Organisation for Economic Co-operation and Development

DELSA/HEA/WD/HWP(2020)7

Unclassified

English text only

16 October 2020

DIRECTORATE FOR EMPLOYMENT, LABOUR AND SOCIAL AFFAIRS
HEALTH COMMITTEE

Health Working Papers

OECD Health Working Paper No. 122
Excess mortality: measuring the direct and indirect impact of COVID-19

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JEL classification: I10, I30

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Acknowledgements

The work presented here was undertaken by David Morgan, Junya Ino, Gabriel Di Paolantonio and Fabrice Murtin with further input and support from Marco Mira D'Ercole and Mark Keese.

The authors would like to acknowledge and thank the delegates of the OECD Working Party on Health Statistics, the OECD Health Committee and the OECD Committee on Statistics and Statistical Policy (CSSP) for their valuable support and comments.

We would also like to thank Stefano Scarpetta, Paul Schreyer, Mark Pearson, Francesca Colombo, Nadim Ahmad and Frederico Guanais for additional feedback and comments. The authors would like to acknowledge and thank Duniya Dedeyn and Lucy Hulett for providing administrative support.

Abstract

Assessing the direct and indirect health impact of the COVID 19 pandemic is central in managing public health and other policy measures while learning to co-exist with the virus. Many countries are publishing statistics on COVID 19 related mortality. While the frequent and timely publication of such figures provides insights into the ongoing trends in a given country, differences in coding and reporting practices pose challenges for international comparisons. Looking at the number of total deaths can help to overcome some of these differences in national practices whilst also providing a better view of the overall impact of COVID 19, by taking into account not just the possible underreporting of COVID 19 deaths but also indirect mortality caused, for example, by health systems not being able to cope with other conditions – acute and chronic.

Résumé

Évaluer les conséquences directes et indirectes de la pandémie de la COVID-19 sur la santé constitue un élément clé pour faire face aux problèmes de santé publique et gérer d'autres instruments d'action tout en apprenant à vivre avec le virus. De nombreux pays communiquent actuellement des statistiques sur la mortalité liée à la COVID-19. Si la publication fréquente et à bref délai de ces chiffres donne une idée précise des tendances pour un pays donné, les différentes méthodes de codage et de déclaration utilisées posent des difficultés en termes de comparaison d'un pays à l'autre. L'étude du nombre total de décès permet de passer outre certaines différences nationales tout en brossant un tableau plus clair de l'impact global de la COVID-19 ; en effet, ce chiffre tient compte non seulement des décès dus à la COVID-19, lesquels sont potentiellement sous-déclarés, mais aussi de la mortalité indirecte causée notamment par l'incapacité du système de santé à prendre en charge d'autres pathologies, à la fois aiguës et chroniques.

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Key findings

1. Since the onset of the coronavirus (COVID 19) crisis, many countries have reported the number of daily COVID 19 deaths in a timely way. These figures have proved essential for monitoring the acute situation as well as understanding the ongoing trends in any given country. However, there are differences in the way countries count the number of COVID 19 deaths, due to where the death took place (e.g. to include care homes and the community), whether the presence of the virus was confirmed through testing, or due to variations in coding and registration practices. These variations can hamper a direct comparison of COVID 19 mortality rates and pose challenges when assessing the overall impact of the virus. However, total deaths, regardless of cause, are more reliably comparable across countries.

2. By examining the total number of deaths recorded, many of the different ways that countries record deaths from COVID 19 are removed. By comparing overall numbers with the level of expected deaths in a country based on the same period in previous years, excess mortality can provide an indication of the overall impact of COVID 19 – by accounting not only for deaths directly attributed to COVID 19 but also those that may be missed or indirectly linked, such as deaths caused by delayed or foregone treatment due to an overloaded health system.

3. Over a 10 week period corresponding to the maximum level of excess mortality in each country, the total number of deaths recorded show that Spain experienced a 61% increase in overall mortality compared with the number of deaths recorded on average over the same time span in the previous 5 years. The United Kingdom registered 56% more deaths than would normally have been expected during a 10 week time frame from the end of March. Chile, Italy and Belgium recorded increases of 40% or more. Germany, Denmark and Norway reported 5% or fewer additional deaths over a 10 week period.

4. Comparing excess deaths with reported COVID 19 deaths may indicate the extent of the potential under-reporting as well as the indirect effects of COVID-19. In some countries (e.g. Belgium), reported COVID 19 related deaths correspond closely to the total number of excess deaths; in others (e.g. the United Kingdom and the United States) reported COVID 19 related deaths are around three quarters of excess deaths; and in others (e.g. Portugal) less than 50%.

5. A clear distinction between confirmed COVID 19 deaths and probable COVID 19 deaths in national reporting in line with international guidelines is recommended. While accurately recording the cause of death can present many challenges, more consistent coding and reporting procedures across countries would help limit some of the differences. Investment in improved health information systems would assist in generating more timely and accurate data.

6. Methodological refinements, such as changing the length of period considered, or adjusting for changes in population growth and ageing, suggest only limited impact on the findings. The OECD will encourage more countries to report “real-time” data and continue to update and expand the statistics on all-cause mortality.

7. As the pandemic moves into a different phase in many OECD countries, the longer term impact on mortality from delayed access to necessary care and the health-related consequences from an economic downturn will continue to be monitored. Accurate data on the levels and trends

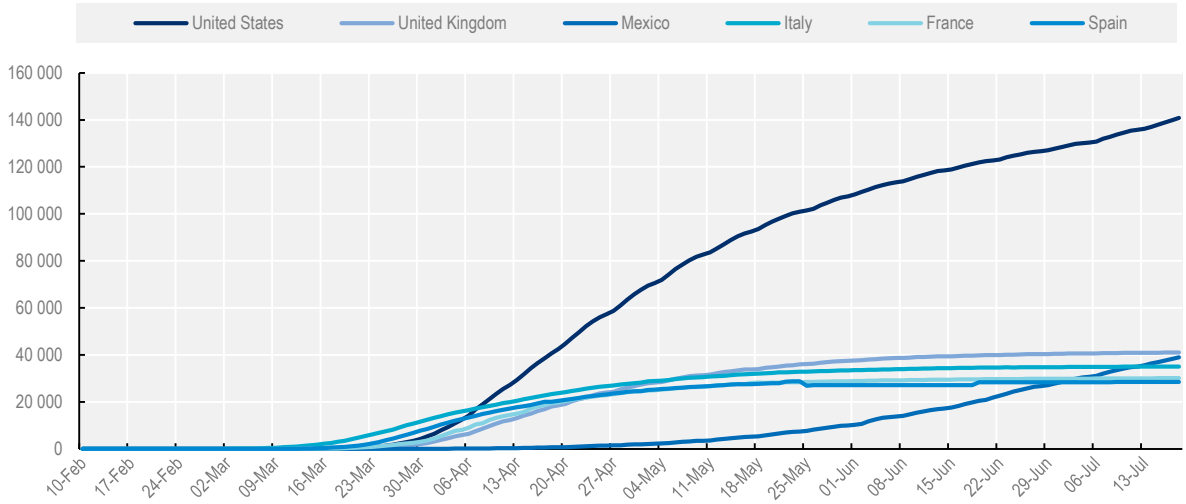
in excess mortality will allow for an analysis of the various demographic, geographical and socio-economic factors. An assessment of the impact of the various measures put in place to tackle the COVID 19 crisis will provide valuable lessons for future outbreaks.

8. Counting and comparing how many people have died from a specific disease would seem to be a straightforward task. In fact, it is not. With the onset of the COVID-19 pandemic, countries have scaled up their efforts to regularly report the number of deaths caused by the SARS-Cov-2 virus. However, the increase in the quantity of regularly released data has not necessarily translated into accurate measures of the number of people dying from the coronavirus. Headline daily statistics on COVID-19 deaths are not fully comparable in the short run, and large revisions are likely to be needed over the medium-term. Procedures for measuring and reporting total numbers of deaths caused by COVID-19 vary widely from country to country. Differences can depend on where death took place (i.e. at home, in a hospital, or in a nursing home), whether a test confirmed the presence of the virus, or on national practices related to the coding and registration of deaths. Furthermore, it is not just those who die from the coronavirus who are the victims of COVID-19 – people who did not seek treatment because of a fear of catching the virus, or who did not receive the care they required because health systems were overstretched, are also victims. A better measure for national and international assessments of both the *direct* and *indirect* impact of COVID-19 would be the number of **excess deaths,** that is, the number of deaths over and above what could normally be expected at this time of year. But even here, a clear picture may only become fully available after the initial phase of the pandemic has passed and when more comprehensive data on deaths are collected.

1 Totalling up the number of COVID-19 reported deaths

9. Figure 1 shows the cumulative number of *reported* COVID-19 deaths for selected OECD countries in absolute terms from mid-February up until the third week of July.[1] These often quoted statistics are compiled by Johns Hopkins University based on a range of national and international sources.[2]

Figure 1. Time distribution of cumulative reported COVID-19 deaths for selected OECD countries, 2020



Note: The chart shows the cumulative numbers of deaths due to COVID-19 as reported by Johns Hopkins University based on national reporting up to 18 July 2020. Data extracted on 05/09/2020 may not take account of all revisions made by national authorities.
Source: The Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU).

10. With the epicentre of the pandemic shifting from China and East Asia to Italy and other Western European countries at the beginning of March, total numbers of deaths attributed to COVID-19 climbed steadily above 20 000 in France, Italy, Spain and the United Kingdom during April, with Italy and the United Kingdom rapidly reaching 30 000 by early May. The number of COVID-19 related deaths in the United States rapidly surpassed these countries in early April to reach more than 100 000 by the end of May. All other OECD countries remained below recorded 10 000 deaths during this time. However, as the rate of increase in deaths started to slow in Europe during May, the number of deaths attributed to COVID-19 has continued to increase more

[1] The first confirmed COVID-19 death among OECD countries occurred on 13 January 2020 in Japan.

[2] The primary sources of data are listed at https://github.com/CSSEGISandData/COVID-19.

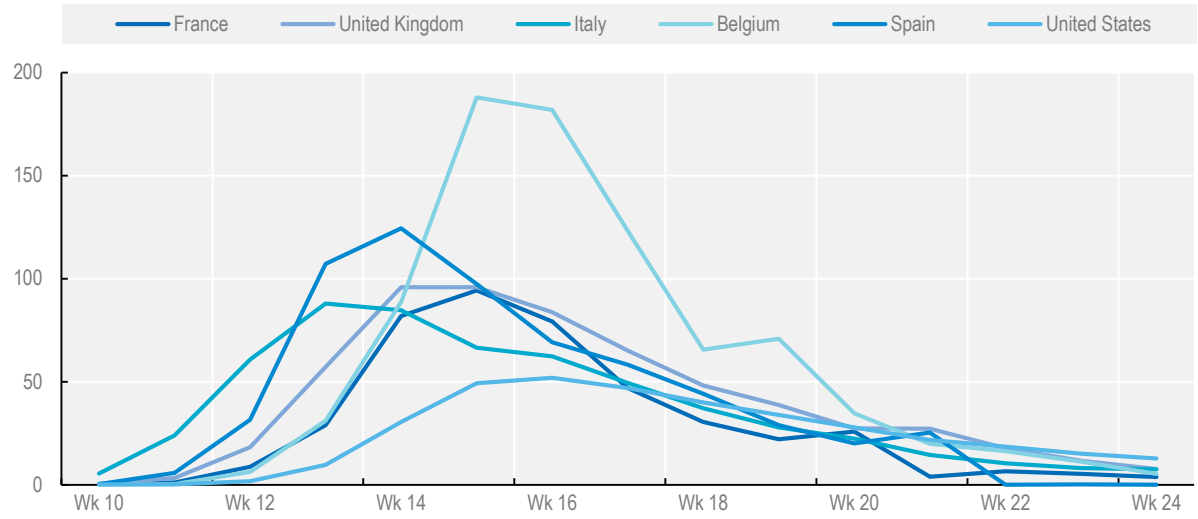
rapidly in other regions, particularly in Latin America, with Mexico passing the 10 000 threshold in mid-May and the 20 000 mark a month later.

11. While the four European countries cited above are broadly comparable in terms of their population size, it is otherwise clear that differences in the size of the population should be taken into account when comparing the number of reported deaths. When adjusting for population size, the United States still lagged behind these four European countries in reported COVID-19 death rates.

12. Figure 2 shows the number of reported COVID-19 deaths in different European OECD countries as reported by Johns Hopkins University on a per capita basis. Rather than a cumulative figure, which does not show as clearly differences in the progression of the virus in countries, the chart shows the total number of deaths per million population on a week by week basis. Adjusting for differences in population sizes, the United States remained somewhat below the peak levels of mortality experienced in some European countries over the period between March and June. Belgium's peak in reported deaths per capita, for example, was around double that of the peaks in other countries. While using an age- and sex- standardised population to adjust death rates would further improve comparability, no such adjustment is applied in Figure 2.

13. Many other factors beyond population structure have been cited as factors determining the number of COVID-19 deaths, e.g. population density in urban areas, the extent of inbound and outbound tourism and international travel, the prevalence of certain risk factors (e.g. obesity) as well as seasonal effects on the transmission of the virus. Assessing the influence of these factors is beyond the scope of this brief.

Figure 2. Weekly reported COVID-19 deaths per million population, March to June, 2020



Note: Chart shows the 5 OECD countries with the highest weekly reported COVID-19 deaths per million population compared to the United States between Week 10 and Week 24, 2020. Data extracted on 05/09/2020 may not take account of all revisions made by national authorities.
Source: The Center for Systems Science and Engineering (CSSE) at Johns Hopkins University; OECD.Stat (populations).

2 Key issues in measuring COVID-19 related deaths

14. Procedures for the measurement and reporting of total numbers of COVID-19 related deaths can vary widely across countries. Some of the issues affecting comparability can be linked to the setting of death, the availability of testing, as well as different practices of coding and reporting.

Where death takes place may affect measurement and reporting

15. In the initial stages of the pandemic in Europe, international comparisons of deaths tended to focus on counting the deaths of patients who had been admitted to hospital, had undergone a test to confirm the presence of COVID-19, and could relatively easily and quickly be recorded through usually centrally based hospital information systems. This reporting led to relatively up-to-date totals, often released by public health officials on a daily basis. However, this exposed difficulties in capturing all COVID-19 related deaths and underlined different patterns in how countries collate information from other settings. Belgium, France and Italy, among others, put in place improved and faster reporting procedures at an earlier stage to include deaths occurring in other settings, notably care homes, which were shown to be accounting for a significant and growing proportion of overall deaths. France, for example, added deaths in care homes (*Établissement d'hébergement pour personnes âgées dependants* – EPHAD) to their figures from 1 April, resulting in a spike in reported deaths. The United Kingdom included deaths occurring in care homes into their daily totals from 29 April, and added them in retrospectively.[3] Similarly, in the United States, for case-based surveillance data, only about half of the States were publicly reporting deaths in nursing homes at the end of April.[4] However, US death certificate data include all deaths from all States regardless of the place of death.

16. Such delays in compiling deaths in care homes are, to some extent, understandable. Compared with hospitals, the number as well as the type of care establishments is much larger. There is often a lack of standardised reporting systems for care homes to ensure accurate and timely statistics on deaths. Often community-based deaths must go through a different and lengthier procedure compared to hospital deaths, with registration at a local administrative level before information is reported centrally. Lack of timely data on deaths in care homes may have contributed to some countries under-estimating the extent of transmission in a particularly vulnerable population group. This strengthens the case for further investment in health information systems and inter-operability across the health and social care sectors.

[3] https://www.gov.uk/government/news/daily-death-reporting-now-includes-all-positive-COVID-19-deaths.

[4] https://theconversation.com/failure-to-count-COVID-19-nursing-home-deaths-could-dramatically-skew-us-numbers-137212.

Including suspected cases as well as deaths that have been positively tested for COVID-19 is important

17. Deaths occurring in hospital will almost certainly have been subject to a test[5], with positive cases confirmed and registered as COVID-19 related deaths. In care homes and in the community at large, depending on the testing practice and capacity in place in a country (and at a particular period), there may be no confirmed infection, and therefore the death certificate may mention only a suspected case of COVID-19, or COVID-19 as a contributory factor. This can result in both under- and over-reporting of the number of deaths caused by COVID-19. At the beginning of an outbreak with physicians perhaps less familiar with the virus and its symptoms, there might have been a tendency to underestimate actual cases and list other causes of death. On the other hand, with the rapid spread of the virus, other causes of death such as from pneumonia, for example, may be wrongly attributed to COVID-19 without a formal test. More generally, both in a hospital and community-care setting, even with a positive test, it may not always be possible to determine the ultimate cause of death as older people who are most at risk of dying from exposure from the coronavirus may suffer from other underlying conditions and diseases contributing to their death.

18. The World Health Organization (WHO) swiftly published *international guidelines* on coding and certification of deaths due to COVID-19, which recommended the inclusion of suspected/probable cases in data reporting on deaths (Box 1). Some countries have adapted their coding practices accordingly. For example, Belgium (the Belgian Public Health Institute) confirmed the inclusion of probable cases in their data,[6] as have the Netherlands. In the United States, the Centers for Disease Control and Prevention (CDC), in accordance with well-established cause-of-death reporting guidance, report both confirmed and probable cases of COVID-19 deaths in their data, but for case-based surveillance reporting, some local or state health departments may include only laboratory-confirmed cases.[7]

Box 1. Emergency use of ICD codes for COVID-19 disease outbreak

According to WHO guidelines, "COVID-19 death 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)". Separate codes were issued for cause of death by testing or by clinical or epidemiological diagnosis.

- An emergency ICD-10 code of 'U07.1 COVID-19, virus identified' is assigned to a disease diagnosis of COVID-19 confirmed by laboratory testing.
- An emergency ICD-10 code of 'U07.2 COVID-19, virus not identified' is assigned to a clinical or epidemiological diagnosis of COVID-19 where laboratory confirmation is inconclusive or not available.
- Both U07.1 and U07.2 may be used for mortality coding as cause of death. See the International guidelines for certification and classification (coding) of COVID-19 as cause of death at the link below.

[5] This may include clinical confirmation without a test. The clinical process with pulmonary distress is quite specific and a clinician may still state COVID-19 as a cause of death without performing the test.

[6] https://www.info-coronavirus.be/en/news/collection-data/.

[7] https://www.cdc.gov/nchs/nvss/vsrr/covid19/tech_notes.htm.

- In ICD-11, the code for the confirmed diagnosis of COVID-19 is RA01.0 and the code for the clinical diagnosis (suspected or probable) of COVID-19 is RA01.1.

Source: https://www.who.int/classifications/icd/covid19/en/ and https://www.who.int/classifications/icd/Guidelines_Cause_of_Death_COVID-19-20200420-EN.pdf?ua=1.

19. With testing capacity varying significantly across countries and time, this can also affect measurement and the number of deaths attributed to COVID-19. For example, significant logistics and capacity constraints – ranging from the availability of trained personnel able to take accurate specimens, to the time required for laboratory analysis and the availability of reagents – may have impeded more widespread diagnostic testing in many countries, particularly in the earlier stages of the pandemic.[8] The impact of including suspected cases can be significant – by 15 May, the number of COVID-19 deaths in the United Kingdom confirmed with a test was 33 998, while all deaths including those due to other reasons but with a judged presence of COVID-19 was 45 231, some 33% higher. In Belgium, up until the end of May, 40% of the cumulative death toll were suspected cases of COVID-19 rather than confirmed cases. Of these suspected cases, almost 95% occurred in care homes.[9]

Differences in coding practices on death certificates and reporting of deaths can hamper direct comparisons

20. Countries also differ in the administrative processes of formally reporting deaths and have different time delays between the moment of death, the reporting of death, and the inclusion of reported deaths in nationally reported statistics. This is one of the reasons that daily reporting can fluctuate considerably due to the reporting practices (e.g. many more cases and deaths may be reported on Tuesday because of delays in reporting over a weekend). For example, Statistics Netherlands (CBS) codes the underlying cause of mortality according to WHO guidelines. However, coding practices can take quite a long time, because the workflow process – from determining the cause of death by a physician to delivering the final data to CBS – is still mostly paper-based. The issue of incomplete reporting is a problem not only for COVID-19 related deaths but also when examining overall patterns of mortality with figures for the most recent periods that are in some cases subject to significant under-reporting (as discussed below). This becomes less of an issue when averaged over a longer period of time but more of a problem for any single-point of time comparisons across countries. Also the depth of coding of the main cause and associated causes of death may differ, to the extent that COVID-19 is mentioned on the death certificate.

21. More consistent coding with WHO guidelines and reporting procedures across countries would help limit some of the differences, and investment in improved health information systems, particularly outside the hospital sector, would assist in collecting and reporting more timely and accurate data. The increased digitalisation of registers of vital events is particularly important. In the case of Italy, electronic registers have been useful in monitoring the surge of deaths in almost real time for many but not in all localities. In some areas there is still a considerable delay in obtaining data on registered deaths because they have not been digitalised.

[8] Testing for COVID 19: A way to lift confinement restrictions. https://www.oecd.org/coronavirus/policy-responses/testing-for-COVID-19-a-way-to-lift-confinement-restrictions/.

[9] COVID-19 bulletin épidémiologique du 31 mai 2020 : https://COVID-19.sciensano.be/sites/default/files/Covid19/COVID-19_Dailypercentage20report_20200531%20-percentage20FR.pdf.

3 The case for looking at all deaths

22. Taking into account the range of factors, caution needs to be exercised in drawing too many conclusions from a direct comparison of reported COVID-19 deaths between countries. While the numbers of COVID-19 deaths can provide important information, overall mortality statistics, for most middle and high-income countries, are more standardised in their reporting. In the absence of shocks, national mortality trends tend to follow a seasonal pattern over corresponding weeks each year. **Excess mortality**, a measure of mortality over and above what could normally be expected for the period (in this case the average over the previous five years) can show the impact – both direct and indirect – of COVID-19.

Excess mortality looks at the total number of deaths over and above what could normally be expected for the time of year

23. Estimations of *excess mortality* can give an overall understanding of the impact of COVID-19, by not only comparing deaths that are directly attributable to the virus, but also by taking into account *indirect* mortality. There may be, for example, deaths due to health systems not being able to cope with other conditions or to the longer-term impact of the pandemic on population health. There has been preliminary evidence of disruptions to continuity of care, hindering people suffering from heart attacks, strokes and other conditions from seeking necessary treatment in emergency rooms, or of delays in accessing regular preventive or ongoing care in primary care practitioner (GP), surgeries or outpatient departments for chronic conditions. For example, the National Health Service (NHS) in England reported a 60% drop in the number of patients being assessed by a cancer doctor in April 2020 compared with the same month in 2019.[10] This drop in referrals was partly due to fewer patients seeing their GPs during lockdown, although essential and urgent cancer treatments continued during this period. Visits to Accident and Emergency departments in England also fell by 57% in the same period.[11] Part of this decrease can be traced to the various lockdown measures put in place and to reduced social interaction, with fewer traffic and workplace accidents, and less exposure to other contractible illnesses and pollutants.

24. As the emphasis shifts from the acute phase of the pandemic to a longer transitional phase, the social and economic impact may become a significant factor in mortality rates, with detrimental effects on mental and physical well-being through periods of confinement and deteriorating financial conditions. Only a longer perspective with more detailed and

10 https://www.theguardian.com/society/2020/jun/11/cancer-patients-missed-out-on-tests-during-uk-coronavirus-lockdown.

11 https://www.health.org.uk/news-and-comment/charts-and-infographics/visits-to-a-e-departments-in-england-in-april-2020-fell-by-57.

comprehensive data on deaths (for example, by age, sex and socio-economic status) will assist in a more thorough analysis of the effects of the coronavirus on mortality.

25. Since the onset of the pandemic, an increasing number of national statistical offices and health authorities have been making timely and detailed data on deaths more readily available. For example, the CDC has started to report provisional death certificate data in the United States.[12] A discussion of the most recent levels and trends often accompany these statistics. The Dutch statistical office provides a regular (weekly) update showing excess mortality in graphs, monitoring deaths registered each week in 2020 and comparing them with the same weeks in 2017, 2018 and 2019.[13] The French National Institute of Statistics and Economic Studies (INSEE) rapidly made available on line data from death certificates broken down by age, sex and place of death, along with comparisons against the previous two years.[14]

26. While reporting total deaths addresses some of the issues, for international comparability purposes national reporting against the underlying "normal" rates may differ depending on which, and over how many years, the "normal" period has been calculated, and whether this is heavily influenced by significant annual variations, for example from severe flu-periods or deadly heatwaves during the years in question. Date of registration of death rather than date of death itself can have an impact when comparing recent trends; the related delays in reporting deaths and revising counts can vary considerably from country to country affecting the degree of completeness, particularly for the most recent time periods (see Box 2). Conclusions about apparent falls in overall mortality may therefore be premature in such cases.[15] For the purpose of international comparisons of the overall impact of COVID-19, both direct and indirect, excess mortality that is based on common definitions and standards should be preferred.[16]

[12] https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm.

[13] Statistics Netherlands (CBS). https://www.cbs.nl/en-gb/news/2020/18/mortality-decline-continues-more-slowly-than-last-week.

[14] https://www.insee.fr/fr/statistiques/4487854#documentation-sommaire.

[15] https://www.health.org.uk/news-and-comment/charts-and-infographics/understanding-excess-mortality-the-fairest-way-to-make-international-comparisons.

[16] https://voxeu.org/article/excess-mortality-england-european-outlier-COVID-19-pandemic.

Box 2. Limitations in comparing excess mortality across countries – data and methodology

All cause death statistics

Looking at the total number of deaths removes a number of the country-specific variations in recording COVID-19 specific deaths. While, for the most part, civil registration systems in OECD countries mean that death registers are eventually complete, there remain some limitations in comparing total deaths – particularly when assessing recent data and comparing countries over a short period, which is why care should be taken in drawing strong conclusions from cross-country comparisons.

Date of occurrence vs. date of registration: Figures for some countries may refer to the date a death is registered (e.g. United Kingdom) rather than the actual date of death. While statistics referring to registration can be adjusted to date of death, and will be compatible over a longer period, the use of statistics based on registration may affect comparisons over short periods of time. Where delays in registering deaths can be impacted by public holidays and weekends, this can distort the figures. Additionally, there can be delays in registering deaths that occur in care homes and in the community, or where an examination of cause of death may be required. Weekly statistics may not always be based on a standard week, for example, counting deaths from Saturday to Friday rather than Monday to Sunday. Changes to registration procedures and the delay between the occurrence and registration of a death may also have changed over the course of the pandemic for some countries. This may impact weekly estimates of excess mortality that are based on date of registration rather than date of occurrence.

Under-reporting and revisions: Due to delays in registering deaths, the numbers reported for the latest periods (days or weeks) can be subject to varying levels of completeness, both by week and by country. Incomplete or late reporting from some provinces or regions (because of different information systems, for example) may result in significant underestimates of the total number of deaths in that country, and therefore excess mortality. Some countries (e.g. the United States) may adjust their series to estimate the total number of deaths for the latest reporting periods.[17] It is important to be aware of unadjusted and adjusted series, as well as to regularly update the time series to account for revisions.

The Human Mortality Database at the University of California, Berkeley (https://www.mortality.org/) has assembled comprehensive information regarding the differences in national reporting practices for mortality statistics.

Methodology behind excess mortality

The preliminary indicators of excess mortality contained in this brief follow a simple and easily interpretable calculation comparing the number of deaths recorded for a certain period against the *expected* number of deaths over the same period. The corresponding percentage change from the expected value (the P-score) is generally deemed “transparent and comparable” (Aron et al., 2020[1]). The expected number of deaths is based on the average number of deaths for the same week or month over recent years (in this case typically the previous five years, 2015-19). This baseline could be considered a lower estimate of the expected number of deaths since both population growth and an ageing population would be expected to push up the number of deaths observed each year. For example, New Zealand has seen

[17] https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm

its population grow by around 9% since 2015, with the number of people aged 65 and over increasing by 18%. Significant events such as severe flu seasons, heatwaves, natural disasters, etc. might have significantly impacted the number of deaths over a period, affecting the underlying average. Comparing current levels of mortality against this baseline may, in effect, either under- or over-estimate the level of excess mortality. The current method has the advantage of being transparent in basing the calculations on the actual number of reported deaths rather than any adjusted values.

The time the virus established a foothold also varied across countries, meaning that caution is needed in making international comparisons of excess mortality rates at a given point in time. This is mitigated by comparing excess mortality rates over a peak ten week period that is specific to each country. However, even this approach requires some care in interpretation. By its nature the virus generates strong 'local effects', meaning that the impact may initially be more severe in some towns, cities, states and regions before progressing to other parts of a country. This effect is likely to mean that, for any given time-limited period, smaller countries are likely to have higher excess deaths than larger countries, where at the national level the 'peak period' is likely to be spread over a longer period of time, reflecting a series of peaks and troughs occurring at a more local level. In the United States, for example, the number of new cases in New York State peaked on 4 April, whilst peaks in many other States only started appearing much later.

A first look at the potential impact of adjusting the length of the period of excess mortality and changes in the population size and structure in described in Box 3.

Refinements of the methodology could take into account national variations in the underlying death rates by employing confidence intervals, as well considering demographic and seasonal trends. Starting from Farrington et al. (1996[2]), several epidemiological studies have calculated standardised scores (z-scores) of deaths, showing by how many standard deviations the weekly number of deaths is above or below the national baseline. A similar strategy has been followed by the consortium Euro-Momo (Nielsen et al., 2012[3]), while Enki et al. (2016[4]) compare the performance of different algorithms to derive scores and detect disease outbreaks.

There are two main advantages of standardised scores over reported deaths: i) they provide essentially a confidence interval to gauge the magnitude of mortality deviations; and ii) they account for trends in mortality rates across years, as well as for seasonal trends within years. On the other hand, standardised scores are more difficult to communicate to the broader public.

27. It is also important to take a longer term view in determining the overall impact of the virus. One of the characteristics of the SARS-Cov-2 virus is that it disproportionally affects the elderly (typically 80% or more of COVID-19 deaths have occurred in the population aged over 65) and those with certain chronic conditions (e.g. cardiovascular disease, diabetes). Indeed, the vast majority of deaths occur in those sections of the population with an already heightened risk of mortality. As such, it might be expected that there could be an increase in mortality (mortality displacement) following, for example, a mild flu season. Similarly, a dip in mortality in the weeks and months following the peak in COVID-19 related deaths is also possible, although whether this translates into an excess or deficit over the year as a whole will depend on the severity of the crisis. Other non-COVID-19 shocks might also affect this year's mortality rate leading to an overestimation of the impact of COVID-19.

4 Excess mortality in OECD countries

28. OECD has compiled data on total deaths from 29 OECD countries. The summary tables and illustrative charts below provide a preliminary and simple perspective on the overall impact of COVID-19 on overall mortality rates across OECD countries in 2020 compared with recent years. While COVID-19 had a direct impact on the overall level of mortality in many countries, a number of factors influence the observed level of excess deaths. Not all COVID-19 deaths can be considered as excess mortality, since a proportion of these deaths would normally have occurred during this period as part of the regular seasonal patterns observed in all countries and which, therefore, form part of the baseline. The total number of COVID-19 reported deaths can therefore be greater than the measure of excess mortality reported below. Where reported COVID-19 deaths are significantly lower than excess mortality, some of these extra deaths may have had COVID-19 as a direct contributing factor and have gone under-reported as such or, as has been discussed above, some of the additional deaths may have been caused indirectly by COVID-19 due to, for example, the severe pressures on the health system. In addition, there may have been a reduction in deaths due to other causes, perhaps as a result of measures taken to combat coronavirus (e.g. shielding of the vulnerable, fewer road traffic accidents, etc.). Further analyses will allow disentangling the influence of various factors. A full picture can only be assembled with more granular data and the complete reporting of all deaths over a longer time period.

29. Figure 3 shows the increase in total recorded deaths for 28 OECD countries[18] over a 10-week period corresponding to the maximum aggregate level of excess mortality recorded in each country. The onset and progression of the crisis differs from country to country, with many European countries observing excess mortality from around early to mid-March onwards, and countries in Latin America typically some weeks later. A 10-week period is selected as, for most countries, this generally corresponds to the duration of the first phase of the pandemic, and because reported data over this period are relatively complete and not subject to significant revisions.[19] Moreover, a ten-week window provides a means to generate timely data at this critical juncture.

30. However care is needed in interpretation, and in making comparisons, as the duration of the first phase of the pandemic may differ across countries. Further, national aggregates, do not reflect the localised impact of the COVID-19 pandemic in some regions, provinces or cities (e.g. Lombardy in Italy, or New York City in the United States[20]) that experienced far greater levels of excess mortality than recorded nationally. In turn, countries with greater geographical dispersions may experience regional outbreaks and varying containment/mitigation measures in place across sub-national jurisdictions over a longer period of time than 10 weeks, which will

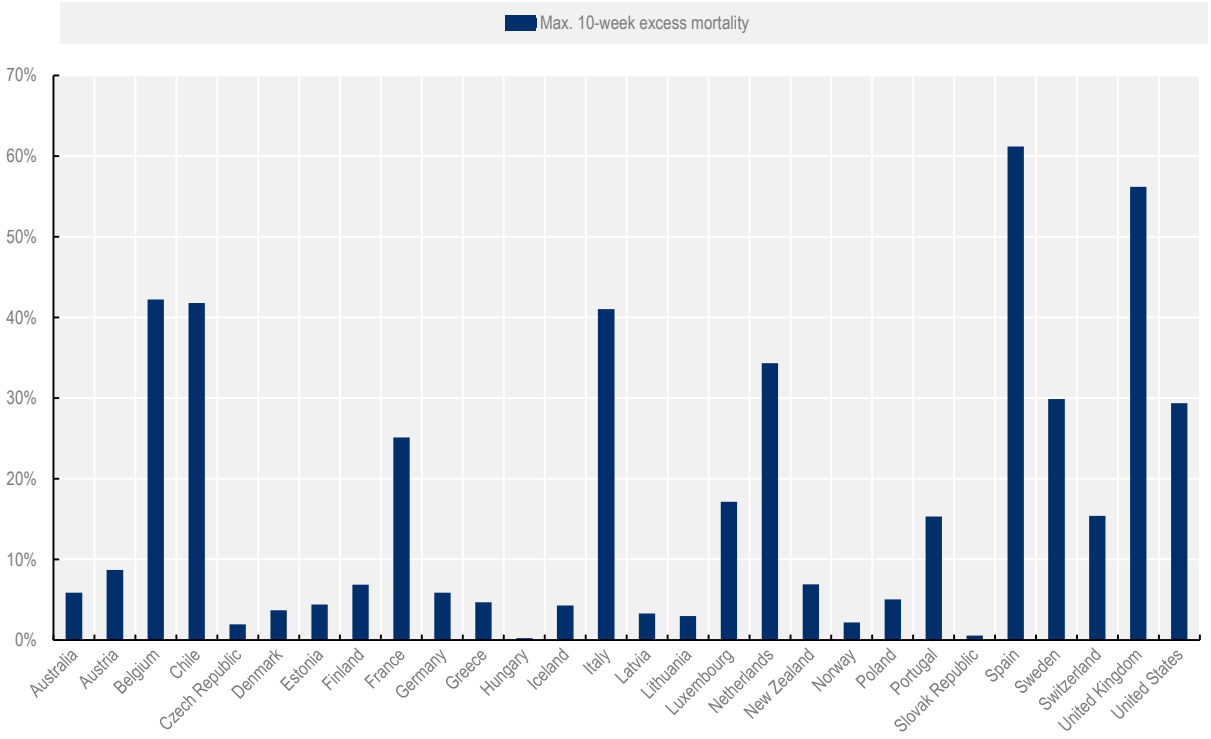
[18] Slovenia is not included since all-cause mortality figures were only available up to Week 13.

[19] For some countries experiencing excess mortality in more recent weeks, the 10-week period of maximum aggregate excess mortality may change as data on the number of deaths are revised and become available.

[20] https://www.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm#dashboard.

flatten the national picture overall. As further data becomes available, longer periods, including full-year comparisons of excess mortality, could also be produced.

Figure 3. The maximum increase in the total number of deaths over a 10-week period during the first half of 2020 compared with the average for 2015-19



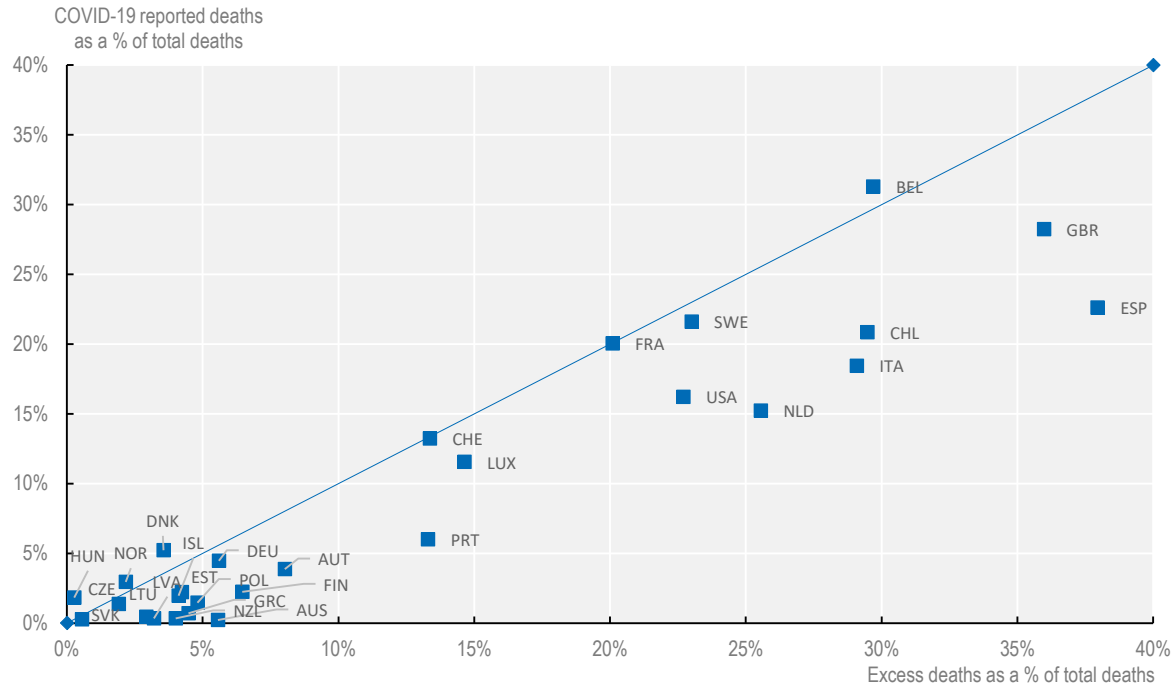
Note: The chart shows the increase in the number of reported deaths from all causes over a 10-week period corresponding to the maximum aggregate excess mortality and compared to the average from 2015 19 for the same period. Figures for Chile, Germany and Greece are compared against the average for 2016-19. Figures for Australia refer to doctor-certified deaths only. Deaths for the most recent weeks may be under-reported and subject to revision. Data available as of 05/09/2020 and cover the period up to Week 28.
Source: Australian Bureau of Statistics (ABS); Eurostat, The Human Mortality Database; Statistics New Zealand; Office for National Statistics; National Records of Scotland; Northern Ireland Statistics and Research Agency; Centers for Disease Control and Prevention.

31. Comparing the number of reported deaths from all causes against the average over the previous five years, Spain recorded a 61% increase in overall mortality over this 10-week period. At the beginning of April (Week 14), Spain also recorded the highest excess mortality for a single week, with a 154% increase in mortality, equating to more than 12 500 additional deaths compared to the 5-year average for the same week. The United Kingdom also registered 56% additional deaths (starting from Week 13) than would normally be expected over the corresponding 10-week. While some other countries (e.g. Austria, Finland and Germany) experienced mortality rates in specific weeks at the height of the pandemic 10-20% higher than expected, excess mortality over a 10-week period was less than 10% overall. For some countries in central and Eastern Europe, where early lockdown measures were put in place, the relatively low levels of infection and the reduced exposure to other causes of death may have resulted in a lower number of deaths compared to the average – although, again, final complete death statistics will only be able to confirm these observations in time.

Comparing the number of reported COVID-19 deaths and excess deaths

32. Comparing overall mortality with the number of *reported* deaths from COVID-19, by country, may give an indication of the potential under-reporting of COVID-19 related deaths. Figure 4 shows the number of reported COVID-19 deaths and our measure of excess deaths, during the 10-week period corresponding to the maximum aggregate measure of excess mortality following the onset of the COVID-19 crisis, expressed as a share of total deaths from all causes in each country.

Figure 4. Excess mortality and reported COVID-19 deaths as a share of total deaths over a 10-week period during the first half of 2020



Note: The chart shows the number of reported deaths from COVID-19 and excess deaths over a 10-week period corresponding to the maximum aggregate excess mortality in each country as a share of total deaths from all causes. The 45º line indicates where the number of COVID-19 deaths is equal to the number of excess deaths. The calculation of excess deaths is with reference to the average of 2015-19. All cause deaths for Australia refer to doctor-certified deaths whereas COVID-19 deaths include all deaths. Excess deaths for Chile and Germany are calculated against the average for 2016-19. Data refer to the number of deaths reported as of 05/09/2020 up to Week 28; data for the most recent weeks may be under-reported and subject to revision.
Source: Australian Bureau of Statistics; Eurostat, The Human Mortality Database; Office for National Statistics; National Records of Scotland; Northern Ireland Statistics and Research Agency; Centers for Disease Control and Prevention; The Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.

33. Potential under-reporting of COVID-19 related deaths, as indicated by the comparison of the number of reported COVID-19 and excess deaths should not be seen as evidence of deliberate hiding of the extent of the crisis, but can happen for reasons as highlighted earlier (e.g. the testing and coding procedures). Moreover, because many factors affect excess mortality, it should not be interpreted as an indication of adequacy of policy measures applied to face the crisis. Some of the factors shaping the relation between the two measures include the season of the year (depending. for example, whether the country is in the northern or southern hemisphere), and the structure of the economy (for example, countries whose tourism sector is

relatively big may have been more exposed to the virus). The number of COVID-19 deaths reported in Chile up to Week 20, for example, accounted for only around a quarter of the excess mortality observed during this period before increasing significantly, perhaps suggesting under-reporting of COVID-19 deaths in the early stages of the crisis. The United Kingdom and the United States show reported COVID-19 deaths at around three-quarters of total excess deaths, suggesting that a significant number of cases were not captured as direct COVID-19 related deaths. In Belgium, often cited as the country adopting a more inclusive definition of COVID-19 deaths in its reporting, the number of COVID-19 deaths is closely aligned to the number of excess deaths. France and Switzerland also feature a number of excess deaths below those reported as deaths due to COVID-19. In Norway and Denmark, very low numbers of COVID-19 reported deaths as a share of total deaths and low or negative levels of excess mortality may reflect the effects of early and stringent lockdown measures.

Country-specific trends in excess mortality

34. Figure 5 shows the pattern of total mortality from all causes for 29 OECD countries on a weekly basis between 2015 and 2020, against the average of 2015-19. An excess number of deaths is recorded in most European countries from around Week 11 onwards with some variation outside of Europe; for example, excess mortality in the United States started slightly later. After Week 20, most countries started to return to a level of mortality generally in line with the 2015-19 average. It is notable, that in many European countries, deaths in the first 10 weeks or so of 2020 had been running below average, due to a relatively benign influenza season over the 2019/20 winter. This mild flu season, with fewer deaths than average, might be seen as a contributory factor in preserving a pool of vulnerable people who were highly susceptible to the more virulent coronavirus.

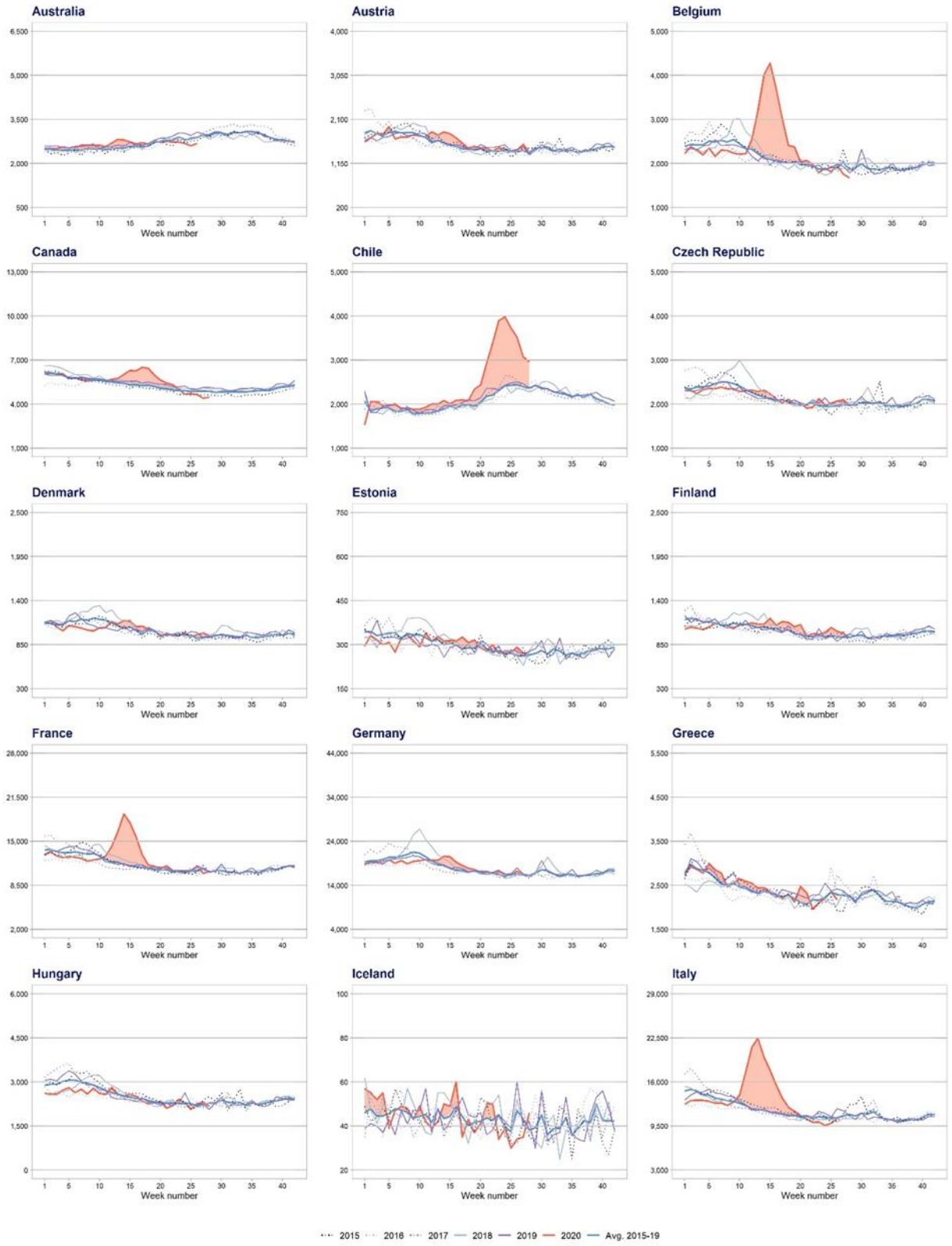
35. In France, the first week of registering excess mortality in 2020 was week 11, covering the period up to mid-March, and just prior to the introduction of national lockdown measures. There was a peak in excess mortality around the beginning of April with 19 000 deaths – or nearly 7 400 (or 64%) more than expected based on the average of the previous years. Interestingly, during the severe heatwave in France in 2009, which resulted in the deaths of many elderly persons, a *daily* peak of more than 3 500 excess deaths was recorded.[21] By the first week of May, the number of deaths recorded in France had returned close to the expected numbers, with overall mortality dipping below the average by mid-May. Again, it is important to note that more recent periods are prone to revisions as delayed death registrations feed into more complete statistics.

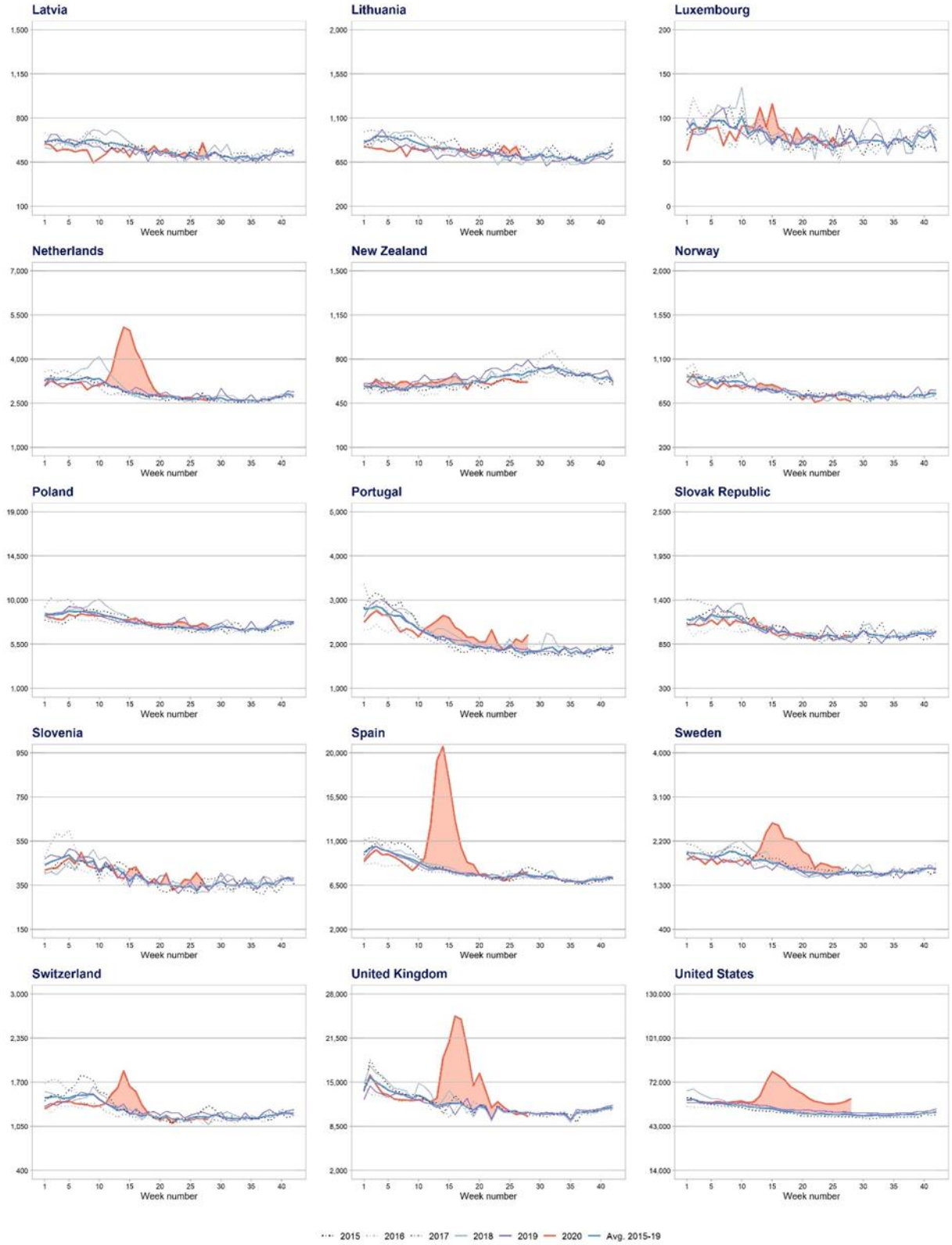
36. The chart for Germany shows that the number of deaths recorded in the first 10 weeks of 2020 was below the average of the previous four years. In 2018, a severe flu season in Germany (and other European countries such as Belgium and the Netherlands) led to significant excess mortality. The impact was particularly strong in Germany, with excess mortality over a 10-week period more than 12% above the expected level, reaching a weekly peak of nearly 5 500 (or 25%) more deaths in early March 2018. This has an effect on our assessment of the effect of the COVID-19 crisis, since the inclusion of 2018 will increase the 2015-19 average mortality level and hence reduce excess mortality calculations for 2020. While Germany has been cited for early widespread testing and measures put in place to contain the impact of coronavirus, this severe flu episode in 2018 may have contributed to a reduction in the pool of people vulnerable to COVID-19. In any case, excess mortality recorded in Germany during this 10-week period was

[21] Source: A. Bayet, S. Le Minez, V. Roux, blog INSEE.

less than 5% overall, reaching a peak of 13% above expected numbers in early April. The curve of excess mortality in Germany, while following a similar timeline to France, appears more flattened, and returned to the expected number of deaths at around the same time in mid-May.

Figure 5. Excess mortality in OECD countries in 2020





Note: The shaded area indicates where the number of deaths exceeds the average number of deaths for the same week 2015-19.
Source: Australian Bureau of Statistics (ABS), Eurostat, The Human Mortality Database; Statistics New Zealand; Office for National Statistics; National Records of Scotland; Northern Ireland Statistics and Research Agency; Centers for Disease Control and Prevention.

37. France, Belgium, Italy, Netherlands and Spain all show a significant peak in excess mortality around early April with a return to normal levels of deaths by mid-May. Sweden and the United Kingdom experienced a slightly delayed peak but a more sustained period of excess mortality with the curve still above the expected values in Week 20.

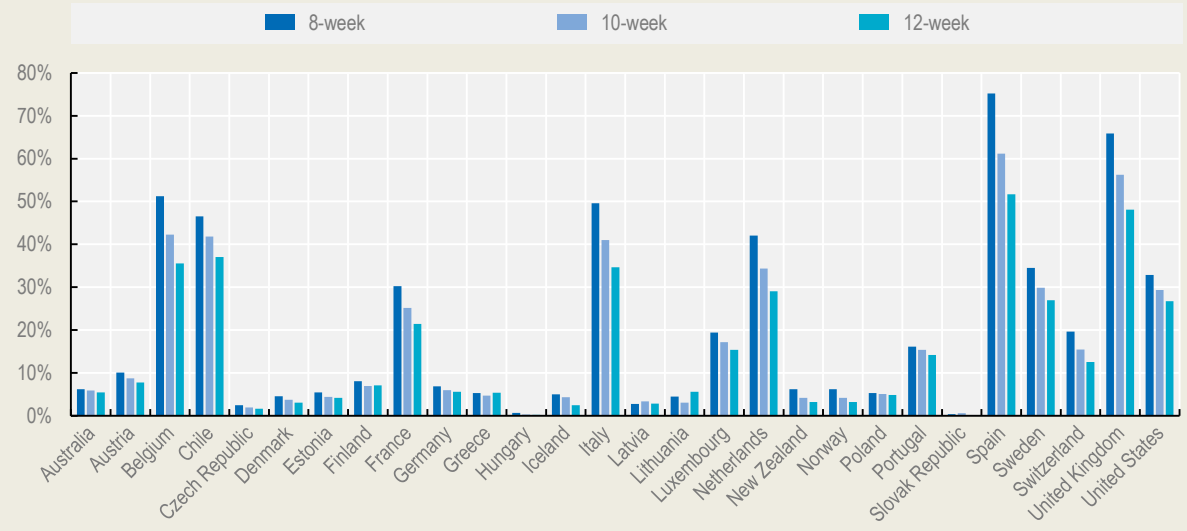
Box 3. Analysing the impact of duration, population change and aging on the calculation of excess mortality

Shortening or lengthening the period of analysis

The method of calculation of excess mortality used here is based on the maximum aggregate excess mortality since the onset of the COVID-19 pandemic in each country over a 10-week period. The choice of a 10-week period rather than a shorter or longer period reflects the average observed duration during which excess mortality occurred in many of the countries analysed. That said, there is a degree of variation such that excess mortality may cover a shorter period in some countries while it extends beyond a 10-week duration in others. For example, smaller countries are likely to have a more intense but shorter period of excess deaths than larger countries, where at the national level the 'peak period' is likely to be spread over a longer period, reflecting a series of peaks and troughs occurring at a more local level.

To examine the impact of adjusting the period of analysis on the relative levels of excess mortality, the calculation was replicated for both an 8-week and a 12-week period. As expected, an extension of the period of analysis generally results in a reduction of the overall level of excess mortality (Figure 6). This is the case in nearly all countries, except where excess mortality itself has been very low. Countries that experienced a shorter, more intense period of excess mortality see a greater decrease in the level of excess mortality as the period of observation is extended. However, the reduction to an 8-week or increase to a 12-week period does not alter significantly the relative levels of excess mortality across countries.

Figure 6. Adjusting the period of analysis for excess mortality



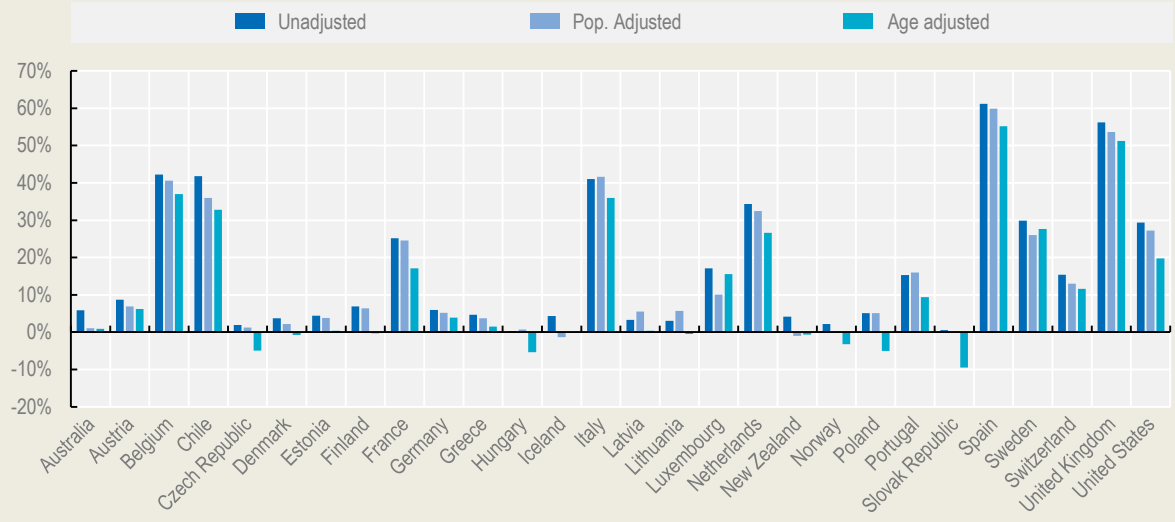
Note: Australian Bureau of Statistics (ABS), Eurostat, The Human Mortality Database; Statistics New Zealand; Office for National Statistics; National Records of Scotland; Northern Ireland Statistics and Research Agency; Centers for Disease Control and Prevention.
Source: Eurostat, The Human Mortality Database; Statistics New Zealand; Office for National Statistics; Centers for Disease Control and Prevention.

Adjusting for demographic change

As a country's population grows or ages year on year, we might also expect the number of deaths each year to increase. By comparing the number of deaths in 2020 against the average of the previous five years, we are assuming that there is no change either in the size of the population or the age structure. Or, by comparing actual numbers deaths in each country, we are in effect assuming the changes in population are the same. Of course, this is not the case, with some countries growing or ageing more quickly than others. Taking into account how the size of the population has changed and to what extent the share of the population, aged over 65 for example, has increased or decreased, gives an estimate of the impact on the number of deaths.

Figure 7 shows the larger impact of population growth on countries such as Australia, Chile and Iceland that have seen their populations grow by more than 5% over the last five years. The opposite effect is observed for Italy and Portugal with have seen a slight decrease in the size of their populations. Adjusting the number of deaths in previous years by using the proportion of the population over 65 in 2020 has the effect of decreasing the measure of excess mortality in most countries. The largest effect is felt in countries like Chile and the United States, where the relative increase in aging has been the greatest. In others, such as Austria and Sweden where the shift has been less, the impact is less pronounced. Again, the effects of adjusting past numbers of deaths to take account of changes in the size of the population and aging does not have a dramatic impact of the relative levels of excess mortality.

Figure 7. Adjusting excess mortality to changes in the size and structure of populations



Note: The chart compares excess mortality calculated using actual number of deaths observed from 2015 to 2020 with (1) a population-adjusted measure based on an estimated 2020 population and (2) an age-adjusted measure using the estimated share of the population aged 65 in 2020.
Source: Australian Bureau of Statistics (ABS), Eurostat, The Human Mortality Database; Statistics New Zealand; Office for National Statistics; Centers for Disease Control and Prevention.

38. A longer term view will take shape over the weeks and months to come. As well as benefitting from more complete statistics, the curves will also show the extent of any mortality displacement, whereby the significant peak in deaths due to COVID-19 may be followed by a dip

in mortality in the subsequent weeks and months. Whether this 'balancing' will itself be subject to the longer-term effects of ill-health and indirect mortality due to the pandemic, and result in an overall increase in mortality in 2020, will remain to be seen and warrants further analysis.

39. OECD will continue to gather nationally reported statistics on total and COVID-19 reported deaths. Figures will be updated and are expanded both geographically (by country and sub-regions) as well as through breakdowns by age and gender. At the same time, efforts should be made to harmonise the method to report total deaths and calculate excess mortality across countries. Member countries are encouraged countries to report more timely and complete data.

40. As the pandemic moves into the next phase, with OECD countries gradually re-opening economic and social activities, it will be important to assess the longer-term (direct and indirect) effects of the crisis on health outcomes. Delayed or foregone access to emergency care and ongoing treatments, and the health-related consequences from an abrupt economic downturn will need to be monitored. Accurate data on the levels and trends in excess mortality will allow for an examination of contribution of the various demographic, geographical and socio-economic factors. Linked to an assessment of the impact of the various measures put in place to tackle the COVID-19 crisis, these data will provide valuable lessons for future waves and pandemics.

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