Excess Deaths Associated with COVID-19

Provisional Death Counts for Coronavirus Disease (COVID-19)

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Estimates of excess deaths can provide information about the burden of mortality potentially related to the COVID-19 pandemic, including deaths that are directly or indirectly attributed to COVID-19. Excess deaths are typically defined as the difference between the observed numbers of deaths in some place and period of interest and expected numbers of deaths in the same time periods. This visualization provides weekly estimates of excess deaths by the jurisdiction of residence for the United States and for 47 jurisdictions with sufficient historical mortality data to determine whether more deaths than expected were observed, and if so, how many more deaths than expected.

Excess deaths are a useful measure for assessing the impact of a disease outbreak when calculation of reporting lags and other factors affecting the completeness and timeliness of cause-specific mortality reporting are not yet complete. Excess deaths can be calculated for COVID-19, and how many excess deaths are reported are due to other causes of death. These deaths could represent misclassified COVID-19 deaths, or potentially could be indirectly related to COVID-19 (for example, deaths among persons who did not receive medical care because of overwhelmed hospitals or medical personnel).

As of June 9, 2020, additional information on weekly counts of deaths by cause of death has been added to this release. Similar to all causes of death, these weekly counts can be compared to values from the same weeks in prior years to determine whether recent increases have been higher than what would be expected based on historical patterns. Comparisons between recent and historical mortality patterns could help identify reported or death certificates where COVID-19 has not been mentioned but may be potentially related to COVID-19.
https://www.cdc.gov/nchs/nvss/vsrr/covid_weekly/index.htm#AllCause(opens in a new window). Cause of death counts are based on the underlying cause of death, and presented for Pneumonia, Influenza, and COVID-19 (Pneumonia, Influenza, and COVID-19), Pneumonia and Influenza, and Other causes due to external causes (i.e. injuries) or unknown causes are excluded. For more detail, see the Technical Notes section. Weekly counts of deaths were also added for Alzheimer's disease.

Estimates of excess deaths can be calculated in a variety of ways, and will vary depending on the methodology and assumptions about how many deaths are expected to occur. Estimates of excess deaths in this visualization are based on estimates calculated using two different approaches (1). A range of values for the number of excess deaths was calculated as the difference between the observed count and one of two thresholds from the upper prediction bound of a 95% prediction interval (2). Weekly and cumulative counts of excess deaths are shown.

Provisional death counts are weighted to account for incomplete data. However, data for the most recent week(s) are still likely to be incomplete because of reporting lags and other factors affecting the completeness and timeliness of cause-specific mortality reporting. Excess deaths related to the pandemic are likely to be underestimated during the most recent weeks for which data are incomplete. For more information about the accuracy of the weighted estimates is obtained, further refinements to the weights may be made, which will impact the estimates. Any changes to the methods used to calculate weighted estimates will be posted on the Technical Notes when they occur. More detail about the methods, weighting, data, and limitations can be found in the Technical Notes.

This visualization includes the following features:

- **Number of excess deaths:** A range of estimates for the number of excess deaths was calculated as the difference between the observed counts and one of two thresholds (either the average expected count or the upper bound threshold), by week and jurisdiction. Negative values, where the observed counts for a week were less than the expected counts, are set to zero.
- **Percent excess:** The percent excess was defined as the number of excess deaths divided by the threshold.
- **Weekly and cumulative counts:** Weekly and cumulative counts of excess deaths are shown, calculated by summing the excess deaths in each week from February 1, 2020 to present. Similarly, the total number of excess deaths for a jurisdiction can be calculated as a sum of jurisdiction-specific weekly estimates of excess deaths. Negative values in weeks are set to zero and not directly estimated using the Farrington surveillance algorithm.

Select a dashboard from the menu, then click on "Update Dashboard" to navigate through the different graphs.

- The first dashboard shows the weekly predicted counts of deaths from all causes, and the threshold for the expected number of deaths. Select a jurisdiction from the drop-down menu to select certain jurisdictions.
- The second dashboard shows the weekly predicted counts of deaths from all causes and the weekly count of deaths from all causes excluding COVID-19. Select a jurisdiction from the drop-down menu to select certain jurisdictions.
- The third dashboard shows the weekly counts of deaths from all causes. Predicted counts (expected) are shown, along with reported counts (observed). Select a jurisdiction from the drop-down menu to select certain jurisdictions. Select a cause of death from the drop-down menu to select certain causes of death.
- The fourth dashboard shows the total number of excess deaths since early February, 2020. Jurisdictions with one or more excess deaths are shown. Use the radio buttons and drop-down menu to select a number of weeks to rank the top 10 jurisdictions by select certain jurisdictions.
- The fifth dashboard shows the percent by which the observed counts exceed the threshold (i.e. percent excess) by week and jurisdiction. Use the radio button to select all-cause mortality, or all-cause excluding COVID-19. Use the drop-down menu to select certain jurisdictions.
- The sixth dashboard shows weekly counts of death by age group. Use the drop-down menu to select certain jurisdictions.
- The seventh dashboard shows weekly counts of death by race and Hispanic origin. Use the drop-down menu to select certain jurisdictions and mortality outcomes (e.g., all-cause mortality, all-cause excluding COVID-19, and COVID-19 deaths).
- The eighth dashboard shows the change in the weekly number of deaths in 2020 relative to 2015-2019, by race and Hispanic origin. Use the drop-down menu to select certain jurisdictions.
- The ninth dashboard shows the number of deaths by cause of death by select groups (Respiratory diseases, Circulatory diseases, Malignant neoplasms, and Alzheimer disease and dementia). Use the drop-down menu to select a jurisdiction.
- The tenth dashboard shows the percent of all deaths in 2020 by cause of death by select groups (Respiratory diseases, Circulatory diseases, Malignant neoplasms, and Alzheimer disease and dementia). Use the drop-down menu to select a jurisdiction.
- The eleventh dashboard shows the change in the weekly number of deaths in 2020 relative to 2015-2019, by cause of death. Use the drop-down menu to select a jurisdiction.
- The twelfth dashboard shows the total number of deaths above the average count since early February, 2020, by cause of death. Use the drop-down menu to select certain jurisdictions.
- The thirteenth dashboard shows the total number of deaths above the average count since early February, 2020, by jurisdiction and cause of death. Use the drop-down menu to select certain jurisdictions.

Download datasets in CSV format by clicking on the link for the desired dataset under "CSV Format" link. Additional formats are available for download for each dataset at Data.CDC.Gov.

Changes to the weighting methodology were made to this visualization, effective as of September 5, 2020. More detail can be found in the Technical Notes. Future refinements to the methodology or other changes will be documented in the Technical Notes.

1. Weights for several jurisdictions were adjusted based on preliminary analysis of the timeliness of reporting of deaths for deaths occurring in April through May of 2020. These analyses have suggested that timeliness has improved with shorter lags in reporting for these jurisdictions. New for this update are Florida, Illinois, New Hampshire, North Carolina, South Carolina, Texas, Vermont, Virginia, and Puerto Rico. Weights for these jurisdictions were adjusted according to improve the accuracy of the predicted counts in these jurisdictions.

Options

Select a dashboard:

- Weekly Excess Deaths
- Excess deaths with and without COVID-19
- Excess deaths with and without weighting
- Number of Excess Deaths

Update Dashboard

- Percent Excess Deaths
- Weekly Number of Deaths by Age Group
- Weekly Number of Deaths by Race/Ethnicity
- Change in Number of Deaths by Race/Ethnicity
- Weekly Number of Deaths by Cause of Death Group
- Weekly Number of Deaths by Cause of Death Subgroup
- Change in the Number of Deaths by Cause
- Total number above average by cause

Total number above average by jurisdiction/cause

Download Data:

CSV Format:

- National and State Estimates of Excess Deaths
- Weekly Deaths by State and Age
- Weekly Deaths by State and Cause of Death
- Weekly Deaths by State and Race and Ethnicity

Data CDC.gov®:

- National and State Estimates of Excess Deaths
- Weekly Deaths by State and Age
- Weekly Deaths by State and Cause of Death
- Weekly Deaths by State and Race and Ethnicity

Select a jurisdiction

United States

- Includes observed count above threshold
- Predicted number of deaths from all causes
- Predicted number of deaths

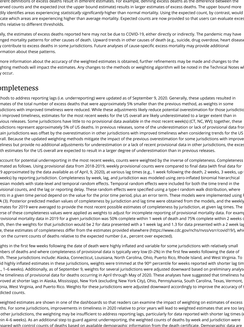

Figure Notes:

Number of deaths reported on this page are the total number of deaths received and coded as of the date of analysis and do not represent all deaths that occurred during the week. Provisional death counts are weighted to account for incomplete data. However, data for the most recent week(s) are still likely to be underestimated in NCHS and provisional for reporting purposes. This delay can range from 1 week to 8 weeks or more, depending on the jurisdiction and cause of death. See https://www.cdc.gov/nchs/nvss/vsrr/covid19/index.htm for more information. Data for New York includes New York City. Data on all deaths excluding COVID-19 include deaths with U07.1 as an underlying or multiple cause of death. Death counts were derived from the National Vital Statistics System database that provides the timeliest access to the vital statistics mortality data and may differ slightly from other sources due to differences in completeness. Provisional death counts are based on the jurisdiction of residence and may differ from other sources due to differences in reporting jurisdiction where the timeliness of provisional data has changed in recent weeks relative to prior years. Data for jurisdictions with fewer than 10 deaths are not shown.

The following data utilizes data from the Farrington algorithm. Click the button to expand / collapse this section.

Weekly excess deaths

Technical Notes

Methods

Counts of deaths in the most recent weeks were compared with historical trends (from 2013 to present) to determine whether the number of deaths in recent weeks was significantly higher than expected using Farrington surveillance algorithms (1). The "surveillance" package in R software was used to implement the Farrington algorithm. Weekly counts of deaths were adjusted for seasonality and trends using a quasi-Poisson regression model trends in counts, according to Serfling's approach. The model predicted counts were used to generate a prior 95 percent prediction and an upper bound threshold based on a one-sided 95% prediction interval of these expected counts is used to determine whether a significant increase in deaths has occurred. Estimates of excess deaths are calculated by subtracting the observed counts from either the average expected count or the upper bound threshold. The lower end of the excess death estimate range is generated by comparing the observed counts to the upper bound threshold, and a higher value for the excess death estimate range is generated by comparing the observed counts to the average expected number of deaths. Reported counts were weighted to account for potential underreporting in the most recent weeks.

This method is adapted from the Farrington algorithm, which was developed to detect outbreaks of disease, but can also be used to determine whether a given jurisdiction has fewer deaths than expected given that the data are provisional. Provisional counts of deaths are known to be incomplete, and the number of deaths reported in recent weeks for a given jurisdiction and cause of death will generally be lower than expected if fewer deaths are reported than usual. Thus, the estimates of excess deaths – the numbers of deaths falling above the threshold – may be lower than expected in these weeks because of reporting lags. This method may underestimate the number of excess deaths if there is a delay in the reporting of all deaths, or if mortality is higher than usual but not high enough to exceed the upper bound threshold of the Farrington algorithm.

A large of estimates of excess deaths is provided based on comparing the observed numbers of deaths to two different thresholds, by week and jurisdiction: 1) the average expected number of deaths, and 2) the upper bound of the 95% prediction interval of the expected number of deaths. Depending on which threshold was used, the estimate of excess deaths can be negative (if the observed number of deaths is lower than the expected number of deaths) or positive (if the observed number of deaths is higher than the threshold). The total number of excess deaths in each state was calculated by summing the excess deaths in each week from February 1, 2020 to present. Similarly, the total number of excess deaths for a jurisdiction can be calculated by summing the total numbers of excess deaths across the jurisdictions.

Different definitions of excess deaths result in different estimates. For example, defining excess deaths as the difference between the observed counts and the upper bound threshold of a 95% prediction interval results in fewer excess deaths than using the difference between the observed counts and the average expected number of deaths. Using the expected count, by contrast, would indicate which areas are experiencing higher than expected mortality. Using the expected count, by contrast, would indicate which areas are experiencing higher than expected mortality. Using the upper bound threshold to define excess deaths results in more conservative estimates of excess deaths relative to different thresholds.

Finally, the estimates of excess deaths reported here may not be due to COVID-19, either directly or indirectly. The pandemic may have changed mortality patterns for other causes of death. Upward trends in other causes of death (e.g., suicide, drug overdose, heart disease) may contribute to excess deaths. Decreases in other causes of cause-specific mortality may offset the increase in deaths. For more information about these patterns.

As more information about the accuracy of the weighted estimates is obtained, further refinements may be made and changes to the weighting methods will impact the estimates. Any changes to the methods or weighting algorithm will be noted in the Technical Notes when they occur.

Completeness

Methods to address reporting lags (i.e. underreporting) were updated as of September 9, 2020. Generally, these updates resulted in estimates of the total number of excess deaths in recent weeks being slightly smaller than in previous releases. However, in some jurisdictions with improved timeliness, the estimates were reduced. While these adjustments likely reduce potential overestimation for those jurisdictions with improved timeliness, estimates for the most recent weeks, for the US overall and many jurisdictions, are still higher than in previous releases. Some jurisdictions have little to no provisional data available in the most recent weeks(NY, CT, NC, NYC) together, these jurisdictions have been excluded from the US estimate. Other jurisdictions have incomplete reporting in some jurisdictions (MA, PA), certain jurisdictions with sufficient data have been included in the US estimate (CA, FL, GA, IL, MI, MN, NJ, TX, WA, and DC). Overall, Because the updated weighting methods mitigate the impact of the previous overestimation for some jurisdictions with improved timeliness but provide additional adjustments for underestimation or a lack of reported provisional data in other jurisdictions, the excess death estimates for the US overall are expected to result in a larger degree of underestimation than in previous releases.

To account for potential underreporting of deaths in recent weeks, the Farrington algorithm has been modified and validated. Completeness was estimated as follows. Using provisional data from 2018-2019, weekly provisional counts were compared to final data (with final data for 2019 approximately 90% complete). Ratios of final to provisional counts in 2018-2019 were used to fit a GAM model (with a 7 week lookback, and 1 week ahead) to predict weekly reporting completeness. Completeness by week, lag, and jurisdiction was modeled using zero-inflated binomial hierarchical models with random intercepts for jurisdiction and a random walk over week. Predictions from the GAM model were used to adjust the provisional counts and their corresponding prediction intervals to account for expected reporting delays. These adjusted counts were then used as the inputs for the Farrington surveillance algorithms. Until data are finalized (typically 12 months after the close of the data year), it is not possible to determine whether observed increases in mortality are partially or wholly due to increasingly complete reporting. Therefore, when computing excess deaths directly for the US, negative values due to incomplete reporting in some jurisdictions will offset excess deaths observed in other jurisdictions. For example, if 100 excess deaths are observed in one jurisdiction and 50 fewer than expected in another, the algorithms also appropriately 25% lower than the number calculated by summing across the jurisdictions with excess deaths. This approach assumes that the relative completeness of reporting is similar across jurisdictions. If it is not, then it could lead to underreporting or an bias in mortality in some jurisdictions compared to others. These factors, in addition, potential differences between the number of excess deaths in the US when estimated directly compared with the sum of jurisdiction-specific estimates could be related to different estimated timeliness for the expected number of deaths in the US and across the jurisdictions.

Mortality Outcomes

Weekly counts of deaths from all causes were reviewed, including deaths due to COVID-19. As many deaths due to COVID-19 may be assigned to other causes of death (for example, if COVID-19 was not recognized as a cause of death or was not tested for, or if tests were delayed), tracking all-cause mortality can provide information about whether an excess number of deaths is observed, even when COVID-19 mortality is not identified as the cause of death. Excess deaths can also be examined to see if other causes of death may be indirectly related to COVID-19. For example, if deaths due to other causes may increase as a result of health care shortages due to COVID-19. Additionally, deaths from all causes **excluding COVID-19** mortality can be examined. These counts include deaths with U07.1 as an underlying or multiple cause of death.

Comparing these two sets of estimates — excess deaths with and without COVID-19 — can provide insight about how many excess deaths are identified as due to COVID-19, and how many excess deaths are due to other causes of death. These deaths could represent misclassified COVID-19 deaths, or potentially could be indirectly related to COVID-19. Additionally, death certificates are often initially completed without a cause of death, and instead coded as R99. Deaths with ICD-10 code R99 are included under the Respiratory disease category. Cause of death coding for deaths with R99 will be updated in coming weeks with cause-of-death information that includes COVID-19. These counts will be updated periodically, and the numbers presented will change as more data are received.

Cause of Death

As of June 9, 2020, weekly counts of deaths due to select causes of death are presented. These causes were selected based on analyses of controlled conditions on death certificates where COVID-19 has been listed as a cause of death (see https://www.cdc.gov/nchs/nvss/vsrr/covid_weekly/index.htm#AllCause). Some causes with insufficient numbers of deaths by week and jurisdiction will not be shown. Deaths from all causes, deaths from all causes excluding COVID-19, and deaths from COVID-19 (U071) are also shown. Deaths are based on the underlying cause of death, and include Respiratory diseases, Circulatory diseases, Malignant neoplasms, and Alzheimer disease and dementia. ICD-10 codes were used to classify deaths according to the following causes:

- Respiratory diseases
  - Influenza and pneumonia (J09-J18)
  - Chronic lower respiratory diseases (J40-J47)
  - Other diseases of the respiratory system (J00-J06, J20-J39, J50-J70, J80-J86, J90-J96, J97-J99, R09.2, U04)
- Circulatory diseases
  - Hypertensive diseases (I10-I15)
  - Ischemic heart diseases (I20-I25)
  - Heart failure (I50)
  - Cerebrovascular diseases (I60-I69)
  - Other disease of the circulatory system (I00-I09, I26-I46, I51-I52, I70-I99)
- Malignant neoplasms (C00-C97)
- Alzheimer disease and dementia (G30, G31, F01, F03)
- Other select causes of death
  - Diabetes (E10-E14)
  - Renal failure (N17-N19)
  - Sepsis (A40-A41)

Estimated numbers of deaths due to these other causes of death could represent misclassified COVID-19 deaths, or potentially could be indirectly related to COVID-19. For example, deaths from diabetes could increase in the context of health care shortages due to COVID-19 or other systemic factors with an underlying cause of death COVID-19 **are not included** in these estimates of deaths due to other causes, but could potentially be related to COVID-19. Additionally, death certificates are often initially completed without a cause of death, and instead coded as R99. For example, a person who died from COVID-19 without other conditions would be coded with R99 as the underlying cause of death. These deaths will be updated in coming weeks with cause-of-death information that includes COVID-19. These counts will be updated periodically, and the numbers presented will change as more data are received.

Limitations

These estimates are based on provisional data, which are incomplete. The weighting method approach may not fully account for reporting lags. If there are large reporting lags for deaths occurring in recent weeks, the estimates of excess deaths in those weeks may be underestimated. Estimates may be lower than expected, and death counts for 2020 may be underestimated. Conversely, the weighting method may overestimate the number of deaths if the reporting of deaths in 2020 is more timely than reporting in previous years, or if there is a change in mortality that is not related to the impact of reporting of provisional death counts. However, these potential provisional counts are incomplete, and the extent to which they may underestimate the true count of deaths is unknown. Some jurisdictions exhibit recent increases in deaths when using weighted estimates, but not for reporting of the estimates presented here to be part of an early indicator of an increase in deaths due to COVID-19. This should be interpreted with caution, until confirmed by other data sources such as state or local health departments. It is possible that recent increases in deaths in these jurisdictions could be related to COVID-19 and may be an early indicator of an increase in COVID-19 deaths in the area, but not for comparability. Formal analyses have not been performed to compare with historically low levels of completeness (e.g., Connecticut, North Carolina) either due to the cause of death or insufficient weighting to address incomplete data.

The completeness of provisional data varies by cause of death and by age group. However, the weights applied do not account for differences in the completeness of provisional data by cause of death or by age group. Although the weighted estimates of excess deaths may be too low for some age groups, underlying patterns, such as a shift toward younger ages, may be observed. Although the number of excess deaths may be too large for specific age groups, the relative change in mortality by age may be accurate. Predicted counts may therefore be too low among the younger age groups. Since the weights were based on the completeness of provisional data by cause of death and by place of death, the weighted estimates for specific causes of death are likely too low, or reporting lags may largely be for specific causes of death than for all-cause mortality. To minimize the degree of underreporting, cause-specific estimates are presented with a two-week lag.

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