCID: 0000-0003-1835-8687

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Period Life Expectancy is the key summary measure of current mortality. Elimination of the direct influence of population age structure allows to meaningfully compare mortality levels and changes across the populations and over time. Calculation of life expectancy demands high quality detailed data on death and population counts disaggregated by sex and age.

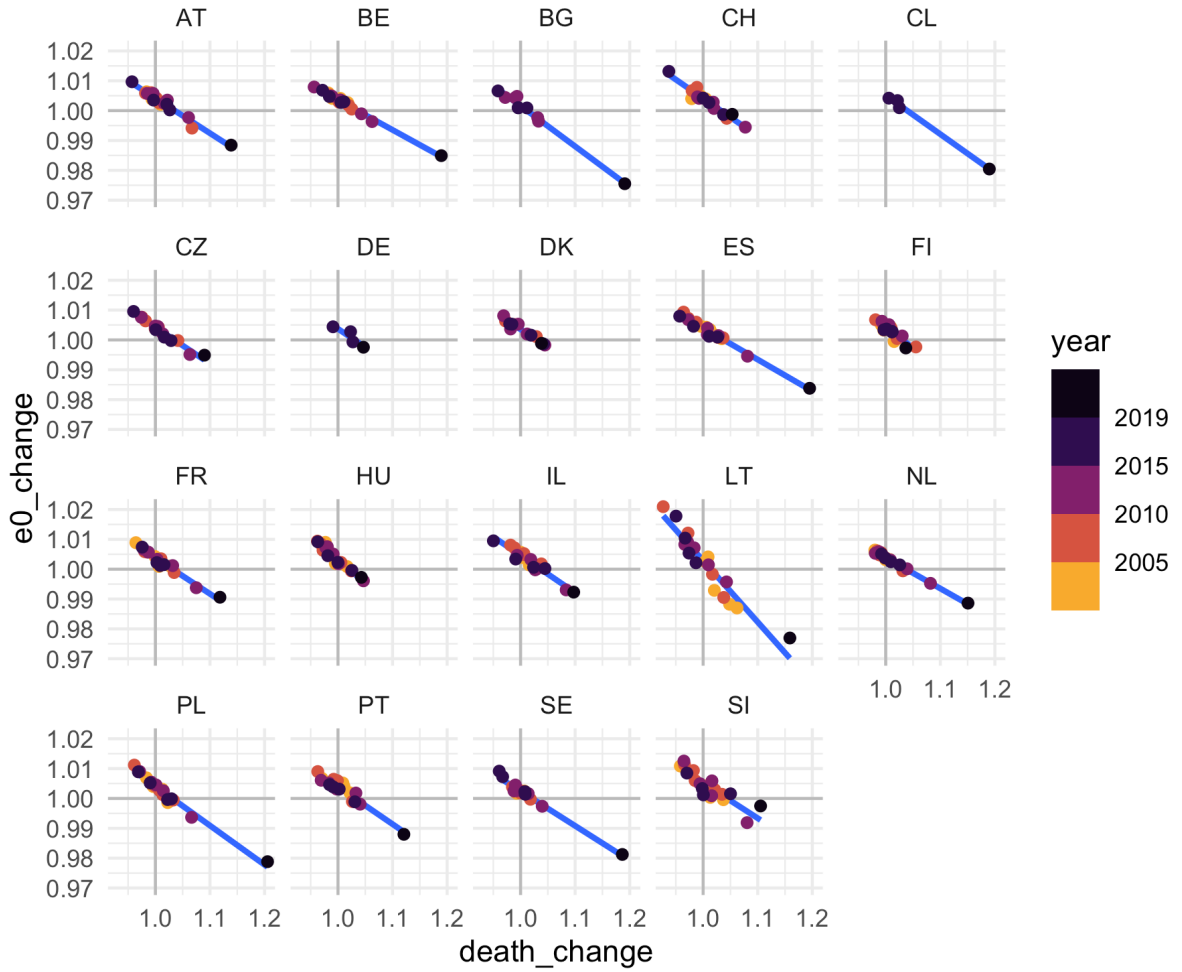
Such data is only available for the more developed countries. Moreover, even in the most developed countries, it becomes available with a considerable time lag. And for the majority of countries across the world timely and high quality deaths statistics is not available. In situations of mortality shocks such as the COVID–19 pandemic near real time mortality level comparisons are crucial.

Building on the studied regulatities of human mortality, we offer a method of reliable life expectancy shortcasting based only on the time series of its previous values and the time series of total deaths counts observed in the population, not disaggregated by sex and age. The radical simplicity of the method allows to monitor changes in life expectancy in near real time, if time disaggregated (daily, weekly, or monthly) total death counts are available.

This is very much work in progress. Here we report the first results with minimal comments. Please excuse the cursory nature of this extended abstract, we want to signal exciting findings

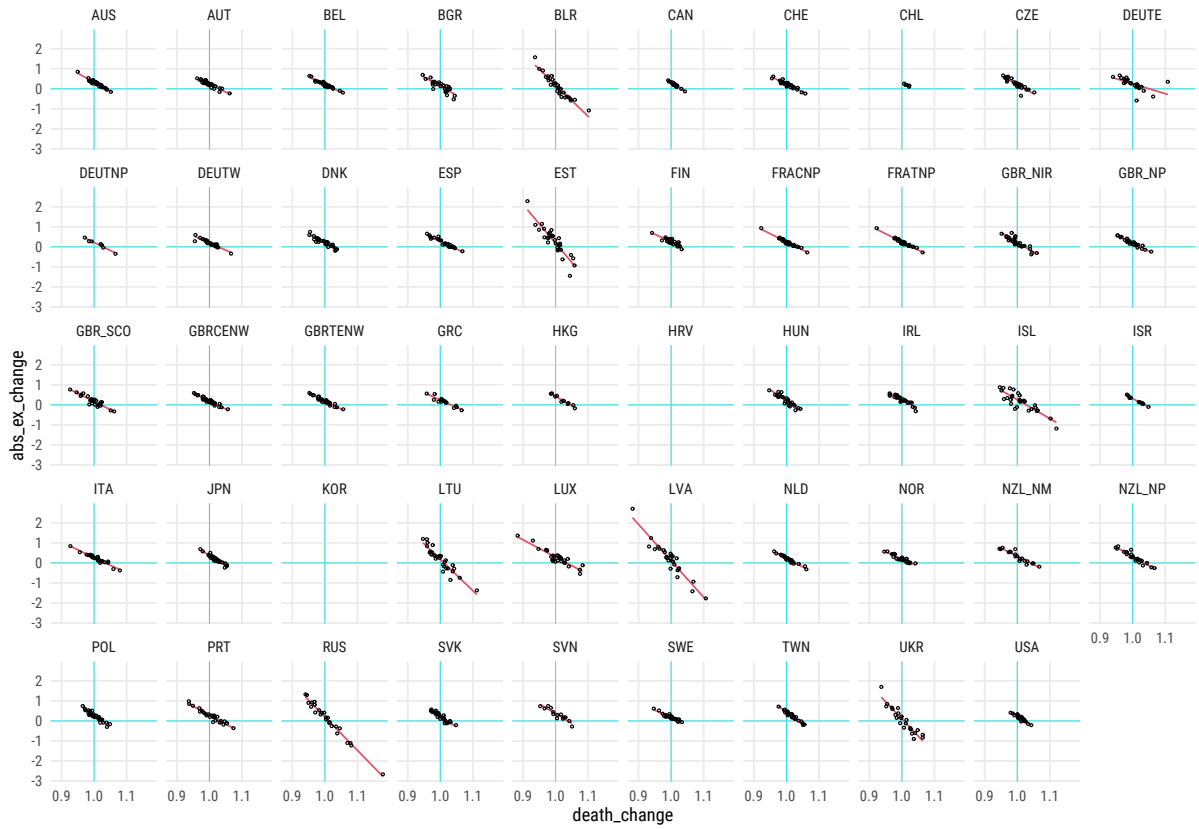
The core idea is very simple, and so far we have produced results that strongly support the robustness of the idea. The idea is:

We can estimate/predict life expectancy of the population knowing **only** (1) previous life expectancy values for a certain period and (2) total deaths counts in the population, not disaggregated by sex and age. Simple linear relationship between year-on-year changes in the two allows us to estimate life expectancy given the total death counts. The primary use case of the method is in monitoring life expectancy. The mortality shock such as the COVID–19 pandemic clearly demonstrated the necessity of such monitoring since period life expectancy is the best indicator to compare the mortality shock across populations of vastly different age structure.

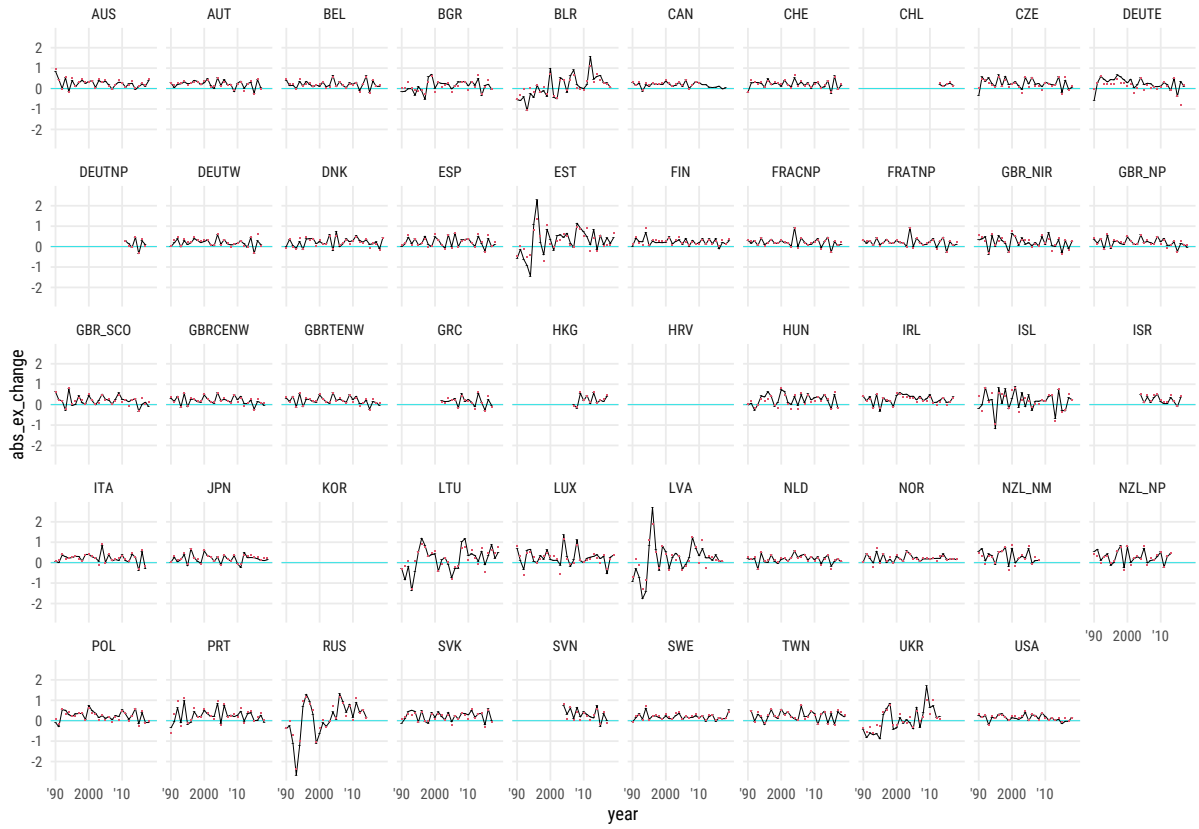


Exploration of the linear relationship between changes in life expectancy at birth and changes in total death tolls – the 2020 values (black dots) are very much on the trend line. The 2020 values are based on the estimations by

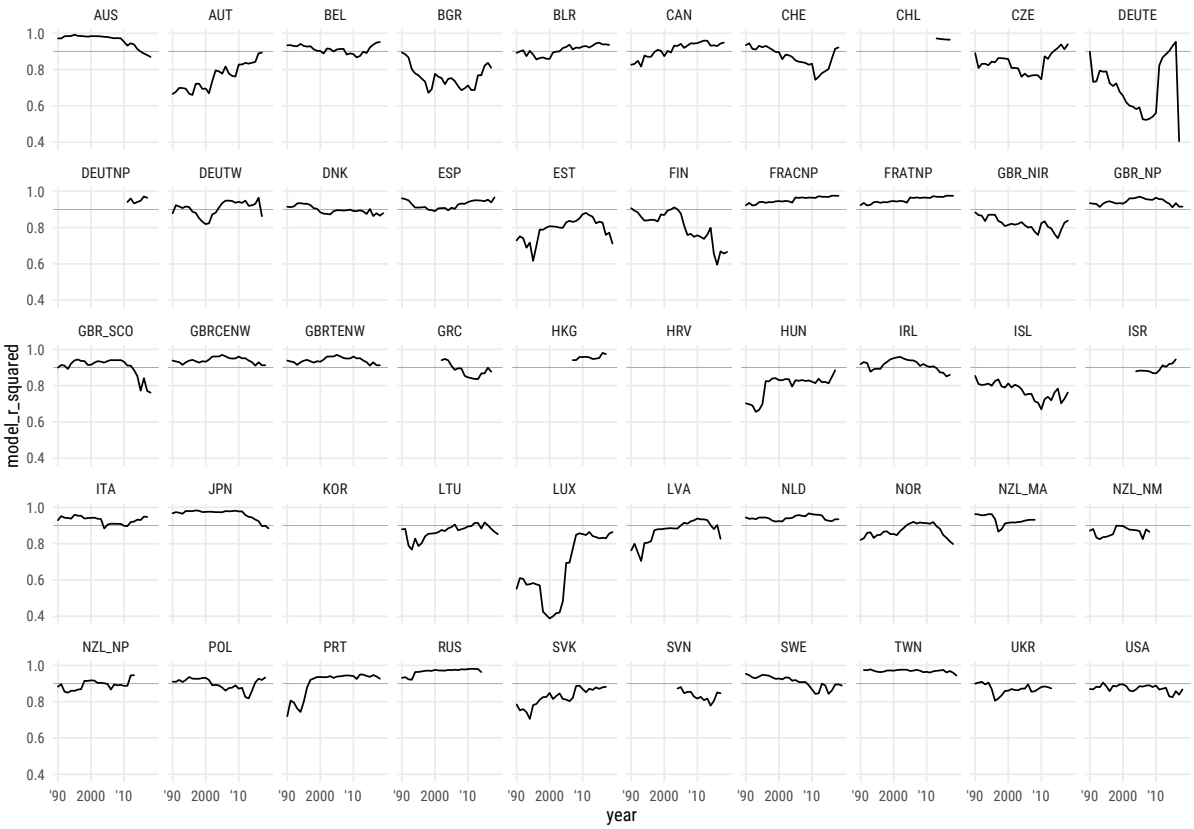
Aburto JM, Schöley J, Kashnitsky I, Zhang L, Rahal C, Missov T, Mills MC, Dowd JB, Kashyap R. 2021. Quantifying impacts of the COVID-19 pandemic through life expectancy losses. *medRxiv*: 2021.03.02.21252772 DOI: 10.1101/2021.03.02.21252772



A similar plot for all population in Human Mortality Database, 20 last years.



Yearly differences in life expectancy at birth: observed (black connected) and predicted (red)



Goodness of fit statistic, R squared, from the linear models based on 20 years of observed differences in life expectancy and death tolls to predict next year life expectancy. Thin blue line marks R^2=0.9. For most of the populations, especially the large ones, the relationship is very strong, see Spain, France, Great Britain, Japan, Russia