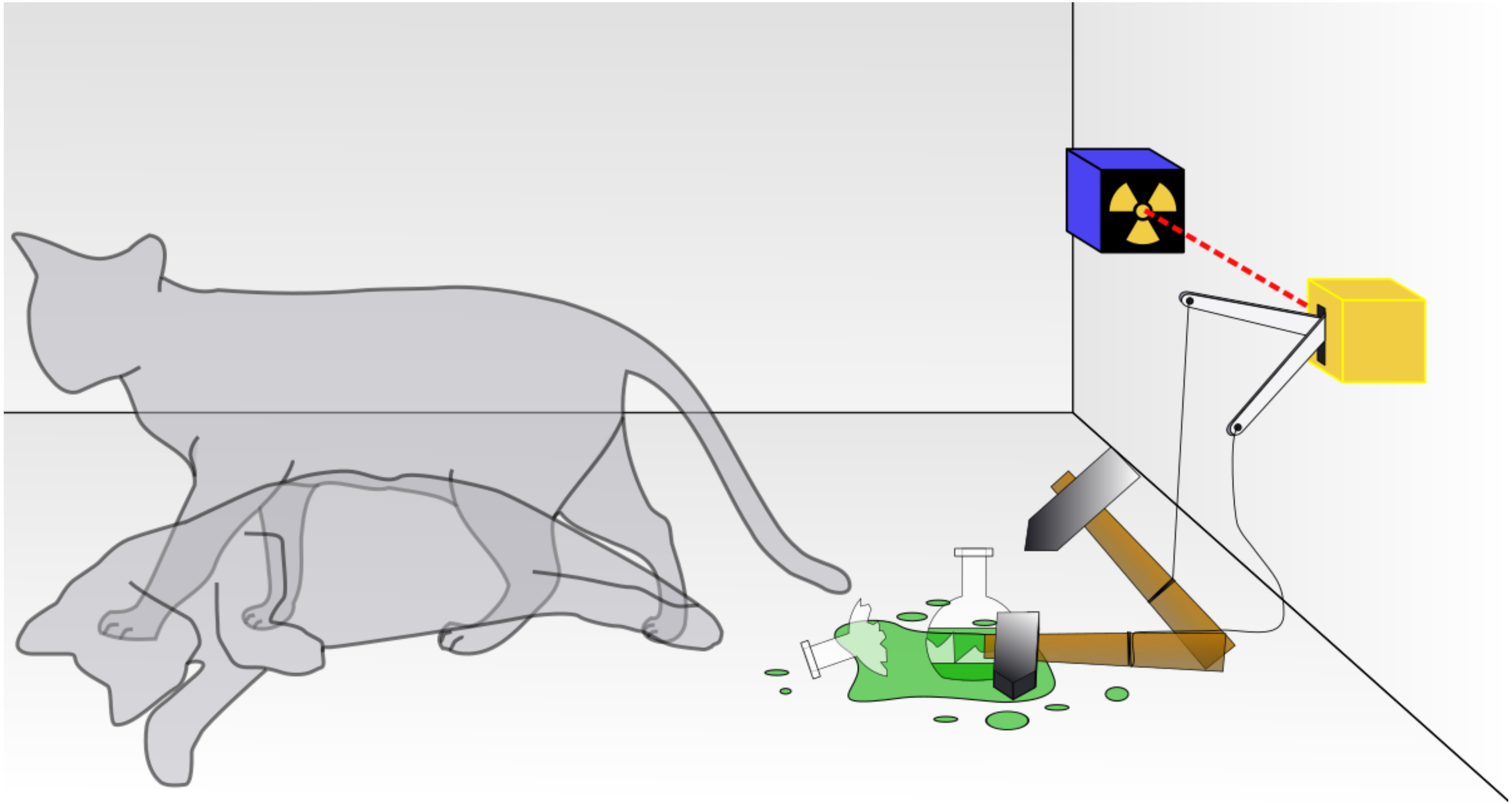
A radically simple way to monitor life expectancy

EAPS Mortality Workshop 2021

Ilya Kashnitsky, *Alexey Raksha, José Manuel Aburto, Jonas Schöley, James Vaupel*

22 September 2021

The current state of the paper



What do I want today?

What do I want today?

What do I want today?

RadioFreeEurope RadioLiberty

A Russian Demographer Questioned Government COVID-19 Numbers. He Was Fired Earlier This Month.

July 13, 2020 16:24 GMT

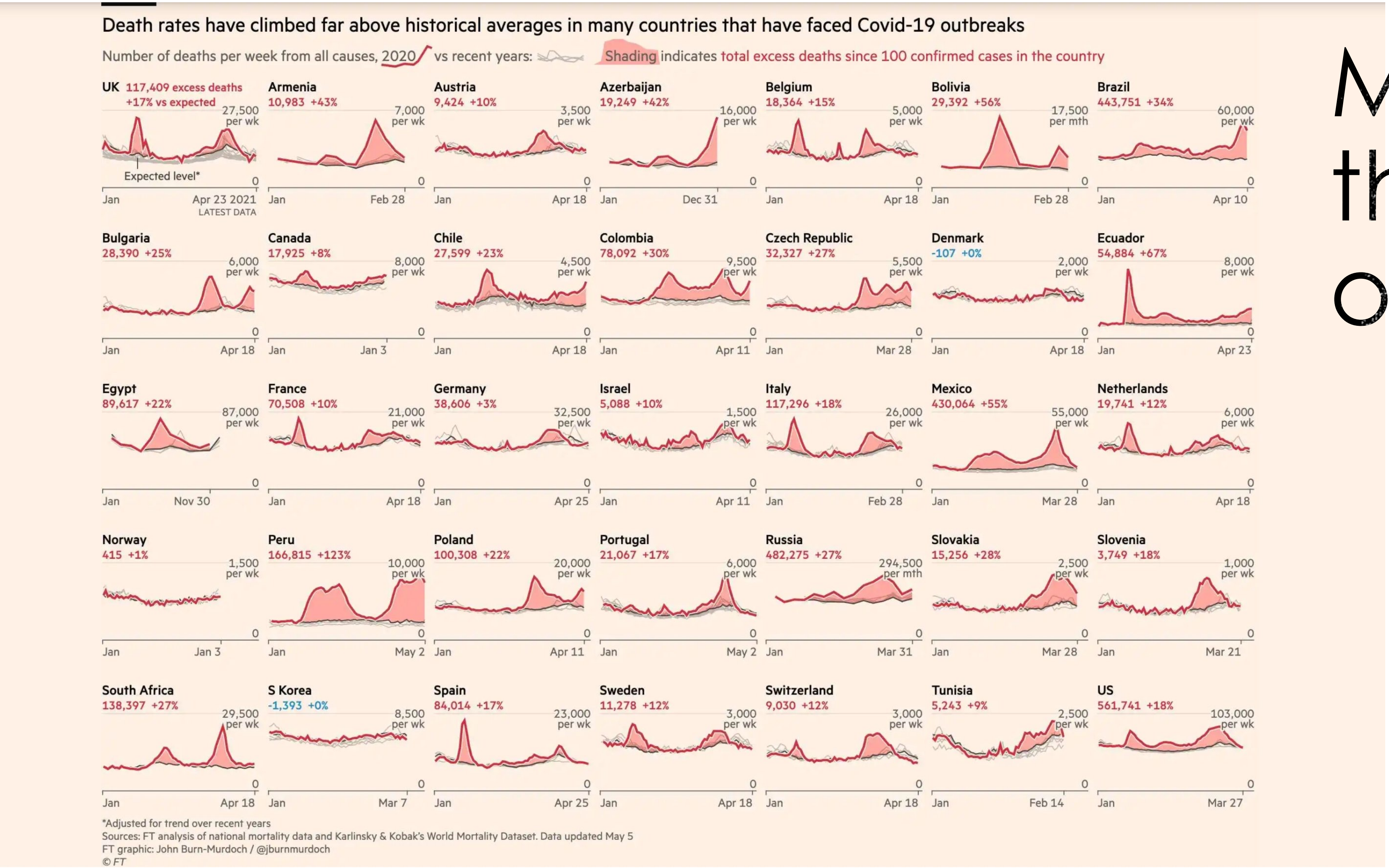
By Mark Krutov Timur Olevsky

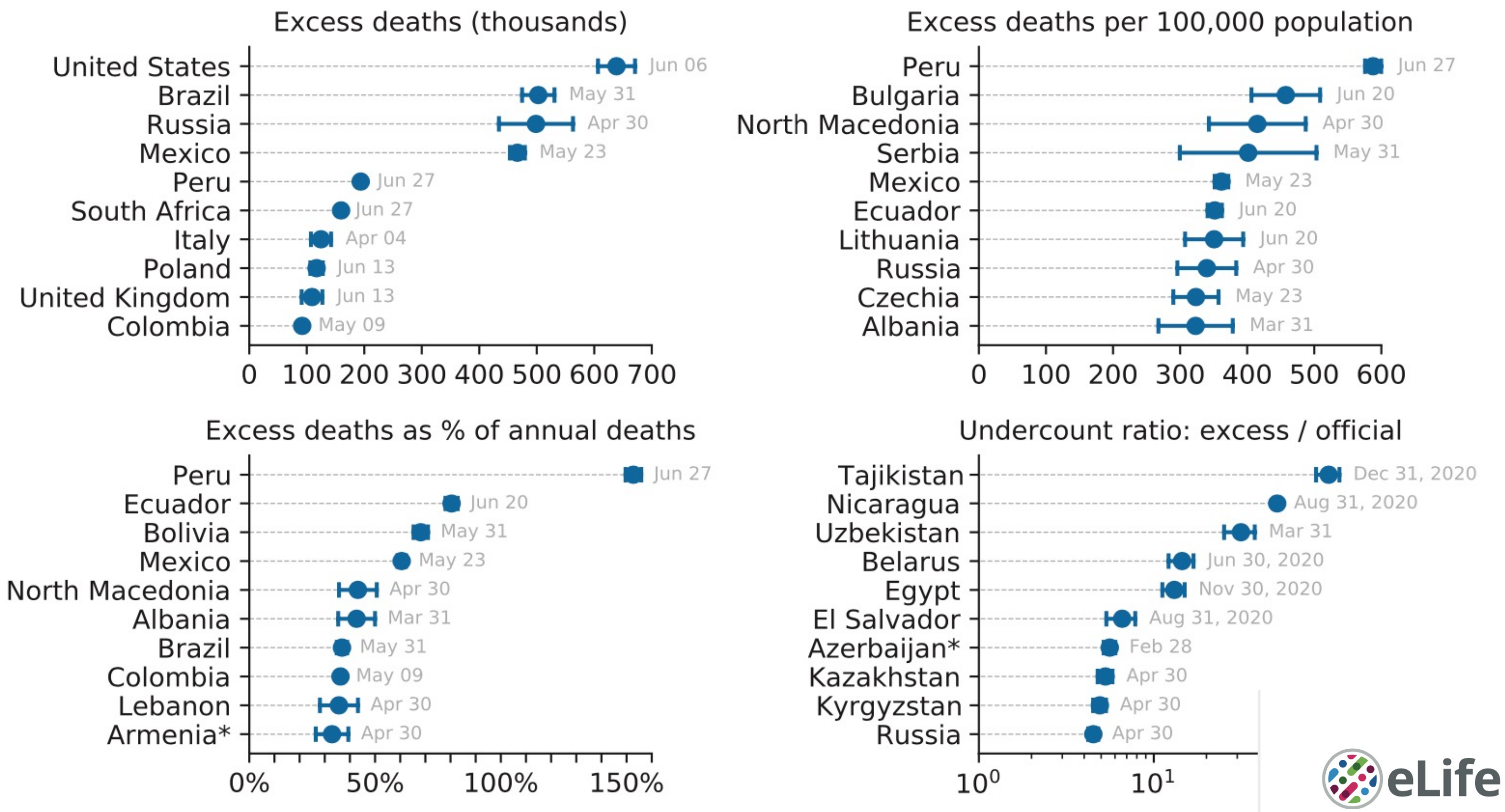
Rusian demographer Aleksei Raksha (file photo)

Initial idea

Alexei Raksha

Measuring the impact of c19





Measuring the impact of c19

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eLife
TOOLS AND RESOURCES

Tracking excess mortality across countries during the COVID-19 pandemic with the World Mortality Dataset

Ariel Karlinsky[1]*, Dmitry Kobak[2]*

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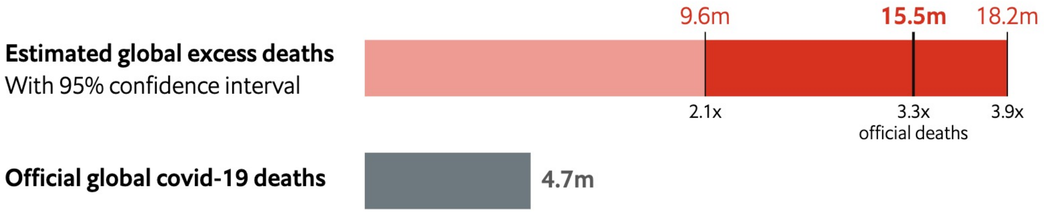

The Economist

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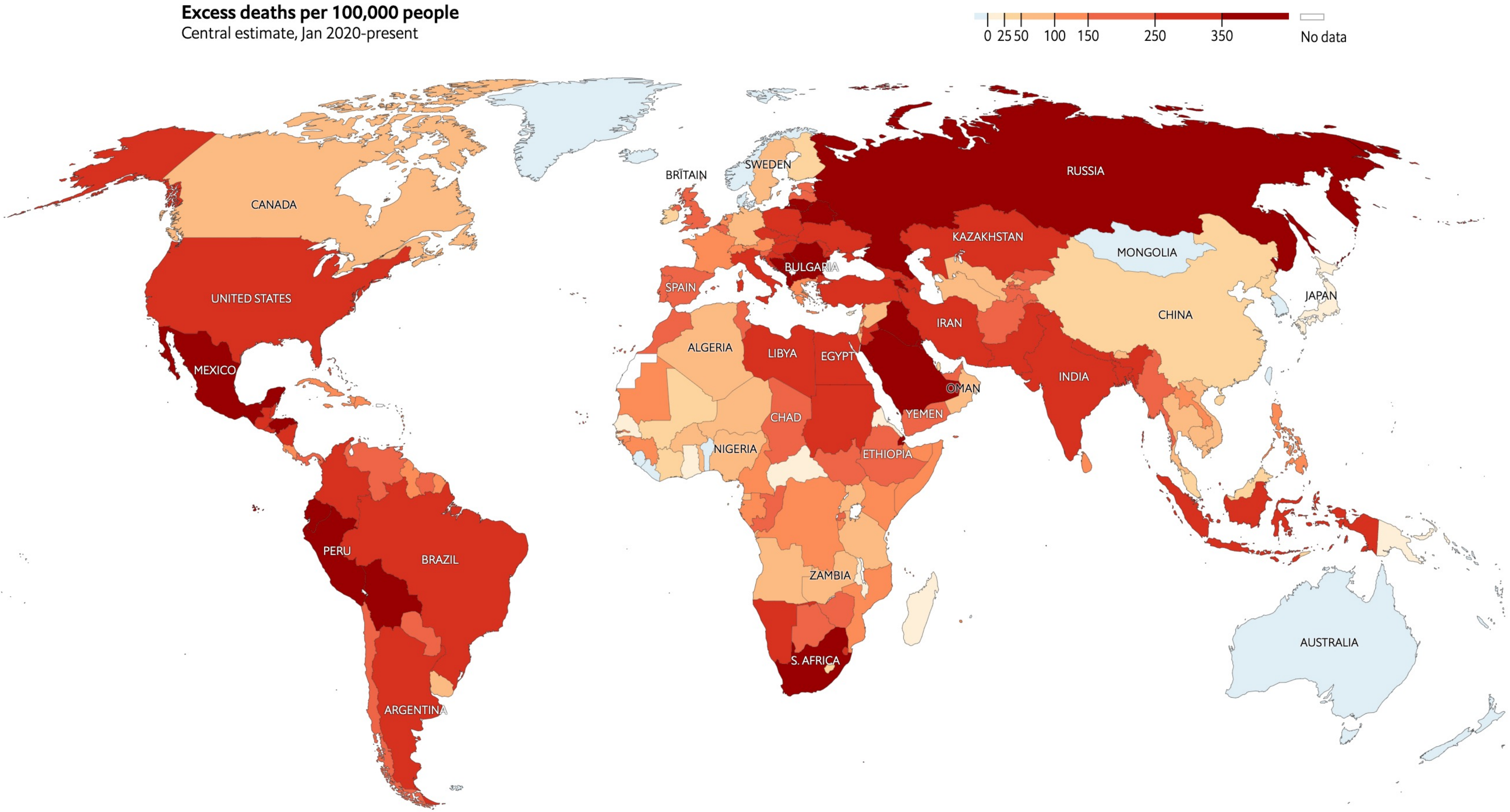
Graphic detail

Covid-19 data

The pandemic's true death toll

f excess deaths around the world



Life expectancy is the ultimate measure of current mortality

Life expectancy is the ultimate measure of current mortality

- Free from population age structure effect
- No need to choose standard
- Widely used

twitter.com/ikashnitsky/status/1367856012548530176

Ilya Kashnitsky @ikashnitsky · Mar 5

Demography 101

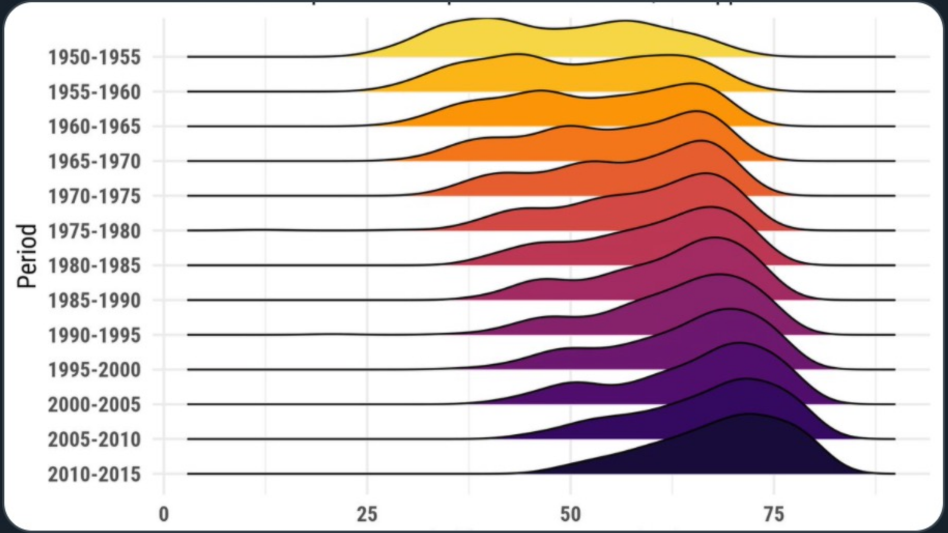
🔥 WHAT IS LIFE EXPECTANCY ? 🔥

and (even more important)

❌ what it isn't ❌

Join in for the most topical demography primer

🧵 THREAD 1/x



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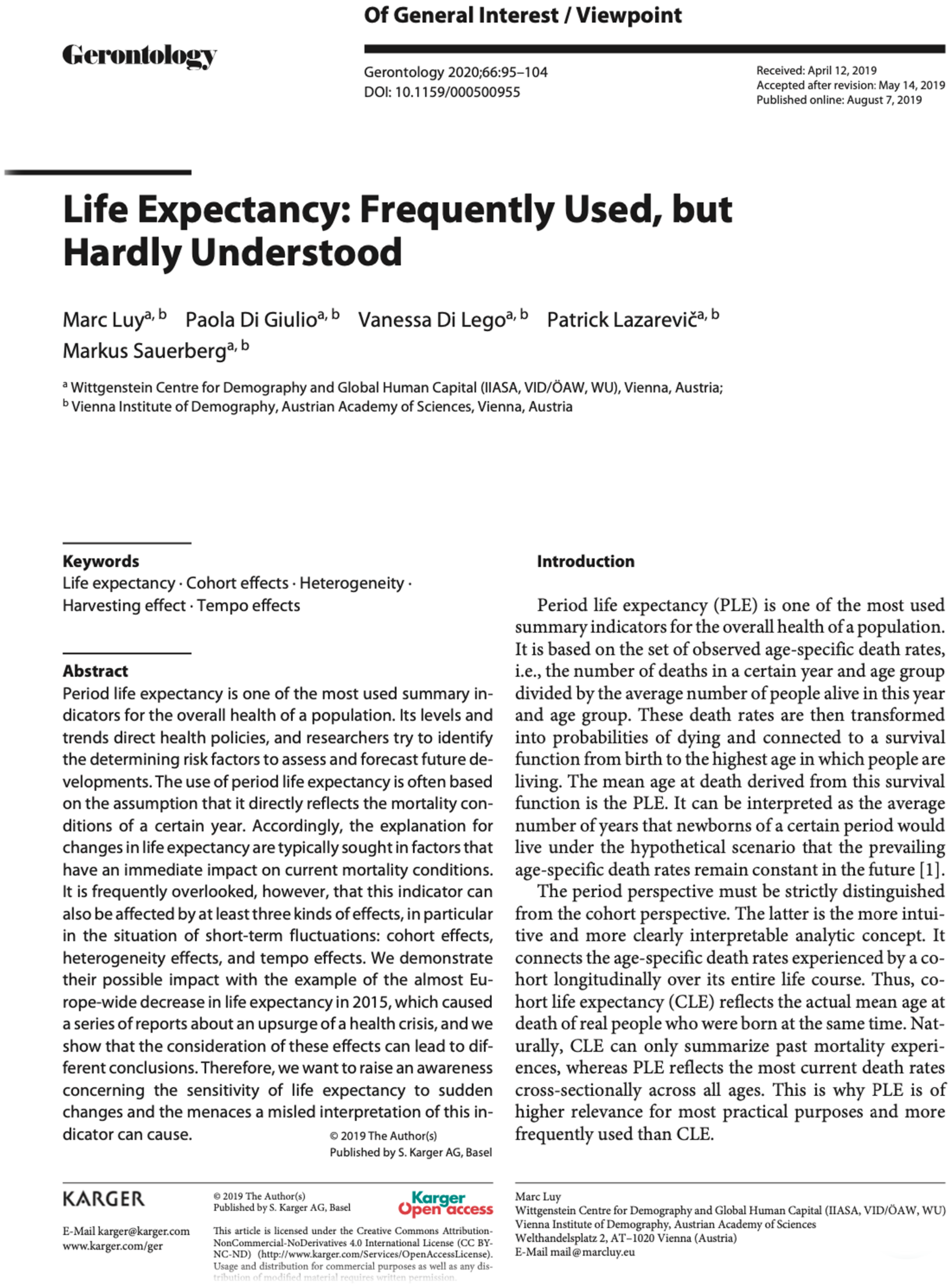
Ilya Kashnitsky
@ikashnitsky

Unlike many statistics and quantities of general use that we tend to see regularly, life expectancy is not observed directly. It's an output of a *mathematical model* called life table.

Life expectancy is the ultimate measure of current mortality

- Free from population age structure effect
- No need to choose standard
- Widely used and misunderstood



Of General Interest / Viewpoint

Gerontology

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Life Expectancy: Frequently Used, but Hardly Understood

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Keywords

Life expectancy · Cohort effects · Heterogeneity · Harvesting effect · Tempo effects

Abstract

Period life expectancy is one of the most used summary indicators for the overall health of a population. Its levels and trends direct health policies, and researchers try to identify the determining risk factors to assess and forecast future developments. The use of period life expectancy is often based on the assumption that it directly reflects the mortality conditions of a certain year. Accordingly, the explanation for changes in life expectancy are typically sought in factors that have an immediate impact on current mortality conditions. It is frequently overlooked, however, that this indicator can also be affected by at least three kinds of effects, in particular in the situation of short-term fluctuations: cohort effects, heterogeneity effects, and tempo effects. We demonstrate their possible impact with the example of the almost Europe-wide decrease in life expectancy in 2015, which caused a series of reports about an upsurge of a health crisis, and we show that the consideration of these effects can lead to different conclusions. Therefore, we want to raise an awareness concerning the sensitivity of life expectancy to sudden changes and the menaces a misled interpretation of this indicator can cause.

Introduction

Period life expectancy (PLE) is one of the most used summary indicators for the overall health of a population. It is based on the set of observed age-specific death rates, i.e., the number of deaths in a certain year and age group divided by the average number of people alive in this year and age group. These death rates are then transformed into probabilities of dying and connected to a survival function from birth to the highest age in which people are living. The mean age at death derived from this survival function is the PLE. It can be interpreted as the average number of years that newborns of a certain period would live under the hypothetical scenario that the prevailing age-specific death rates remain constant in the future [1].

The period perspective must be strictly distinguished from the cohort perspective. The latter is the more intuitive and more clearly interpretable analytic concept. It connects the age-specific death rates experienced by a cohort longitudinally over its entire life course. Thus, cohort life expectancy (CLE) reflects the actual mean age at death of real people who were born at the same time. Naturally, CLE can only summarize past mortality experiences, whereas PLE reflects the most current death rates cross-sectionally across all ages. This is why PLE is of higher relevance for most practical purposes and more frequently used than CLE.

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Life expectancy is the ultimate measure of current mortality

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Демографическое обозрение

электронный научный журнал

ТЕКУЩИЙ ВЫПУСК   АРХИВЫ   ENGLISH SELECTION   АВТОРАМ   О НАС

ГЛАВНАЯ / АРХИВЫ / ТОМ 8 № 2 (2021) / Оригинальные статьи

Действительно ли ожидаемая продолжительность жизни при рождении является наилучшим измерителем уровня смертности населения?

Евгений Михайлович Андреев
Национальный Исследовательский Университет «Высшая Школа Экономики»

PDF

ДЕЙСТВИТЕЛЬНО ЛИ ОЖИДАЕМАЯ ПРОДОЛЖИТЕЛЬНОСТЬ ЖИЗНИ ПРИ РОЖДЕНИИ ЯВЛЯЕТСЯ НАИЛУЧШИМ ИЗМЕРИТЕЛЕМ УРОВНЯ СМЕРТНОСТИ НАСЕЛЕНИЯ?

Евгений Андреев

Принято считать, что наиболее адекватной характеристикой уровня смертности населения в некоторый период времени является показатель «ожидаемая продолжительность жизни при рождении» (ОПЖ). Данный показатель имеет серьезные недостатки, а подобный выбор создает ряд неоправданных трудностей. Главный недостаток – метод расчета ОПЖ до сих пор не унифицирован и, скорее всего, унифицирован быть не может. В силу этого ОПЖ для разных стран и периодов могут быть несравнимы. Данные международной Human Life-Table Database позволяют утверждать, что часто при сравнениях нельзя использовать первый десятичный знак.

Определение ОПЖ требует расчета таблиц смертности для условного поколения календарного периода. Когда уровень смертности быстро снижается, как это происходит в большинстве стран с середины XX века, таблицы смертности условного поколения мало что говорят о возрастных закономерностях смертности когорт, но, скорее, формируют ложные впечатления. Подсчет числа человек в условном поколении, которые доживают или не доживают до некоторого возраста, не имеет отношения ни к какой реальной совокупности. Лишь расчет ОПЖ оправдывает построение таблиц смертности.

Переход от возрастных показателей смертности к ОПЖ описывается не формулой, а вычислительной процедурой. Это создает серьезные трудности при попытках оценить влияние на ОПЖ смертности отдельных возрастов, от отдельных причин смерти, в отдельных регионах и группах населения.

Всеми этими недостатками не обладает стандартизованный коэффициент смертности (СКС), расчет которого становится безальтернативным, как только задано стандартное население. Данные Human Mortality Database (Demographic Research 2021) позволили показать, что оценка уровня смертности с помощью СКС почти совпадает с оценкой на основе ОПЖ.

СКС – линейная функция возрастных коэффициентов смертности, поэтому расчет влияния смертности отдельных возрастов, причин смерти, смертности регионов или групп населения на СКС осуществить несложно.

Непрофессионалы воспринимают ОПЖ на интуитивном уровне как длительность человеческой жизни, что, скорее, недостаток показателя. Использование СКС требует больше объяснений. Но в практических исследованиях и в профессиональных публикациях ориентация на СКС облегчит работу и защитит от необоснованных эмоций.

Ключевые слова: *смертность, ожидаемая продолжительность жизни, стандартизованный коэффициент смертности, уровень смертности.*

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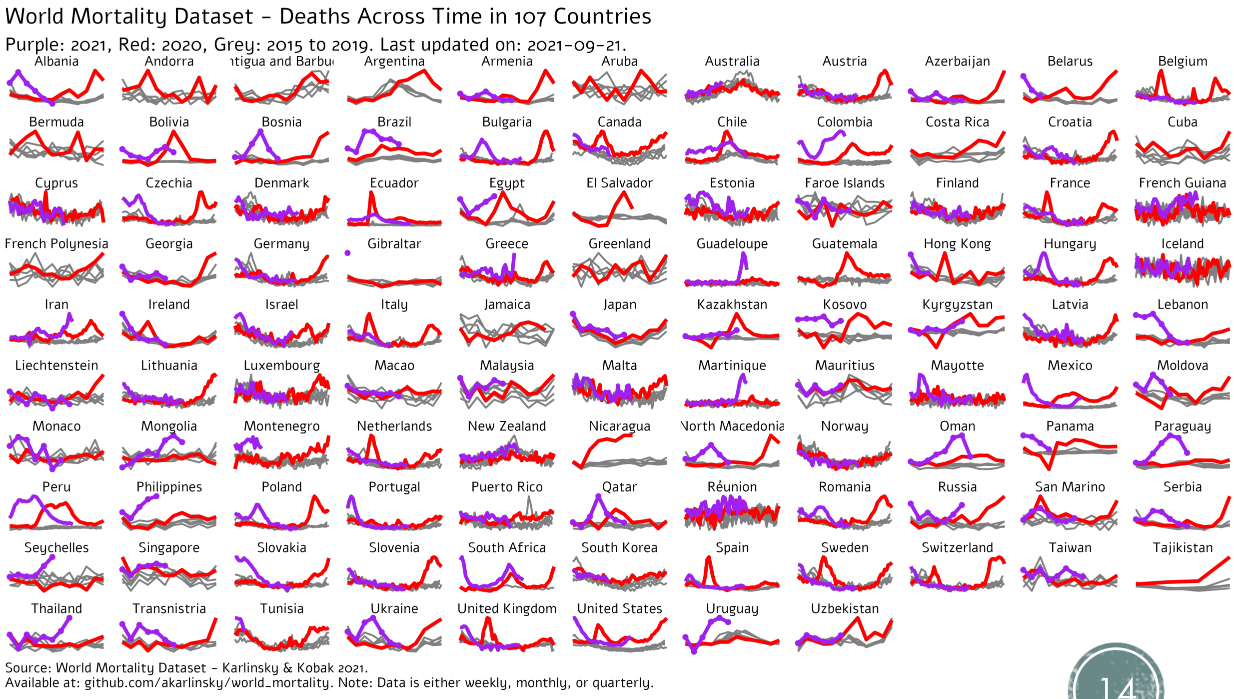
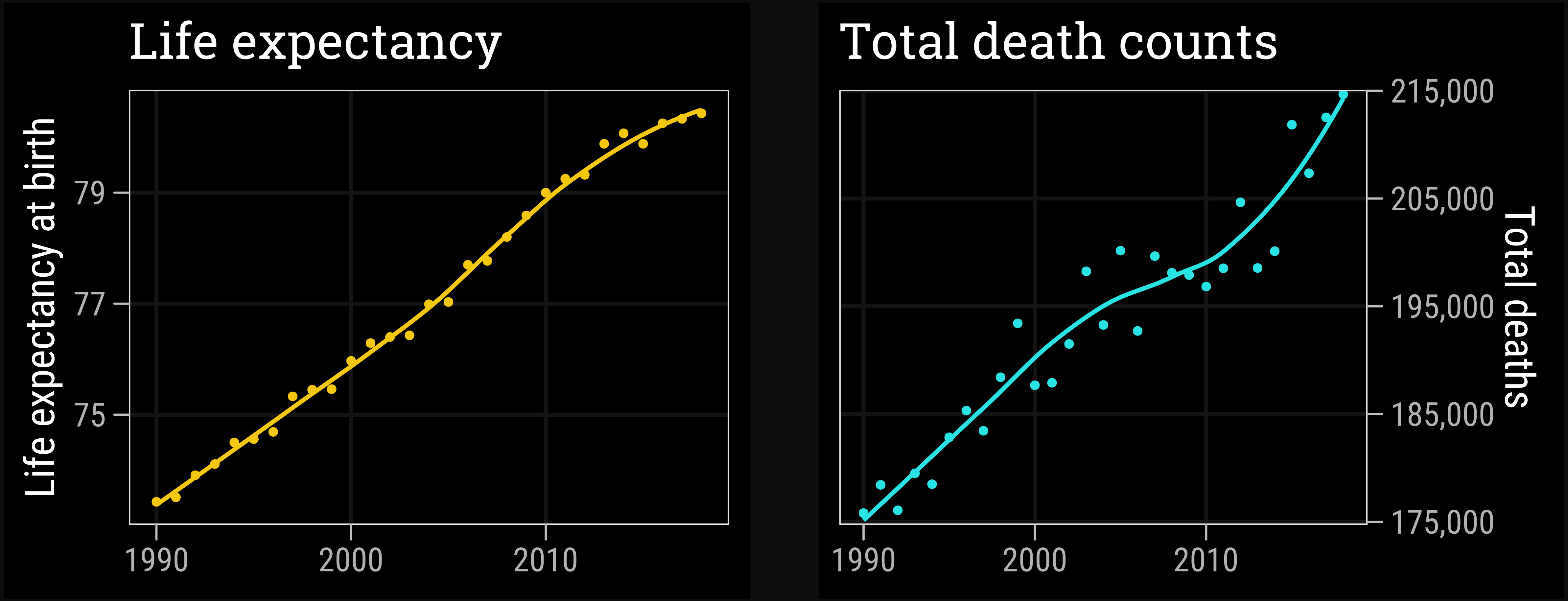
Initial idea

Life expectancy can be **accurately** approximated with just **its own time series** and the **change in total death count**

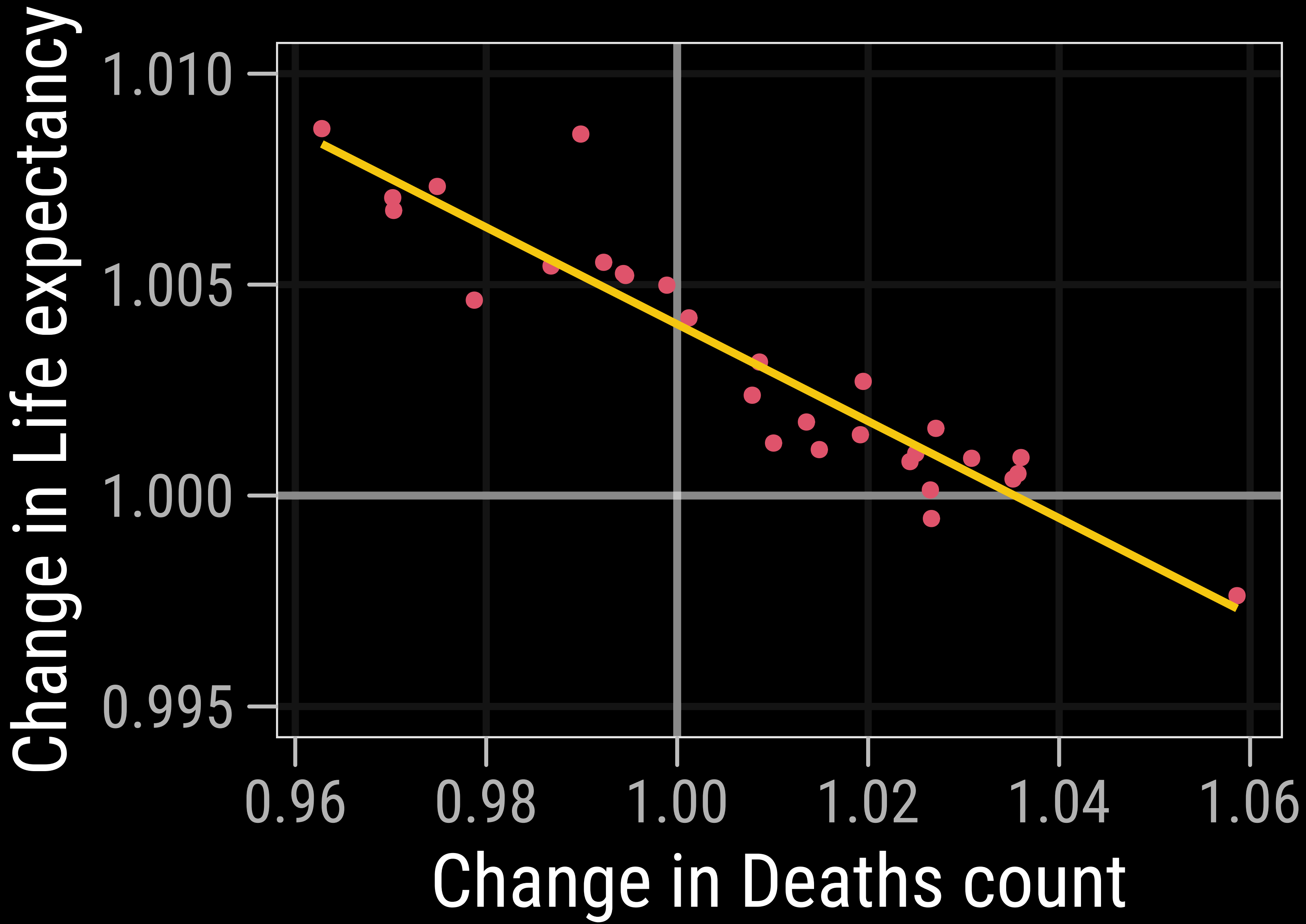
using a linear model





One country example: Spain, males

Linear fit



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Change in Life expectancy
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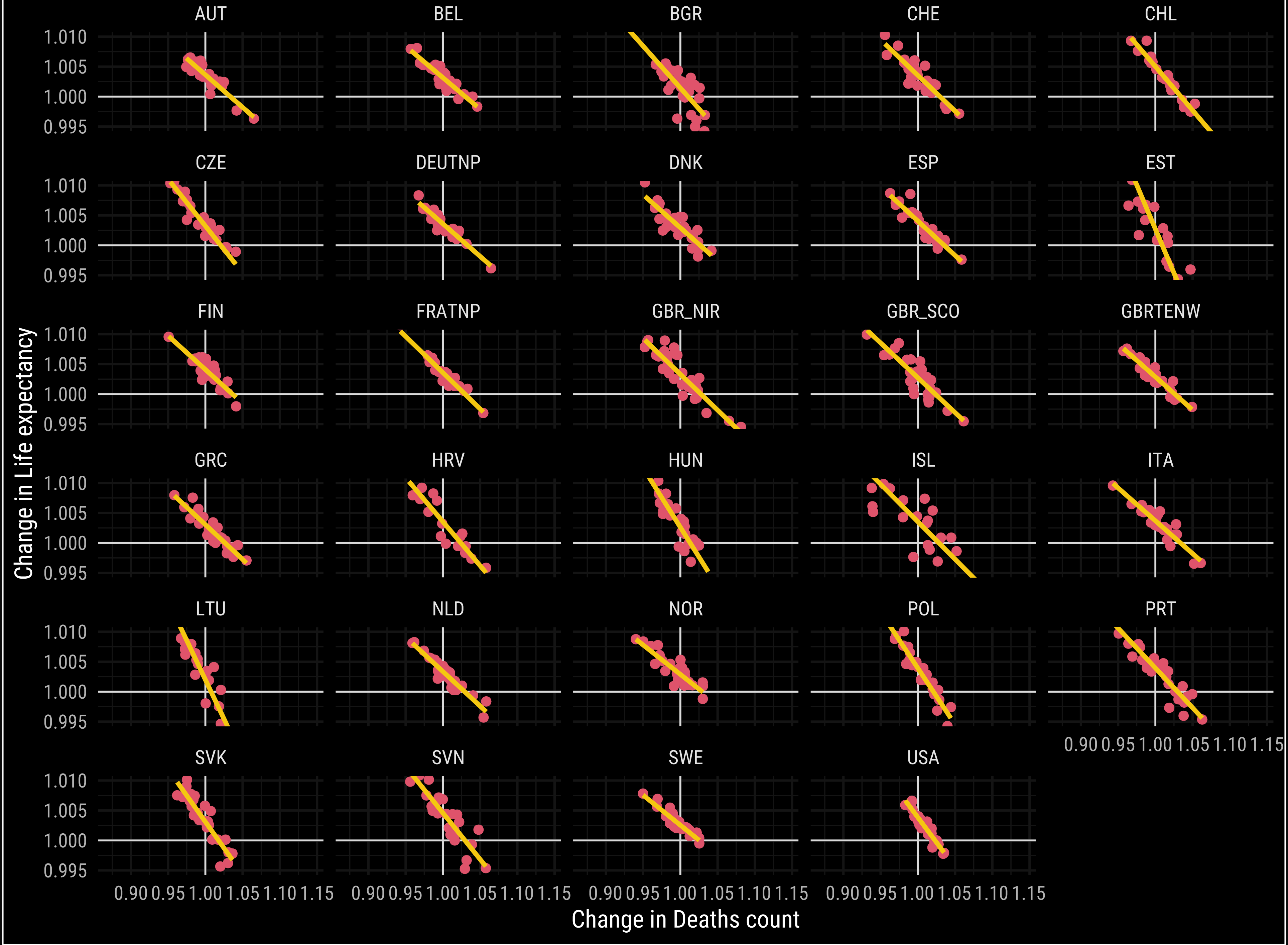
Change in Deaths count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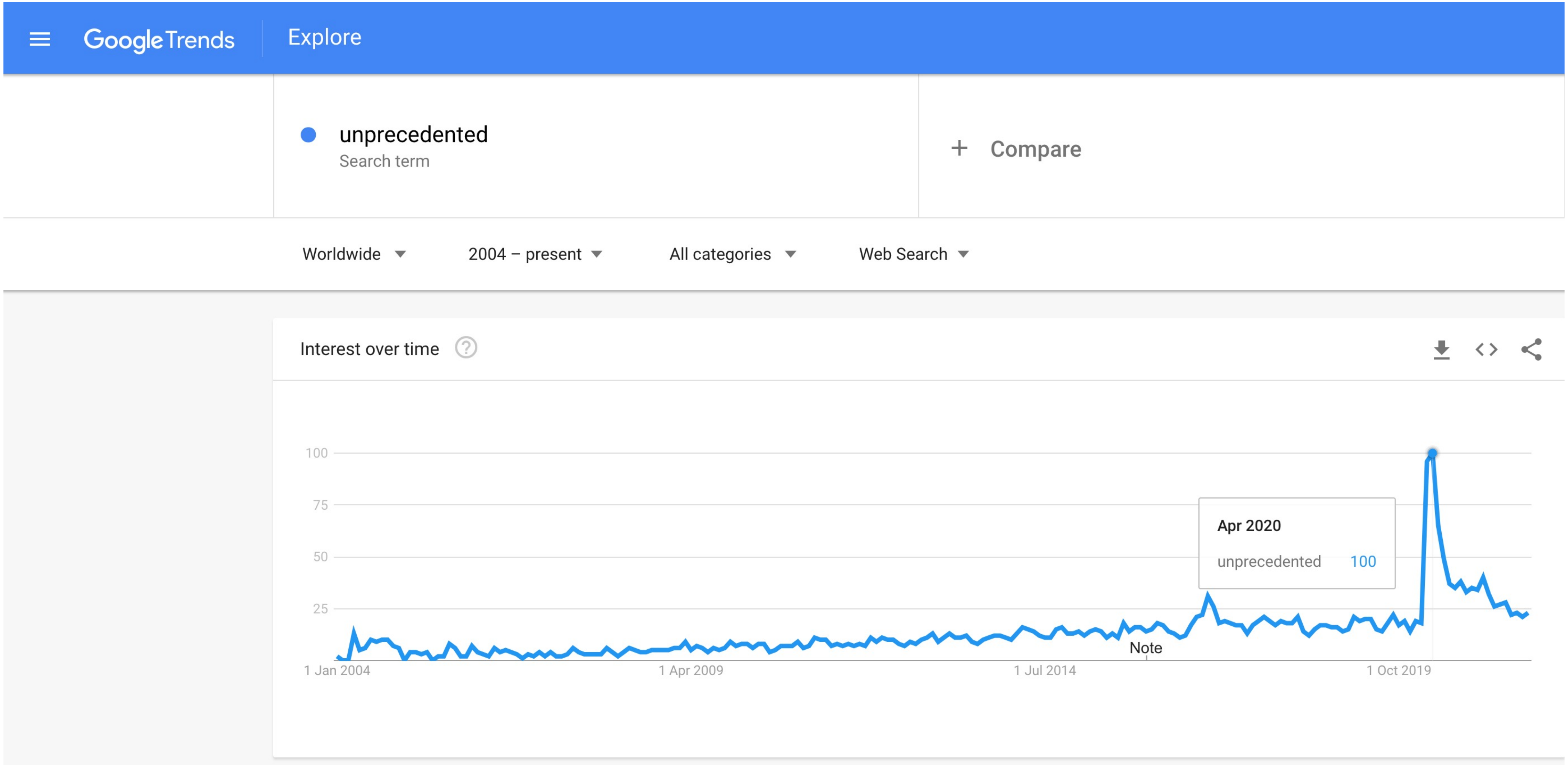
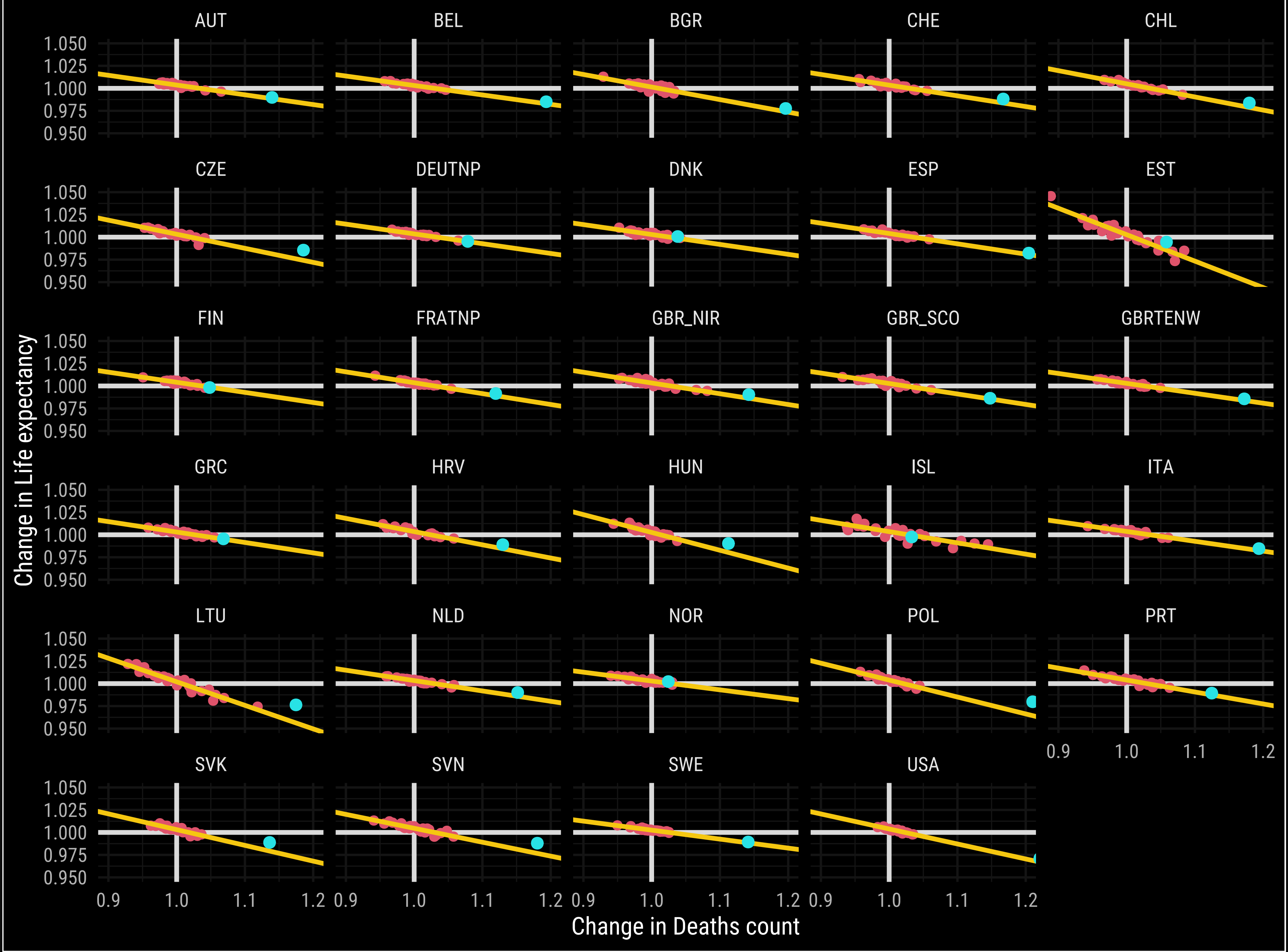
Change in Life expectancy
Change in Deaths count

What about 2020?





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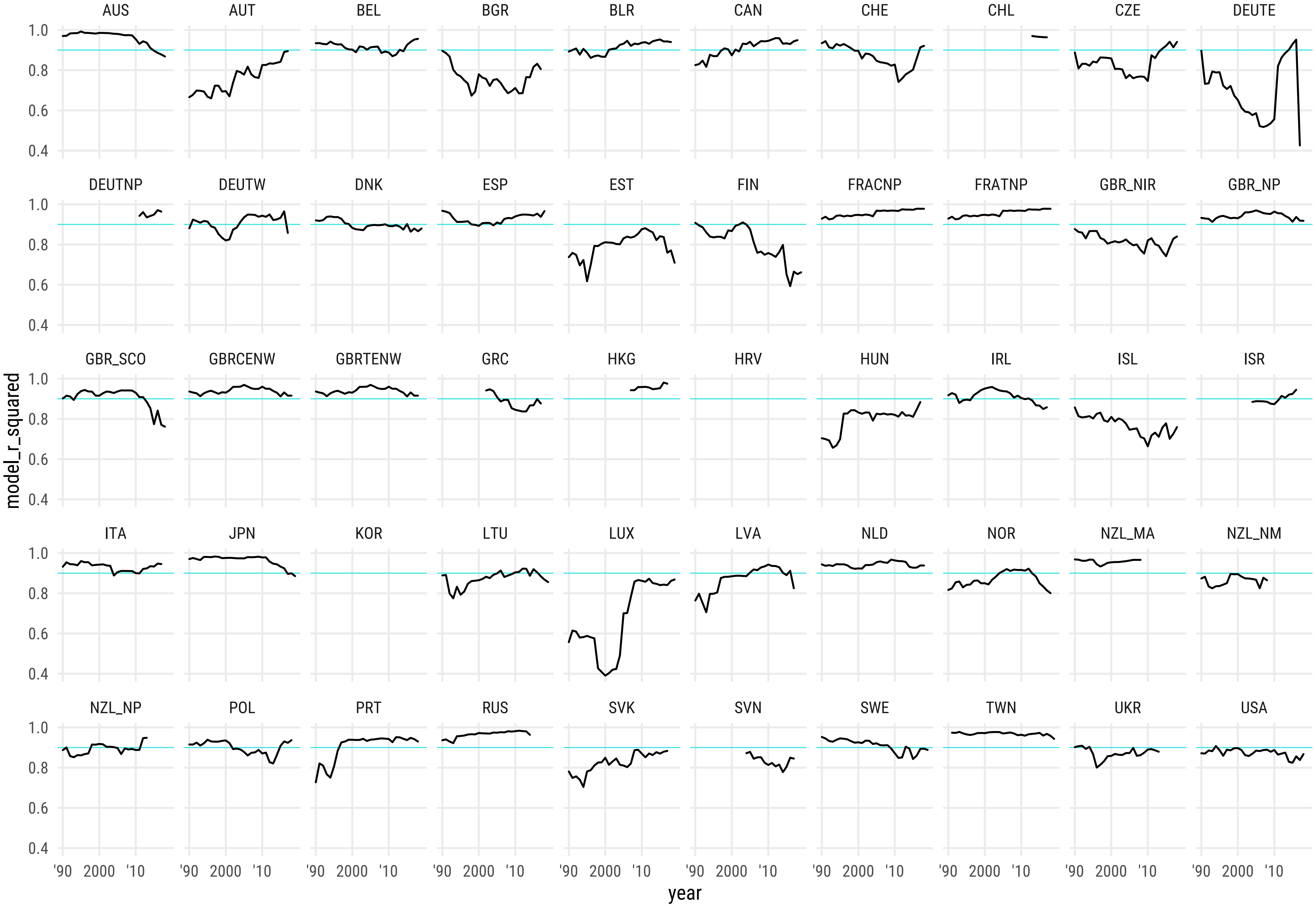
Change in Life expectancy
Change in Deaths count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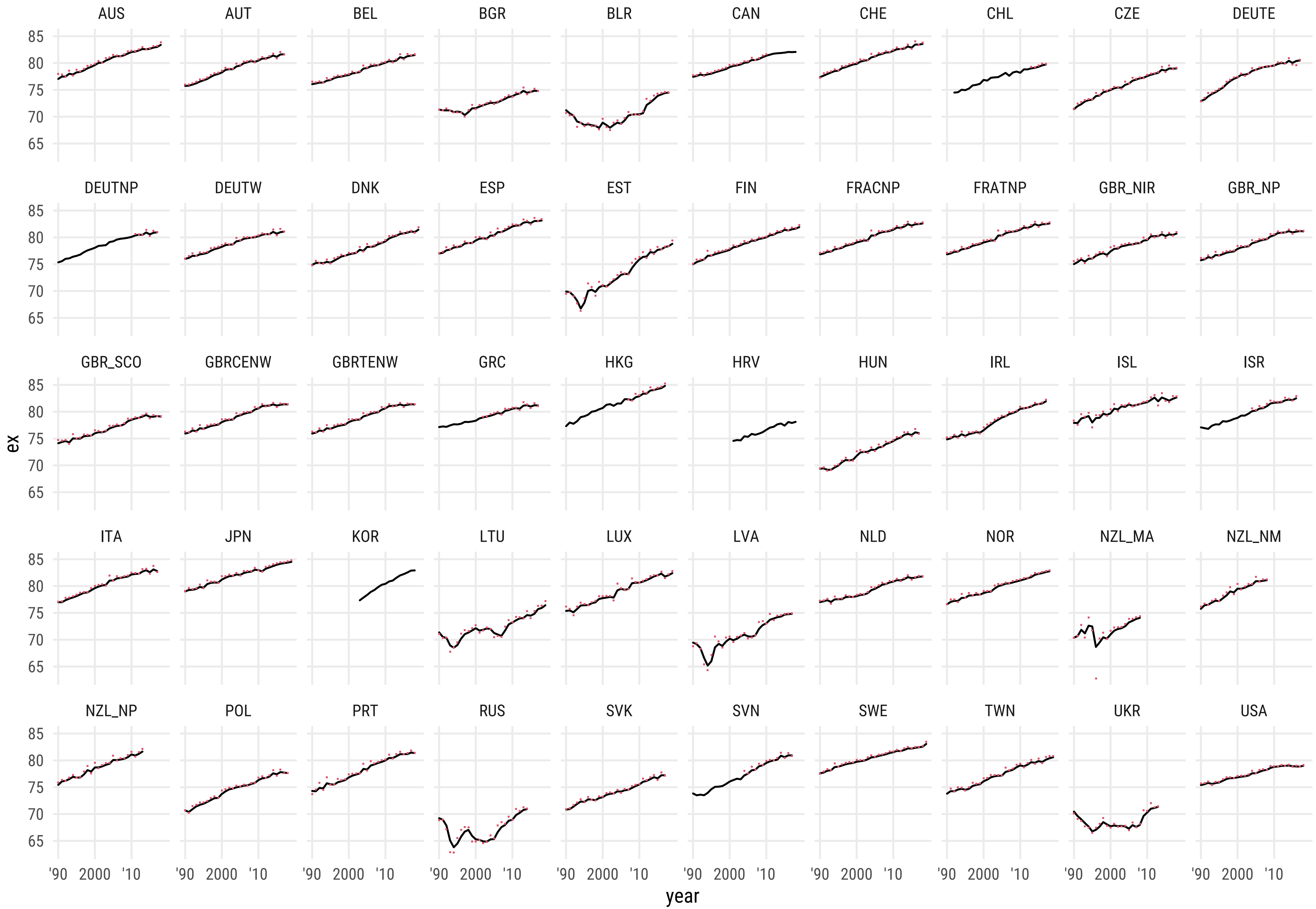

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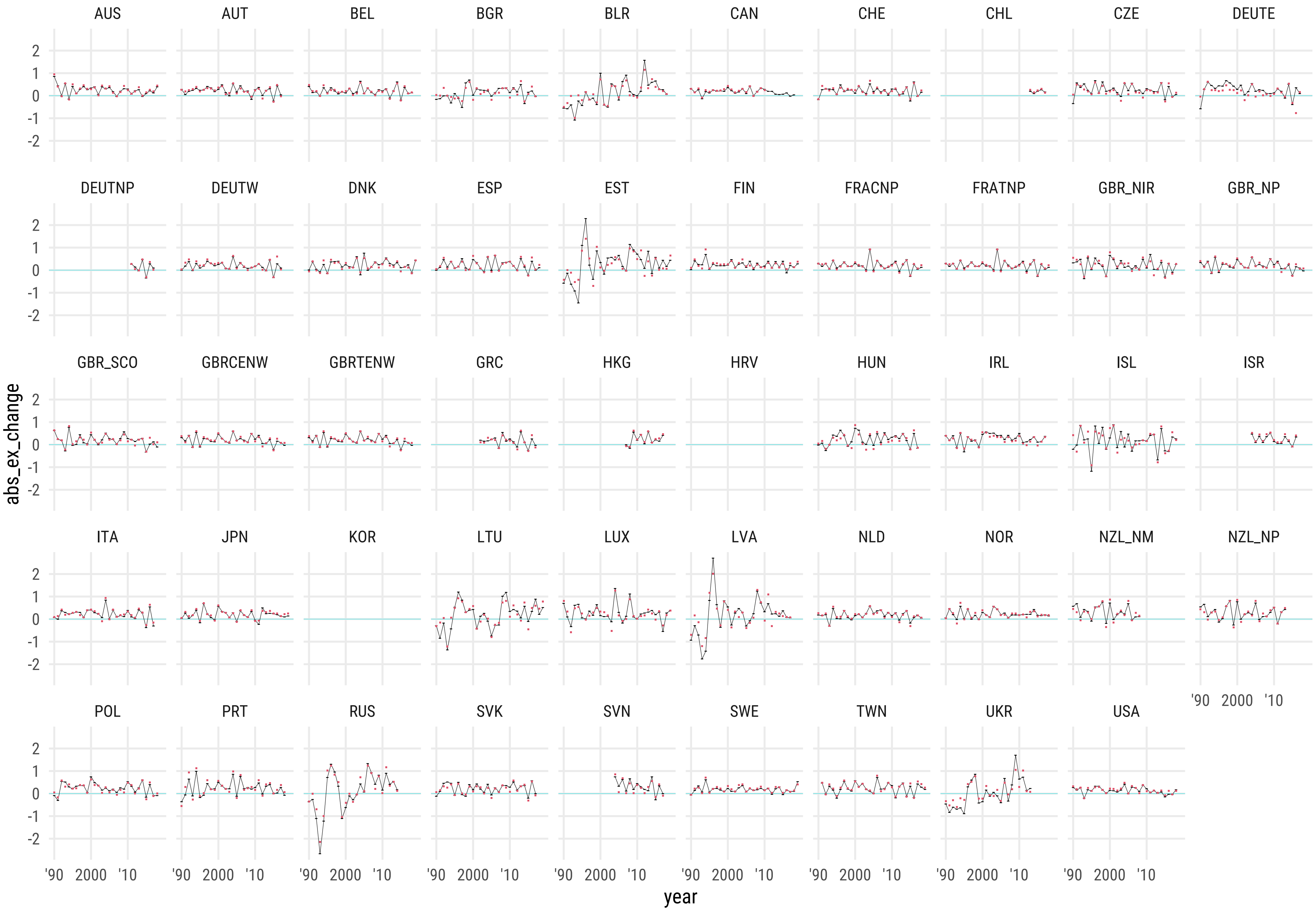
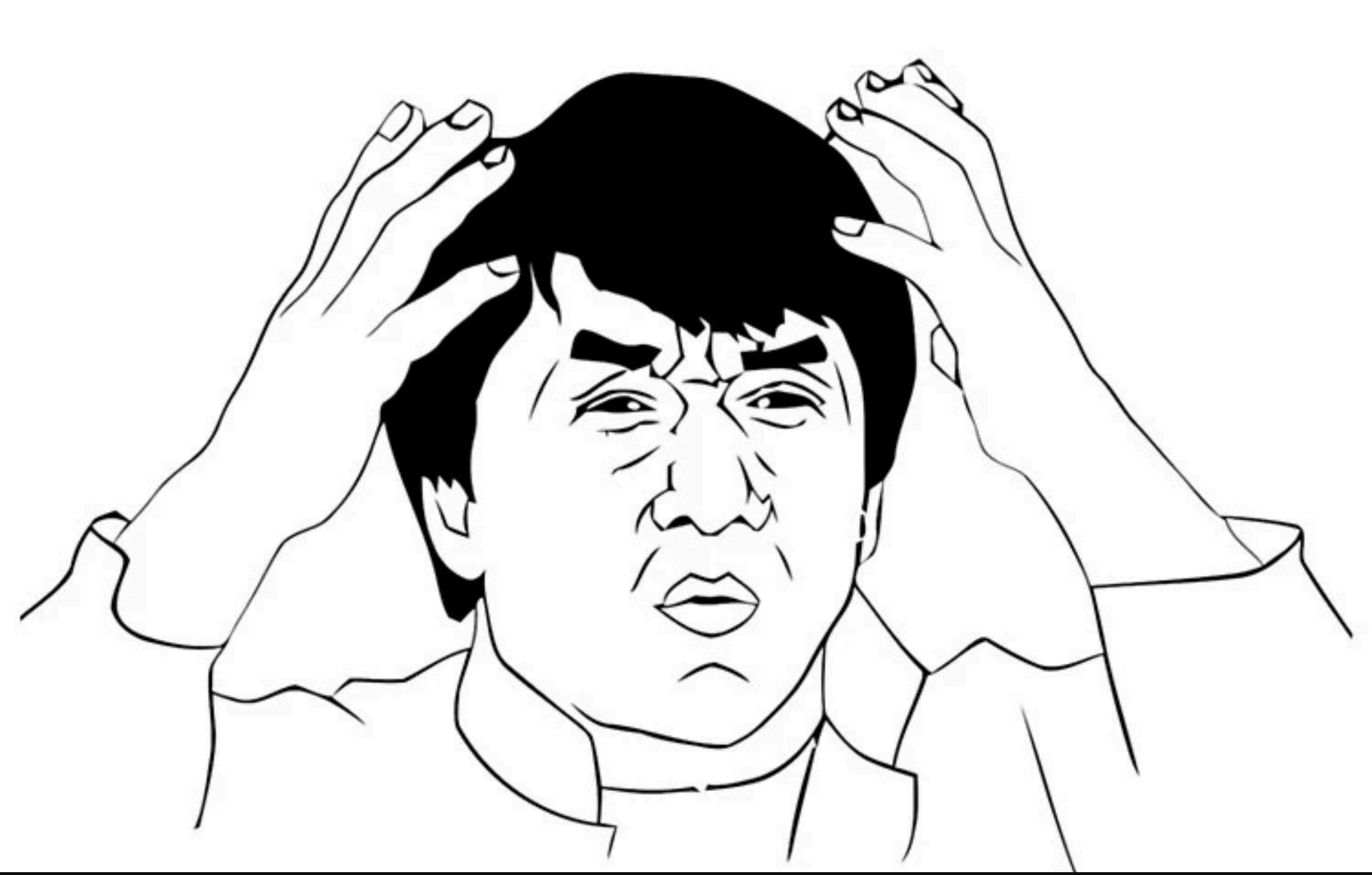
Are we close?

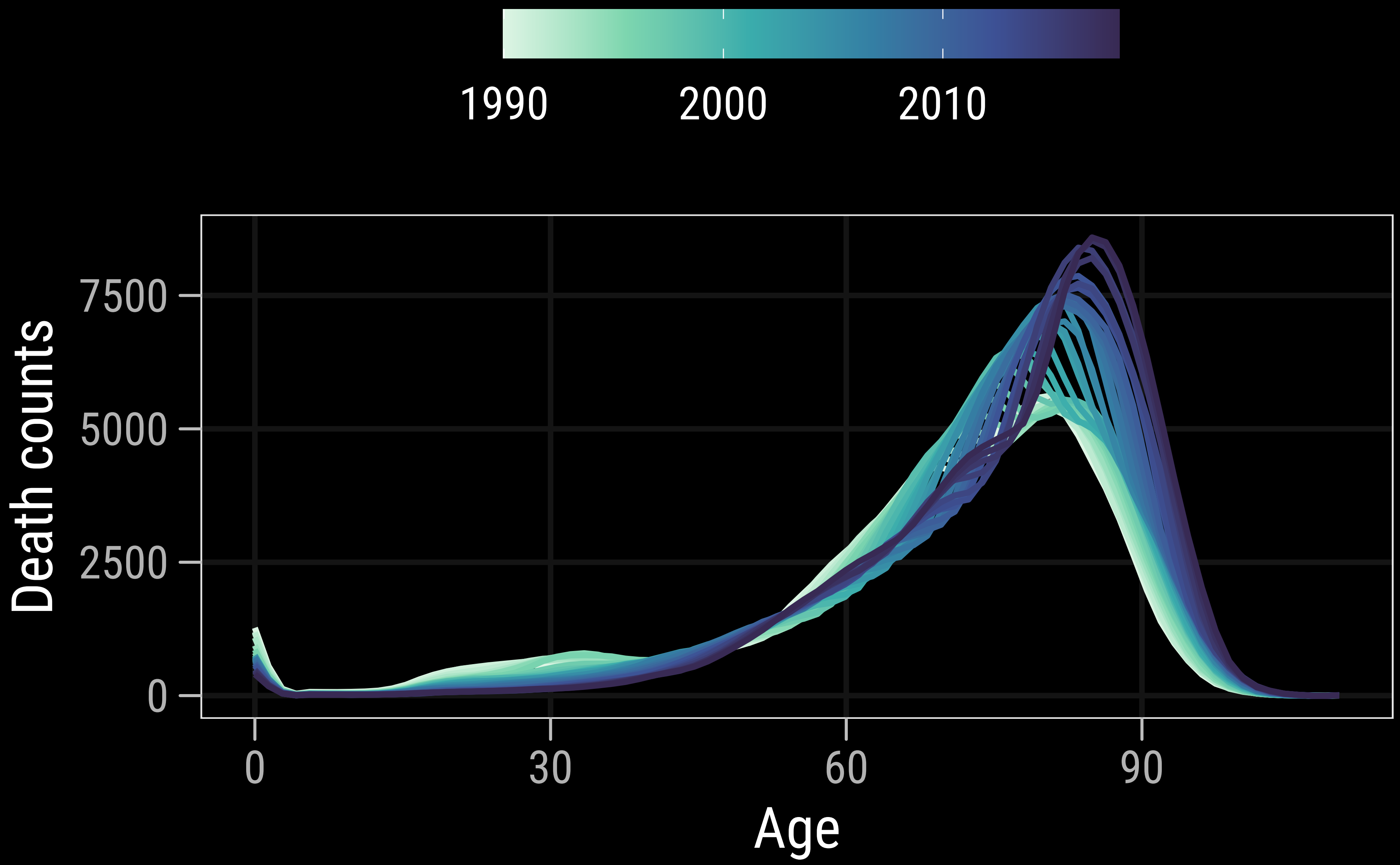


Absolute changes and errors

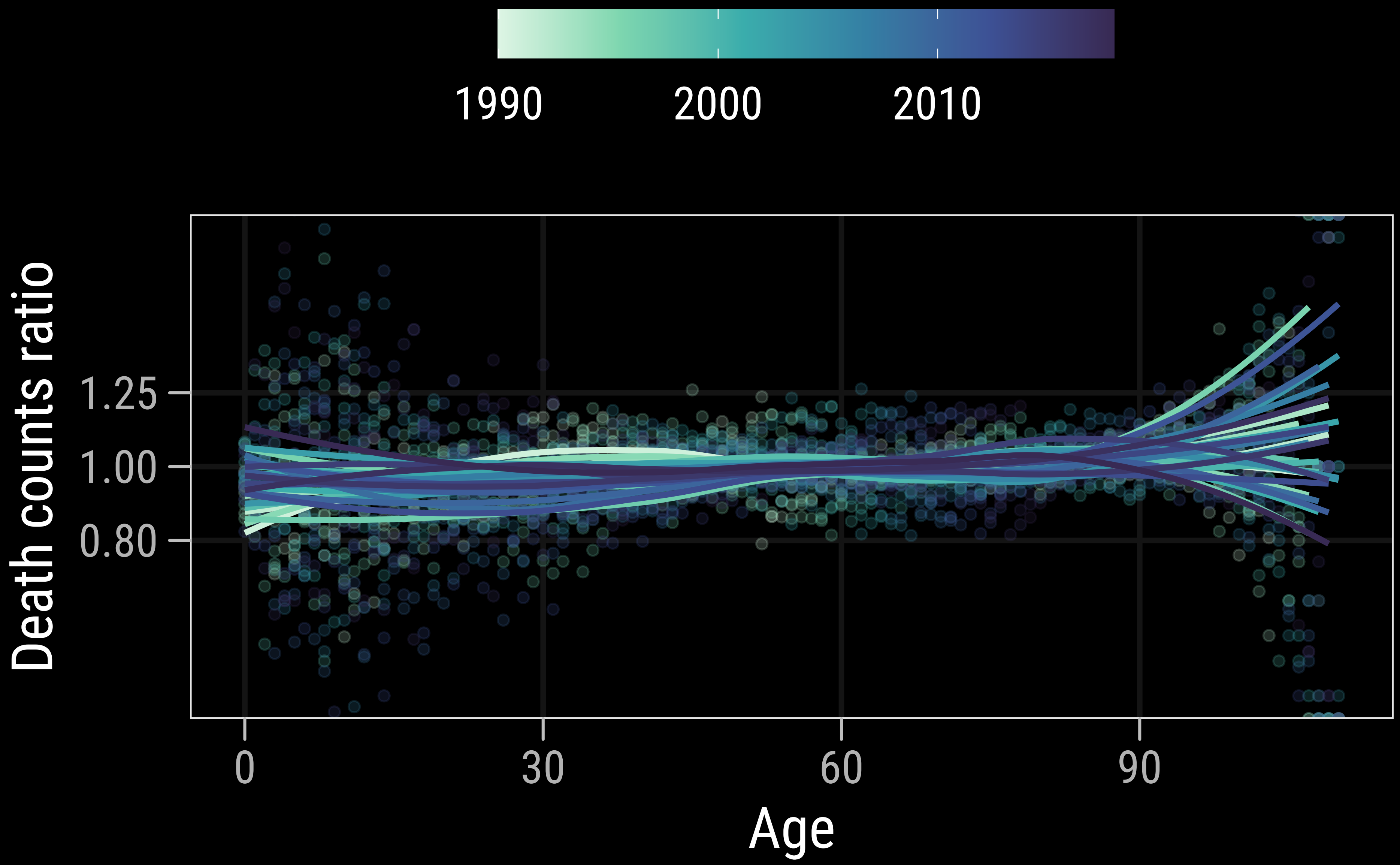
Why does it work?



Spain



Spain



Keyfitz's H

doi.org/10.1073/pnas.2006392117

Demographic perspectives on the mortality of COVID-19 and other epidemics

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Edited by Douglas S. Massey, Princeton University, Princeton, NJ, and approved July 31, 2020 (received for review April 7, 2020)

To put estimates of COVID-19 mortality into perspective, we estimate age-specific mortality for an epidemic claiming for illustrative purposes 1 million US lives, with results approximately scalable over a broad range of deaths. We calculate the impact on period life expectancy (down 2.94 y) and remaining life years (11.7 y per death). Avoiding 1.75 million deaths or 20.5 trillion person years of life lost would be valued at $10.2 to $17.5 trillion. The age patterns of COVID-19 mortality in other countries are quite similar and increase at rates close to each country's rate for all-cause mortality. The scenario of 1 million COVID-19 deaths is similar in scale to that of the decades-long HIV/AIDS and opioid-overdose epidemics but considerably smaller than that of the Spanish flu of 1918. Unlike HIV/AIDS and opioid epidemics, the COVID-19 deaths are concentrated in a period of months rather than spread out over decades.

COVID-19 | epidemic | mortality | demography | life expectancy

August 29 (1). The prospect of subsequent and afterward is uncertain. Earlier projections tality suggested that deaths could total mor if nothing were done to slow the spread of navirus (2). For illustrative purposes we use scenario of 1 million deaths in 2020 due direc across all waves, at times comparing it to a 250,000 and a higher one of 2 million. The m scale approximately proportionately with the so readers can translate our results under d scenarios.

The age pattern we use in this paper does no rect increase in deaths as healthcare systems ar the long-term effect of infection on the mortality of survivors. It also does not take into account any potential lowering of mortality, for example, from decreased air pollution, traffic accidents, and consumption of alcohol resulting from the economic slowdown. These effects may be important, but the age pattern of these changes might be quite different

SOCIAL SCIENCES

Materials and Methods

Mathematical Models.

Keyfitz's result for life table entropy. Life expectancy at age 0 y is computed as the sum of expected person years of survival of a newborn:

$$e(0) = \int_0^\omega \ell(x)\,dx.$$

Survival $\ell(x)$ is given in terms of the hazard of death $m(a)$ as

$$\ell(x) = e^{-\int_0^x m(a)\,da}. \qquad [1]$$

A population subject to a new cause of mortality that increases death rates at all ages by Δ, such that $m(x|\Delta) = m(x)(1+\Delta)$, will have life expectancy given by

$$e(0|\Delta) = \int \ell(x)^{1+\Delta}\,dx.$$

Differentiating the logarithm of life expectancy with respect to Δ,

$$\frac{d \log e(0|\Delta)}{d\Delta} = \frac{\int \log \ell(x)\ell(x)^{1+\Delta}\,dx}{\int \log \ell(x)^{1+\Delta}\,dx}.$$

At $\Delta = 0$, this simplifies to

$$\left.\frac{d \log e(0|\Delta)}{d\Delta}\right|_{\Delta=0} = \frac{\int \log \ell(x)\ell(x)\,dx}{e(0)}.$$

Keyfitz defines H as $-\int \log \ell(x)\ell(x)\,dx / e(0)$. Some further manipulation gives us the form for H in terms of remaining life expectancy:

$$H = \frac{\int d(x)e(x)\,dx}{e(0)}. \qquad [2]$$

Thank you!

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