Patterns of excess mortality and life expectancy losses across developed countries

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This presentation includes research results from studies co-authored with:

International Conference “New Challenges of Demographic, Epidemiological and Medical-Technological Development”. The Human Capital Multidisciplinary Research Center. HSE University

15 December 2021
Excess mortality: method for measuring mortality impacts of epidemics
Influenza: deaths “from” or deaths “with”

Influenza deaths in England, 2016-2017 season

From earlier presentation by Danilova, Shkolnikov, Jdanov. HSE Webinar: COVID-19: Quantification
Cases of COVID-19 vs. deaths from COVID-19 across countries

Total confirmed COVID-19 cases vs. deaths per million, May 25, 2021

Both measures are expressed per million people of the country's population. The confirmed counts are lower than the totals. The main reason for this is limited testing.

Source: Johns Hopkins University CSSE COVID-19 Data – Last updated 26 May, 09:03 (London time)  OurWorldInData.org/coronavirus • CC BY

Shkalnikov V.M. Principal patterns of excess mortality and life expectancy losses across developed countries. HSE, 15 December 2021
Problems with data on causes of death

• It has been known since the 1970s that influenza and respiratory diseases always constitute a minor part of winter mortality elevations during influenza epidemics. This completely agrees with the WHO rules for diagnostics and coding of underlying (main) cause of death.

• During the COVID-19 pandemic, registration of the disease as the underlying COD has been greatly varying across countries and time. To increase completeness of registration of SARS-CoV2 related deaths, the WHO released a recommendation for a prioritized registration of COVID-19 as an underlying cause of death.

WHO, 16 Apr 2020: A death due to COVID-19 is defined for surveillance purposes as a death resulting from a clinically compatible illness, in a probable or confirmed COVID-19 case, unless there is a clear alternative cause of death that cannot be related to COVID disease (e.g. trauma).

• This has not solved the problems. Implausibly great variations in cases, deaths, and deaths-to-cases ratio across countries are sustaining.
Excess mortality assessment as a strong alternative to data on causes of death

We therefore urge all national authorities who can collate counts of weekly deaths to expedite the publication of these data and place them in the public domain. The dissemination of this information should be done within 3–4 weeks of the period of observation. At a minimum, tabulations by sex and 5-year age groups are essential. Unfortunately, most countries do not publish such statistics publicly.


Submitted to The Lancet 23 March 2020, published 22 April 2020. A shorter version of the Letter was published by the Financial Times 6th of April 2020
Excess mortality = excess in observed mortality relative to baseline level estimated from the past mortality experience
STMF data series in the HMD – the most reliable data source for estimation of excess mortality

https://mpidr.shinyapps.io/stmortality/
Important choices in the excess mortality estimation

- **Measure of mortality:** Deaths, CDR, **SDR**, LE, YLL, ...

- **Method for baseline mortality:** Average, Average + Trend, Harmonics + Trend, **Lee-Carter**, ...

- **Metrics of the deviation:** absolute difference, relative ratio


- **Time series’ units:** years, months, w

Mortality peaks during the reference period: **included**, excluded


Panel B of the figure demonstrates that assumptions of the baseline mortality in 2020 being equal to mortality in 2019 or equal to the average mortality in 2016-19 lead to underestimation of the excess mortality in presence of the general mortality decline. Such decline is observed in almost all countries.

Excess mortality and life expectancy losses across countries in 2020
Excess deaths associated with covid-19 pandemic in 2020: age and sex disaggregated time series analysis in 29 high income countries

Nazarul Islam, Vladimir M Shkolnikov, Rolando J Acosta, Ilya Klimkin, Ichiro Kawachi, Rafael A Irizarry, Gianfranco Alickandro, Kamlesh Khunti, Tom Yates, Dmitri A Jdanov, Martin White, Sarah Lewington, Ben Lacey

ABSTRACT

OBJECTIVE

To estimate the direct and indirect effects of the covid-19 pandemic on mortality in 2020 in 29 high income countries with reliable and complete age and sex disaggregated mortality data.

RESULTS

A model that accounts for temporal trends and seasonal variability in mortality.

An estimated 979 000 (95% confidence interval 956 000 to 1 001 000) excess deaths occurred in 2020 in the 29 high income countries analysed. All countries had excess deaths in 2020, except New Zealand, Norway, and Denmark. The five countries with the highest absolute number of excess deaths were the US (458 000, 454 000 to 461 000), Italy (89 100, 87 500 to 90 700), England and Wales (85 400, 83 900 to 86 800), Spain (84 100, 82 800 to 85 300), and Poland (60 100, 58 800 to 61 300). New Zealand had lower overall mortality than expected (-2500, -2900 to -2100). In many countries, the estimated number of excess deaths substantially exceeded the number of reported deaths from covid-19.

Effects of covid-19 pandemic on life expectancy and premature mortality in 2020: time series analysis in 37 countries

Nazarul Islam, Dmitri A Jdanov, Vladimir M Shkolnikov, Kamlesh Khunti, Ichiro Kawachi, Martin White, Sarah Lewington, Ben Lacey

ABSTRACT

OBJECTIVE

To estimate the changes in life expectancy and years of life lost in 2020 associated with the covid-19 pandemic.

RESULTS

A change in life expectancy in Denmark, Iceland, and South Korea. The highest reduction in life expectancy was observed in Russia (men: -2.33, 95% confidence interval -2.50 to -2.17; women: -2.14, -2.25 to -2.03), the United States (men: -2.27, -2.39 to -2.15; women: -1.61, -1.70 to -1.51), Bulgaria (men: -1.96, -2.11 to -1.81; women: -1.37, -1.14 to -1.01), Lithuania (men: -1.83, -2.07 to -1.59; women: -1.21, -1.36 to -1.05), Chile (men: -1.64, -1.97 to -1.32; women: -0.88, -1.28 to -0.50), and Spain (men: -1.35, -1.53 to -1.18; women: -1.13, -1.37 to -0.90). Years of life lost in 2020 were higher than expected in all countries except Taiwan, New Zealand, Norway, Iceland, Denmark, and South Korea. In the remaining 31 countries, more than 31 million
Excess SDR per 100 000 in 37 countries, both sexes

Mean = 107.4 / 100 000
Median = 100.9 / 100 000
Q1 = 63.3 / 100 000
Q3 = 141.3 / 100 000

Mortality measure = SDR
Method for the baseline = Average + Trend
Metrics = \( SDR_{obs} - SDR_{baseline} \)
Ref. period = 2005-2019

Sources for slides 12-19: author’s calculations from the observed and baseline death rates in 2020 by age and sex from the study Islam N. et al. http://dx.doi.org/10.1136/bmj-2021-066768. Weekly mortality data from STMF.
ESDR: absolute vs. relative

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Spearman RC = 0.946

Mean 10.1%
Median 9.4%
Q1 6.4%
Q3 14.5%

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Mortality excess tended to be larger in higher-mortality countries: ESDR vs. SDR_{baseline}

Slope = 0.205 (CI95% 0.106-0.303)  
\( r = 0.58 \) (p<0.01)
ESDR among men and women and the gender gap


M-F Diff. per 100 000
Mean 61.9 1.9
Median 59.4 1.9
Q1 35.4 1.6
Q3 74.6 2.3


Shkolnikov V.M. Principal patterns of excess mortality and life expectancy losses across developed countries. HSE, 15 December 2021
Life expectancy losses and their age components

Mortality measure = LE,
Method = Lee-Carter projection,
Metrics = LE_{baseline} – LE_{obs}
Ref period = 2005-2019
Excess mortality trajectory
ESDR by week in 2020 for both sexes: East
ESDR by week in 2020 for both sexes: West

USA
Belgium
Italy
Spain
Netherlands
Portugal
England & Wales
Switzerland
Germany
Denmark
Finland
Norway
Geographic spread of excess mortality across Russia in 2020


Shkolnikov V.M. Principal patterns of excess mortality and life expectancy losses across developed countries. HSE, 15 December 2021
Stringency index by week of 2020

Source: Stringency index values by week of 2020 downloaded from https://github.com/OxCGRT/covid-policy-tracker/blob/master/data/OxCGRT_latest.csv
Summary

• Excess mortality is the gold standard method for estimation of mortality impacts of the COVID-19 pandemic irrespective of well-known problems with SARS-CoV-2 testing and its registration as the main cause of death.

• Quantitative estimates of excess mortality and lifetime losses depend on the choice of mortality measure, method of calculation of the baseline mortality (incl. accounting or not accounting for the annual trend), length of the reference period, and time units. Scholars and policymakers interpreting the results should understand sense of the mortality measures and underlying assumptions.

• In this presentation, we reported excess age-standardized death rates (ESDRs) in 37 developed countries in 2020 as the difference between the baseline weekly SDRs calculated from the weekly death rates in 2005-19 using the Average+Trend method and the observed weekly SDRs.

• The highest ESDRs for both sexes were found in Russia, Bulgaria, Poland, Czechia, Lithuania, the USA, Slovenia, Belgium, Italy, and Croatia. New Zealand, Taiwan, South Korea, and Scandinavian countries experienced no mortality excess. In countries with non-negative ESDRs, the mean ESDR constituted 10% of the baseline SDR with the lower and the upper quartiles 6.4% and 14.5%, respectively.

• Male ESDRs were 1.9-fold higher than the female ones on average with the largest absolute gender gaps being the highest in Bulgaria, Russia, Poland, and some other Eastern European countries.
Summary (2)

• To estimate life expectancy losses, we subtracted the observed LE values from the baseline LE values calculated from (Lee-Carter-forecasted) age-specific death rates with 2005-19 as the reference period.

• The mean LE losses were 0.9 years for men and 0.6 years for women. The lower and upper quartiles were equal to 0.5 and 1.3 years for men and 0.3 and 0.9 years for women.

• The largest LE losses were observed in Russia and the USA. High LE losses were seen also in Bulgaria, Lithuania, Poland, Italy, Spain, Czechia, and Belgium. In the USA, excess mortality at ages 15 to 64 produced almost 60% of LE losses among males and almost 50% of LE losses among females. In Bulgaria, Russia, Lithuania, Scotland, Chile (males only), and Canada the share of ages below 65 in the total life expectancy losses was also surprisingly high. New Zealand, Taiwan, Norway, and South Korea did not experience LE losses.

• While in Belgium, Italy, Spain, and parts of the UK, major mortality peaks were observed in Spring 2020, in Eastern European countries the mortality excess was concentrated on the last 10 weeks of the year. Russia and the USA faced ESDR peaks in both April-May and November-December. In these two countries with large and heterogeneous territories, mortality excess was observed during most of 2020 possibly due to different schedule of the pandemic in different parts of these countries.
Спасибо за внимание!
Additional
COVID-19: a need for real-time monitoring of weekly excess deaths

The first-line epidemic response to coronavirus disease 2019 (COVID-19) requires estimation of parameters, including case fatality and fatality rate, and tabulations by sex and 5-year age groups are essential.

We therefore urge all national authorities who can collate counts of weekly deaths to expedite the publication of these data and place them in the public domain. The dissemination of this information should be done within 3–4 weeks of the period of observation. At a minimum, tabulations by sex and 5-year age groups are essential.