

Variability in excess deaths across countries with different vulnerability during 2020-2023

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ABSTRACT

Importance: Excess deaths provide estimates of total impact of major crises, such as the COVID-19 pandemic.

Objective: To evaluate excess deaths trajectories during 2020-2023 across countries with accurate death registration and population age structure data; and to assess how excess death patterns and trajectories correlate with economic indicators of vulnerability overall and in different age strata.

Methods: Data were used from the Human Mortality Database on 34 countries. Excess deaths were calculated for 2020-2023 (to 2/26/2023) using 2017-2019 as baseline reference, with weekly expected death calculations and adjustment for 5 age strata. Countries were divided into less and more vulnerable; the latter had per capita nominal GDT<\$30,000, Gini>0.35 for income inequality and/or at least 2.5% of their population living in poverty.

Results: Excess deaths (as proportion of expected deaths, p%) were strongly inversely correlated with per capita GDP ($r=-0.61$), strongly correlated with proportion living in poverty ($r=0.65$) and modestly correlated with income inequality ($r=0.42$). The 17 less vulnerable countries had 201,471 excess deaths versus 2,005,380 among the 17 more vulnerable countries. The USA would have had 1.50 million fewer deaths if it had the performance of Sweden, 1.13 million fewer deaths if it had the performance of Finland, and 0.93 million fewer deaths if it had the performance of France. Excess deaths started deviating in the two groups after the first wave when correlational patterns with the 3 economic indicators also started to emerge. Between-country heterogeneity diminished over time within each of the two groups. Less vulnerable countries had mean $p\%=-0.4\%$ and 0.9% in 0-64 and >65 year-old strata while more vulnerable countries had mean $p\%=8.3\%$ and 9.0% , respectively. Certain countries performed substantially

worse (USA, Canada, Chile, UK) or better (France, Poland, Slovenia) in the non-elderly than in the elderly. Usually lower death rates were seen in children 0-14 years old during 2020-2023 versus pre-pandemic years.

Conclusion: While the pandemic hit some countries earlier than others, country vulnerability dominated eventually the cumulative impact. Half of the analyzed countries witnessed no substantial excess deaths versus pre-pandemic levels, while the other half suffered major death tolls.

Keywords: COVID-19, mortality, excess deaths, bias, demography

INTRODUCTION

Estimates of excess deaths are considered to offer an aggregate picture of the impact on overall mortality during the COVID-19 crisis.^{1,2} Excess deaths capture the composite of deaths due to SARS-CoV-2, indirect effects of the pandemic, and the effects of the measures taken during the crisis (both positive and negative). Three years after COVID-19 was proclaimed as a pandemic by the WHO, one can have a mature picture of the evolution of the excess deaths in different countries over time. This is most reliable in countries that have adequately complete death registration data and information on the evolution of the age structure of their population, so that proper age-adjustments can be made.³ The performance of different countries in terms of cumulative deaths may have varied markedly. Moreover, the trajectory of excess deaths over time has also shown diverse patterns across countries over time, as different countries witnessed more excess deaths during different periods.

Here, we evaluate the trajectories of excess deaths over time in the period between January 2020 and March 2023 in 34 countries with the most reliable data. We try to get insights on how and why these trajectories have diverged across different countries overall and within different age groups. We categorize these countries in two groups of more and less vulnerable ones. Vulnerability is judged based on per capita gross domestic product (GDP) as well as income inequality and proportion of population below the poverty level, since the COVID-19 crisis disproportionately affected the poor and the disadvantaged.⁴⁻⁶

METHODS

Excess death calculations, eligible countries, and mortality data

We performed excess death calculations using methods similar to those we have used in our previously published work for the period of 2020-2021.³ In brief, we used the average of the

years 2017-2019 as the baseline and included age-adjustment in the calculations, by considering data in 5 age strata (0–14, 15–64, 65–75, 75–85, and >85 years old). For each age stratum, we obtained the average mortality, the number of deaths per million for the population of the specific age stratum and estimated the expected deaths during each week of the pandemic periods of interest, correcting for the population size in the specific age stratum and summing expected deaths across the population strata.

We used the Human Mortality Database (<https://www.mortality.org>),⁷ specifically the Short Term Mortality Fluctuations (STMF) file (<https://www.mortality.org/Public/STMF/Outputs/stmf.csv>) that includes weekly all-cause deaths and mortality values allowing the population size to be calculated as their ratio for each week. Only countries that have excellent death registration and include data with weekly deaths in the STMF during the period from 2017 until at least the second half of 2022 were considered, so as to avoid spurious changes in recorded deaths over time due to changes in death registration. STMF had data from 34 such eligible countries at the time we downloaded the database (March 2023). Data extended to include part of 2023 for 31 countries (to 26 February 2023). Italy was covered to the end of 2022 and the last few weeks of 2022 were missing for Canada and Australia.

We calculated weekly excess deaths and focused on cumulative excess deaths up to the end of each week starting from the first week of 2020. We proceeded with these calculations until the latest week with available death data in each country. The Human Mortality database uses ISO weeks that end on Sunday, e.g. the first week of 2020 ends on Sunday January 5, 2020. We expressed the excess death impact as percentage above the expected deaths, p%. E.g. $p\%=2\%$ means that excess deaths (observed minus expected deaths) are 2% of the expected

deaths for the period of interest and $p\% = -1\%$ means that the observed deaths are 1% lower than the expected deaths (“death deficit”).

All analyses use 2017-2019 as the reference period to calculate expected deaths. We have previously shown that relative country performance tends to be similar with shorter and longer windows for the reference period,⁸ even if exact absolute excess deaths may vary with different modeling options.⁸

Classification of countries in vulnerability groups

We classified the 34 countries with available eligible data into two groups of 17 countries each. The more vulnerable countries’ group included countries that had per capita nominal GDP below \$30,000, large income inequality (Gini>0.35) and/or sizeable percentage (at least 2.5%) of their population in poverty (defined as living with <\$5.50 per day (2011 PPP values)). The less vulnerable group countries’ group had none of these vulnerability features.

Information on these three indicators was obtained from World Bank for per capita nominal GDP (2021 estimates;⁹ OECD for Gini of income inequality (2020 or more recent estimates, "Income Distribution Database". OECD.org. Measure: Gini (disposable income, post taxes and transfers), coupled with data from the World Bank for countries that are not OECD members;^{10,11} and Wikipedia (2019 for most recent data of proportion of population living in poverty.¹²

The magnitude of the differences across more and more vulnerable countries can be best appreciated if one estimates how many fewer deaths a more vulnerable country would have had if it had the same performance as a less vulnerable country. To obtain this number, the absolute excess deaths of the more vulnerable country are multiplied by the difference in $p\%$ between the

compared countries. Illustratively, we present such absolute numbers of deaths that could have been saved for the USA, if it had the performance of Sweden, Finland, or France.

Analyses of cumulative excess deaths over time

Cumulative excess deaths for each country were analyzed for each week starting with week 1, 2020 and until the most recent available data. For the few countries with missing data on the last few weeks in this interval, the last available value was carried forward. Main milestones were: week 12 (22-March 2020, at the start of the impact of the pandemic wave in Europe and the USA), mid-2020, end-2020, mid-2021, end-2021, mid-2022, end-2022, and latest available (26 February 2023 or latest). The mean p% and its standard deviation for cumulative excess deaths at each time point of interest was calculated separately for the more vulnerable and for the less vulnerable countries.

We also examined the Pearson and Spearman correlation coefficients for the correlation between the P at each main milestone and the three economic variables (GDP per capita, Gini coefficient, percentage of population living in poverty) across all 34 countries.

Age subgroups

We performed similar analyses splitting excess death estimates in non-elderly (0-64 years, i.e. combining the 0-14 and 15-64 years old strata) and elderly people (65 years old and above, i.e. combining the 65-74, 75-84, and over 85 years old strata). We also examined whether there were excess deaths in the 0-14 age bin, i.e. among children in particular, in any of the 34 countries.

RESULTS

Cumulative excess deaths and vulnerability indicators

Table 1 shows the estimated cumulative excess deaths during the entire pandemic period and the 3 vulnerability indicators for each of the 34 countries (scatterplot in Figure 1). The Pearson correlation coefficients of p% with GDP per capita, Gini coefficient, and percentage living in poverty across the 34 countries were -0.61, 0.42, and 0.65. The corresponding Spearman rank correlation coefficients were -0.71, 0.25, and 0.61, respectively.

Table 1 also shows the total absolute numbers of excess deaths. Across the 34 countries they amounted to a total of 2,210,782 excess deaths, 57% of which were accounted by the USA alone (1,270,578). There were only 201,471 excess deaths in the 17 countries of the less vulnerable group (557 per million in the total population of 361,730,277 people) versus 2,005,380 in the 17 countries of the more vulnerable group (3,180 per million in the total population of 630,541,384 people).

The USA would have had 1.50 million fewer deaths if it had the performance of Sweden, 1.13 million fewer deaths if it had the performance of Finland, and 0.93 million fewer deaths if it had the performance of France.

Cumulative excess deaths in the two vulnerability groups over time

Table 2 shows the mean and standard deviation of the excess death estimates p% for more and less vulnerable countries, respectively and Figure 2 shows the trajectories in each country over time. Both groups of countries had similar estimates of modest death deficit for the first 12 weeks of 2020 as compared with the average of 2017-2019 and both groups had similar standard deviations. By mid-2020, both groups had reverted from this initial death deficit to a picture that resembled 2017-2019 for the mean p% (no sizeable excess or deficit), but there was large between-country heterogeneity already, especially in the more vulnerable group. Some countries had already reached excess deaths exceeding 8% (UK 14.9%, Spain 14.3%, Chile

11.4%, USA 9.9%, Belgium 9.0%, Italy 8.7%) – all in the more vulnerable group except for Belgium (see Figure 2).

After mid-2020, the less vulnerable group of countries maintained until February 2023 a very small mean of excess deaths. The mean value never exceeded 1.2% and it was just 0.7% by the latest update. Their between-country heterogeneity also diminished during 2021-2023. The standard deviation at the latest update was less than half the standard deviation of end-2020 in that group. This is because countries that initially had prominent death deficits compared with 2017-2019 lost much or all of these death deficits by the latest follow-up; while countries with substantial excess deaths in 2020 or early 2021 improved markedly their performance subsequently. As of the latest update in March 2023, with the exception of Austria (cumulative excess deaths 6.5%), all countries in the less vulnerable group had cumulative p% estimates in the narrow range -3.4% to 3.7%.

Conversely, in the group of more vulnerable countries the mean excess death estimate reached 8.2% by the end of 2020. Between-country heterogeneity diminished markedly compared with mid-2020, because although many of these countries had been spared in the first wave, only Latvia and Estonia were still spared by end-2020 (standard deviation of p% fell from 8.2% to 4.6%). The mean excess death estimate continued to increase during 2021 reaching 9.8% by mid-2021 and 11.8% by end-2021, while between-country heterogeneity remained stable at modest levels. During 2022 and into 2023, the mean excess death estimate decreased modestly over time and some further decrease was seen also in the standard deviation. As of the latest update in February 2023, all countries in the more vulnerable group have cumulative excess deaths (4.2-18.1%) exceeding the estimates of 16/17 countries in the least vulnerable group (the one exception being Austria).

As shown in table 3, there was no correlation between excess deaths p% and per capita GDP in 2020 but this changed in the next year and then it remained steady with correlation coefficients around -0.6 (Pearson) or -0.7 (Spearman). Similarly, there was no correlation between excess deaths p% and the proportion of poverty until mid-2020 but this changed in the next year and then it remained steady with correlation coefficients around 0.6 or higher. Throughout the 2020-2023 period, there was a modest correlation (correlation coefficients mostly between 0.2 and 0.4) between excess deaths p% and Gini coefficient for income inequality.

Age groups

Across all 34 countries, total excess deaths were 581,755 and 1,627,810 in the non-elderly (0-64 years) and elderly (65 and over) strata, respectively (Table 4). For the non-elderly, at the latest update on 26 February 2023, the mean of excess deaths was -0.4% and 8.3% in the less and more vulnerable groups, respectively. For the elderly, the respective means were 0.9% and 9.0%. In the 17 less vulnerable countries, there were only 16,642 and 184,828 excess deaths in the non-elderly and elderly strata, respectively; non-elderly excess deaths accounted for only 8% of total excess deaths. In the 17 more vulnerable countries the respective numbers were 565,114 and 1,442,983, i.e. non-elderly excess deaths accounted for 28% of total excess deaths.

Most countries had similar performance in terms of p% in the non-elderly and elderly strata, with some notable exceptions (Figure 1). USA, Canada, Chile, and UK had a much higher p% in the non-elderly than in the elderly (difference >6.5%). In fact, USA had the highest excess deaths than any country among the non-elderly (p%=19.0%), while Canada had high excess deaths in the non-elderly (p%=9.2%), but no excess deaths in the elderly (p%0.8%). The higher excess death P estimates in the non-elderly rather than elderly was manifest in these

countries from the first months of the pandemic and persisted subsequently. Conversely, France, Poland, and Slovenia performed much better in the non-elderly than in the elderly (difference > 7.5%); both France and Slovenia had a death deficit in the non-elderly.

For children in particular (0-14 years), all countries with sizeable population of children to have meaningful results had lower death rates during 2020-2023 versus 2017-2019 with the exception of Canada. Numerically, the largest death deficits came actually from more vulnerable countries, specifically USA (-3,803), Chile (-1,219), Poland (-845) and UK (-805).

DISCUSSION

Analysis of data during 2020-2023 from 34 countries with reliable mortality data and information of population age structure over time shows that half of these countries had minimal excess deaths or even death deficits during 2020-2023 versus the 3 pre-pandemic years, while the other half had substantial excess deaths. The performance of different countries could be grouped based on vulnerability indicators pertaining to their wealth, income inequality and poverty. Excess deaths during 2020-2023 was strongly inversely correlated with per capita income, strong correlated with proportion of the population living in poverty and modestly correlated with the Gini coefficient of income inequality. These correlational patterns were not seen during the first wave, but they became manifest and persistent subsequently.

Some less vulnerable countries transiently had notable excess deaths during 2020 and/or 2021. However, eventually by March of 2023 all of them (with the exception of Austria) had no major excess deaths considering the entire 2020-2023 period. This is consistent with the possibility that transient peaks of excess deaths in these countries were to a large extent due to the demise of frail elderly individuals, e.g. in long-term care facilities, with limited life expectancy.¹³ For individuals with life expectancy less than 2-3 years, premature deaths in the

early phases of the pandemic, will have no impact on the excess death estimates when the whole 2020-2023 period is considered.^{13,14} The group of less vulnerable countries have high income, no prominent income inequalities and no major proportion of their population living in poverty. All of them also have practically universal health coverage. Thus, they may have avoided a substantial number of excess deaths among disadvantaged people. These countries also had more means to mobilize sufficient healthcare and public health resources. The exact ingredients of their success cannot be deciphered from ecological, country-level data. Regardless, these countries with large shares of elderly populations managed to pass the crisis with no more deaths than during the recent pre-pandemic years, after adjusting for their age structure.

Conversely, all countries that were categorized as more vulnerable based on their economic indicators fared poorly during 2020-2023. Their excess death estimates have decreased modestly after a peak by end-2021. This may reflect a relative contribution of the same phenomenon of some early deaths among frail elderly people with limited life expectancy, especially in Slovenia, Spain and UK, where the decrease in cumulative excess deaths was more prominent from 2020 to 2023. It may also reflect the more limited fatality of the Omicron waves in 2022-2023,¹⁵ especially given the almost ubiquitous prior infections and high rates of vaccination.¹⁶ However, cumulative excess death estimates remain high (and occasionally very high) in the more vulnerable countries. Some countries already reached high excess levels in early 2020, while others succumbed during the second wave. Again, the exact ingredients of their failure cannot be pinpointed in detail. However, the common denominator for these countries was their less robust economies and/or large share of poor, disadvantaged people. COVID-19 was a crisis of inequalities and many measures taken may even have fostered worsening inequalities.

The USA is a striking case, with extremely high cumulative excess death rates despite high per capita GDP. USA income inequality is high and many people live in poverty, while 16% lack health coverage. Up to 27-fold differences in the rates of COVID-19 death rates in strata defined by race, gender, and educational achievement have been described in the USA.⁶ Area deprivation may be a risk factor for COVID-19 mortality especially among minorities.^{17,18} Moreover, a large share of excess deaths apparently are due to sharply increasing deaths due to overdose¹⁹ and of deaths due to suboptimal access to care during 2020-2023.²⁰ Such non-infectious causes may largely explain the exceptionally high excess death p% estimate among USA non-elderly people. It was also accompanied by a very high proportion (35%) of excess deaths contributed by the under-65 age stratum.

Income inequalities have been strongly associated with COVID-19 deaths also in other countries among the more vulnerable group, e.g. in Spain^{21,22} and Chile.²³ The pandemic widened all-cause pre-existing mortality gaps according to income even in some less vulnerable countries, such as the Netherlands²⁴ and Sweden.²⁵ In a vicious circle, the pandemic caused more poverty worldwide.²⁶

The gap between the more and less vulnerable group of countries was overall similar among the elderly and the non-elderly. However, a few countries (USA, Canada, Chile, UK) had a very poor performance specifically among the non-elderly (as compared with their performance in the elderly, while some others (France, Poland, Slovenia) showed the opposite pattern. Population obesity rates are markedly different in these two groups of countries (28-36% versus 20-23%) and additional differences in the background health status of non-elderly individuals may explain these patterns, e.g. overdose and poor health access in the USA – as discussed above. USA, Chile, and UK were categorized here as more vulnerable countries,

while Canada was categorized as less vulnerable. However, the classification is not absolute. Canada also has a modest proportion of people living in poverty (0.74%), and data from Ontario suggest that low income and low educational attainment increased the risk of COVID-19 deaths.²⁷ Also some data from Canada (British Columbia) shows that death rates from overdose more than doubled during the pandemic versus 2019).²⁸

For children in particular, the available data suggest consistently fewer deaths during 2020-2023 compared with the pre-pandemic years. This may be due to the exceptionally low infection fatality rate of SARS-CoV-2 among children,²⁹ plus the almost complete disappearance of influenza for 2 years. More granular data would need to be examined to see if the death deficit extends also to adolescents and very young adults.

Our study has some limitations. First, excess death estimates depend on modeling assumptions that may affect the absolute values.^{30,31} For example, if one were to expect a trend of decreasing mortality rates over the years, then the estimated excess deaths would be higher than what we calculated using the 2017-2019 average as reference. However, even if mortality rates have decreased in many countries over time, there is no guarantee that this pattern should continue, especially among the increasingly elderly and frail populations of high-income countries.⁸ Moreover, we have previously shown that different modeling assumptions do not affect the comparative performance of different countries.⁸ I.e. poor performers are consistently poor performers regardless of the exact modeling. Therefore, the contrast between less and more vulnerable countries is likely to be robust to modeling choices. Second, some of the data may have imperfections, e.g. some missing data on deaths in the last few weeks of the covered period, or inaccuracies in the inferred data for the population structure in each age bin and country over time. However, the data for the 34 chosen countries are likely to be the most reliable.

Extrapolations to countries with less reliable death and age structure data are precarious.³²

Socioeconomic factors are likely to have had a major impact on mortality during 2020-2023 also in other countries, perhaps even to a larger extent than in the 34 countries that we analyzed.³³⁻³⁵

Their impact might have been even larger for non-COVID-19 deaths.³³ Conversely, most countries not analyzed here have much younger populations and few frail elderly in long-term care facilities than the 34 analyzed countries, and thus deaths directly due to SARS-CoV-2 are expected to have been fewer.^{29,36} Third, we used three high-level economic indicators and these should be seen as surrogate of a mixture of many socioeconomic and other factors that operate at the individual, household, work, community, and societal level. Poor outcomes during the COVID-19 crisis are likely to have been determined by a large web of inter-related factors.

Acknowledging for these caveats, the country-level analyses that we performed offer a picture of how countries succeeded or failed in dealing with this major crisis. Half the countries went through the 3 crisis years without witnessing substantial excess deaths versus their pre-pandemic levels, while others suffered major death tolls. Continuous monitoring of excess death patterns may be useful, given that the consequences of the COVID-19 crisis and several measures taken may continue to have an impact for several years.

Table 1. Excess deaths and vulnerability indicators

Country	Excess deaths, p (%)*	Excess deaths, absolute*	Reported COVID-19 deaths*	Per capita nominal GDP (\$)	Gini for income inequality	Living in poverty (%)
New Zealand	-3.42	-3,931	2,542	48,781	0.320	No data
Denmark	-2.59	-4,821	8,274	68,008	0.268	0.40
Sweden	-2.51	-7,409	23,634	61,029	0.276	0.60
Australia	-2.08	-10,714	16,100	60,443	0.318	0.74
South Korea	-2.03	-17,373	7,067	34,998	0.331	0.74
Norway	-1.62	-2,230	5,175	89,154	0.263	0.20
Luxembourg	-0.81	-114	1,207	133,590	0.305	0.30
Iceland	0.98	73	199	68,728	0.250	0.04
Israel	1.47	2,270	12,236	52,171	0.342	2.47
Switzerland	1.50	3,417	14,203	91,992	0.316	0.14
Finland	1.59	2,847	8,739	53,655	0.265	0.10
Canada	2.33	20,184	46,931	51,988	0.280	0.74
Netherlands	2.93	15,376	22,990	57,768	0.304	0.30
Germany	3.25	101,657	167,812	51,204	0.296	0.50
Belgium	3.39	12,098	33,616	51,247	0.262	0.20
France	3.71	72,617	160,917	43,659	0.292	0.11
Portugal#	4.15	15,353	26,033	24,568	0.310	0.90
Spain#	5.09	69,711	118,434	30,104	0.320	2.50
Slovenia#	5.24	3,610	7,067	29,291	0.246	0.10
UK#	5.51	111,636	14,203	46,510	0.355	0.86
Hungary#	6.04	25,156	48,658	18,728	0.286	1.80
Austria	6.53	17,524	21,872	53,638	0.274	0.80
Italy#	6.63	134,220	184,642	35,658	0.330	3.05
Estonia#	6.76	3,421	2,926	27,944	0.305	1.30
Greece#	7.50	29,934	34,779	20,193	0.308	3.40
Croatia#	7.76	13,088	17,895	17,685	0.292	1.80
Latvia#	8.64	7,774	6,255	21,148	0.355	2.00
Slovakia#	9.97	17,646	20,938	21,392	0.222	1.30
Czechia#	10.26	34,014	42,303	26,821	0.248	0.30

Poland#	10.90	146,894	118,779	18,000	0.281	1.20
Lithuania#	11.40	13,976	9,535	23,723	0.357	1.40
Chile#	12.67	47,069	64,230	16,265	0.460	4.40
USA#	13.99	1,270,578	1,107,690	70,249	0.375	1.50
Bulgaria#	18.05	61,300	38,184	12,222	0.408	8.20

*excess deaths are calculated from week 1, 2020 until the latest update of available data (see Methods) and cumulative recorded COVID-19 deaths are counted for the same time period.

#belongs to the group of more vulnerable countries (see Methods for definitions)

Table 2. Mean and standard deviation of excess deaths p% (% of expected deaths) at different time points for more and less vulnerable countries

Time point	Excess deaths in less vulnerable countries, mean p% (standard deviation)	Excess deaths in more vulnerable countries, mean p% (standard deviation)
22 March 2020 (week 12)	-7.4 (3.7)	-7.7 (3.9)
Mid-2020 (week 26)	-1.6 (4.7)	0.0 (8.2)
End-2020 (week 52)	1.2 (5.7)	8.2 (4.6)
Mid-2021 (week 78)	-0.7 (4.4)	9.8 (4.4)
End-2021 (week 104)	0.4 (4.2)	11.8 (4.8)
Mid-2022 (week 130)	0.5 (3.0)	10.4 (4.8)
End-2022 (week 156)	1.1 (3.0)	9.8 (4.0)
Latest update to 26 February 2023 (week 165)	0.7 (2.8)	9.1 (4.0)

Table 3. Correlations between excess death estimates p% and vulnerability indicators at different time points

Time point	Pearson (Spearman) correlation with per capita nominal GDP	Pearson (Spearman) correlation with Gini for income inequality	Pearson (Spearman) correlation with proportion living in poverty
22 March 2020 (week 12)	-0.07 (0.16)	0.19 (0.18)	0.12 (0.06)
Mid-2020 (week 26)	0.02 (0.22)	0.35 (0.22)	0.05 (0.00)
End-2020 (week 52)	-0.30 (-0.34)	0.24 (0.14)	0.33 (0.28)
Mid-2021 (week 78)	-0.54 (-0.65)	0.31 (0.19)	0.50 (0.51)
End-2021 (week 104)	-0.59 (-0.69)	0.32 (0.19)	0.60 (0.58)
Mid-2022 (week 130)	-0.62 (-0.73)	0.41 (0.24)	0.68 (0.63)
End-2022 (week 156)	-0.61 (-0.71)	0.41 (0.25)	0.65 (0.61)
Latest update to 26 February 2023 (week 165)	-0.61 (-0.71)	0.42 (0.25)	0.65 (0.61)

Table 4. Excess deaths from January 2020 and up to latest update (26 February 2023) per age group*

Country	0-64 years, absolute	0-64 years, p%	65 years and over, absolute	65 years and over, p%	0-14 years, absolute	0-14 years, p%
Denmark	-1,667	-6.4%	-3,153	-2.0%	-39	-4.4%
Sweden	-1,828	-6.0%	-5,581	-2.1%	-72	-5.7%
France	-10,139	-3.4%	82,756	5.0%	-561	-5.0%
Luxembourg	-74	-3.0%	-39	-0.3%	41	44% (NR)
Norway	-492	-2.8%	-1,738	-1.5%	-69	-11.5%
New Zealand	-580	-2.7%	-3,352	-3.6%	-32	-2.9%
Finland	-637	-2.6%	3,484	2.3%	-34	-6.6%
Israel	-598	-2.3%	2,867	2.2%	-403	-15.5%
Australia	-1,682	-1.9%	-9,031	-2.1%	-481	-11.8%
Belgium	-690	-1.3%	12,788	4.2%	-393	-20.6%
Switzerland	-160	-0.6%	3,577	1.8%	-28	-2.2%
South Korea	542	0.3%	-17,916	-2.6%	-776	-20.8%
Netherlands	1,559	2.3%	13,816	3.0%	-25	-1.0%
Germany	15,951	3.7%	85,706	3.2%	-637	-5.5%
Iceland	47	3.9%	27	0.4%	20	60% (NR)
Austria	2,409	6.4%	15,115	6.6%	-99	-8.8%
Canada	14,682	9.2%	5,501	0.8%	879	13.4%**
Slovenia	-215	-2.0%	3,824	6.6%	-10	-4.7%
Hungary	2,049	2.3%	23,107	7.0%	-113	-7.4%
Croatia	910	3.4%	12,179	8.6%	-38	-5.7%
Portugal	2,368	4.7%	12,984	4.1%	-108	-9.1%
Poland	14,944	5.0%	131,950	12.6%	-845	-12.5%
Spain	11,245	6.2%	58,467	4.9%	-203	-4.4%
Czechia	3,704	6.3%	33,025	11.0%	-223	-15.5%
Italy	13,282	6.4%	120,939	6.7%	-958	-17.0%
Estonia	682	7.3%	2,740	6.6%	-7	-3.9%
Slovakia	3,039	7.5%	14,607	10.7%	-51	-4.0%
Latvia	1,583	7.9%	6,191	8.8%	-84	-23.9%
Greece	4,549	9.2%	25,384	7.3%	-141	-10.3%
Lithuania	3,121	11.5%	10,855	11.4%	-96	-20.9%
UK	35,759	11.8%	75,876	4.4%	-805	-6.5%
Bulgaria	11,285	16.5%	50,015	18.4%	-276	-15.8%
Chile	16,324	17.5%	30,746	11.0%	-1,219	-19.4%
USA	440,485	19.0%	830,094	12.3%	-3,803	-4.0%

*Countries are listed in increasing p% among the 0-64 years old age stratum

**For Canada, the 0-14 year old age band given in stmf is extrapolated from the 0-44 year age band in the original data <https://www150.statcan.gc.ca/n1/tbl/csv/13100768-eng.zip>. See

<https://www.mortality.org/File/GetDocument/Public/STMF/DOC/STMFNote.pdf> for stmf methods.

NR: not reliable (given the very small population and extremely small number of deaths of children, excess deaths can be markedly influenced by single anomalies, e.g. in Iceland there were only 6 reported deaths in that age stratum in 2019 (less than a third versus 2017) and in Luxembourg there were 76 in 2022 (more than double versus the 2017-2019 average))

FIGURE LEGENDS

Figure 1. Scatterplot of excess deaths p% against the per capita GDP also showing countries with substantial income inequality and/or high proportion of population living in poverty. The left panel shows the data for the entire countries' populations and the other two panels show the strata or non-elderly and elderly using a cut-off of 65 years.

Figure 2. Estimated cumulative excess deaths at different timepoints during 2020-2023 in 34 countries grouped into more vulnerable (upper group) and less vulnerable (lower group). The color scale corresponds to excess deaths increasing from green to red.

Figure 1

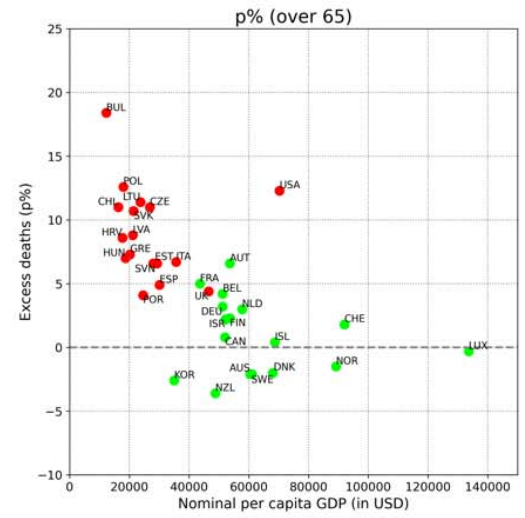
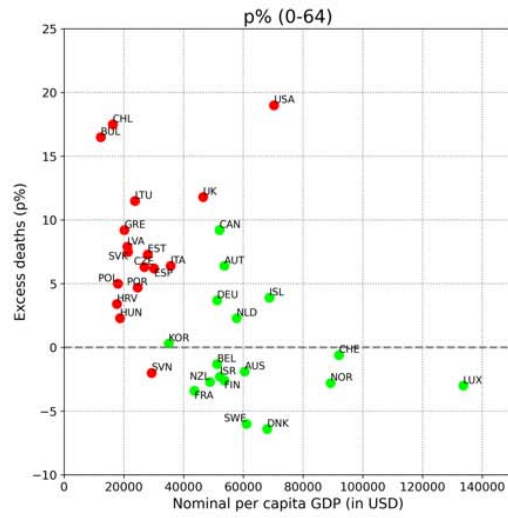
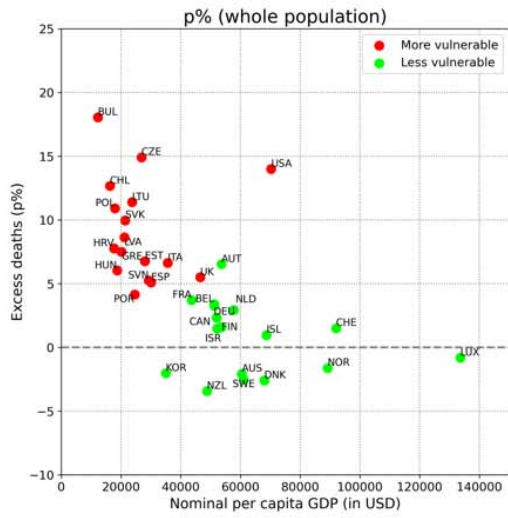


Figure 2

Country	22-Mar-2020	Mid-2020	End-2020	Mid-2021	End-2021	Mid-2022	End-2022	26-Feb-2023
Bulgaria	-10.9%	-7.5%	11.9%	16.2%	23.9%	22.3%	19.4%	18.1%
USA	-1.7%	9.9%	15.8%	14.6%	16.8%	15.5%	14.5%	14.0%
Chile	-2.5%	11.4%	9.6%	15.4%	13.3%	14.4%	13.2%	12.7%
Lithuania	-11.1%	-3.5%	8.9%	9.7%	14.4%	12.4%	11.8%	11.4%
Poland	-9.3%	-4.4%	13.1%	15.7%	17.1%	13.9%	12.0%	10.9%
Czechia	-8.2%	-4.7%	10.8%	16.0%	15.0%	11.6%	10.6%	10.3%
Slovakia	-9.4%	-6.5%	4.3%	12.9%	15.7%	12.5%	10.8%	10.0%
Latvia	-11.1%	-5.5%	0.8%	5.4%	10.9%	9.7%	9.0%	8.6%
Croatia	-11.4%	-7.6%	5.4%	6.3%	10.8%	9.6%	8.8%	7.8%
Greece	-1.1%	-1.5%	3.6%	3.8%	7.9%	8.3%	8.0%	7.5%
Estonia	-11.0%	-4.8%	-0.7%	4.1%	7.3%	6.9%	7.4%	6.8%
Italy	-1.1%	8.7%	11.8%	9.5%	8.3%	6.6%	6.6%	6.6%
Hungary	-12.5%	-7.7%	4.5%	7.9%	9.9%	7.5%	6.8%	6.0%
UK	-6.9%	14.9%	9.7%	7.3%	7.4%	5.1%	5.6%	5.5%
Slovenia	-9.0%	-4.4%	11.5%	8.2%	8.9%	6.8%	6.3%	5.2%
Spain	-5.3%	14.3%	12.2%	7.4%	6.8%	5.4%	5.8%	5.1%
Portugal	-8.2%	-0.5%	6.8%	6.6%	6.1%	4.6%	5.0%	4.2%
Austria	-5.9%	-1.4%	7.4%	5.1%	7.0%	6.1%	7.2%	6.5%
France	-7.4%	3.3%	6.1%	4.8%	4.6%	3.7%	4.4%	3.7%
Belgium	-9.4%	9.0%	12.4%	6.0%	5.5%	3.8%	3.9%	3.4%
Germany	-9.8%	-4.1%	1.1%	0.3%	2.4%	1.5%	3.7%	3.3%
Netherlands	-9.0%	4.7%	5.8%	3.3%	5.1%	3.3%	3.6%	2.9%
Canada	-5.6%	2.1%	3.0%	1.5%	2.5%	2.4%	2.3%	2.3%
Finland	-8.5%	-3.0%	-1.4%	-3.1%	-0.7%	0.3%	1.9%	1.6%
Switzerland	-9.4%	-2.3%	7.5%	2.8%	3.2%	2.0%	2.6%	1.5%
Israel	-7.1%	-3.0%	2.7%	2.0%	3.1%	3.2%	2.4%	1.5%
Iceland	0.8%	-3.7%	-2.9%	-4.0%	-3.4%	-0.6%	0.6%	1.0%
Luxembourg	-15.5%	-5.2%	2.6%	0.4%	0.3%	-0.9%	-0.9%	-0.8%
Norway	-7.8%	-5.6%	-4.2%	-6.6%	-3.5%	-2.7%	-1.2%	-1.6%
South Korea	-5.5%	-5.3%	-4.8%	-6.4%	-5.0%	-1.9%	-2.0%	-2.0%
Australia	-2.5%	-4.2%	-5.8%	-4.9%	-4.7%	-2.4%	-2.1%	-2.1%
Sweden	-9.4%	5.8%	3.6%	0.0%	-0.8%	-2.3%	-2.1%	-2.5%
Denmark	-11.3%	-6.8%	-4.1%	-5.5%	-3.0%	-2.9%	-2.1%	-2.6%
New Zealand	-2.7%	-6.7%	-8.2%	-7.1%	-6.6%	-4.5%	-3.6%	-3.4%

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