National Center for Health Statistics

Excess Deaths Associated with COVID-19

Provisional Death Counts for Coronavirus Disease (COVID-19)

Updated June 10, 2020

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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 number of deaths in a given place, time period, and population and expected numbers of deaths in the same time periods. This visualization provides weekly estimates of excess deaths by the jurisdiction in which the death occurred. Weekly counts of deaths are compared against historical trends to determine whether the number of deaths is significantly higher than expected.

Counts of deaths from all causes of death, including COVID-19, are presented as soon as deaths due to COVID-19 may be assigned to other causes of death (for example, if COVID-19 was not diagnosed or not mentioned on the death certificate), tracking all-cause mortality can provide information about whether an excess number of deaths is observed, even when COVID-19 mortality may be underestimated. These measures can also provide information on deaths that may be indirectly related to COVID-19 where any underlying cause of death, including 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 identified as a multiple cause of death. Deaths directly or indirectly related to the pandemic COVID-19 deaths, or potentially could be indirectly related to the COVID-19 pandemic (e.g., deaths from other causes occurring in the context of health care disruption, or deaths from underlying conditions).

As of June 2, 2020, additional information on weekly counts of deaths by cause of death has been added to this release. Similar to all cause of death, these weekly counts of deaths are compared to historical trends to determine whether the number of deaths in recent increases are higher than occurred for specific causes of death. The causes shown here were chosen based on analyses of the most prevalent comorbid conditions mentioned on death certificates and causes of death that have been reported to be elevated in 2020 (https://www.cdc.gov/nchs/data/nvsr/nvsr69/nvsr69_03-508.pdf#xxxii). Cause of death trends are presented for Alzheimer disease, cardiovascular disease, diabetes, influenza and pneumonia, kidney disease, mental health, Parkinson disease, pneumonia, respiratory and stress, sepsis, and symptoms, signs, and abnormal clinical and laboratory findings not elsewhere classified. Deaths from COVID-19 are also added by age for all causes.

Weekly Process Model Updates: Due to the inherent variability of noisy, and not very dispersed data on the methodology, which assumptions about how the data behave are needed to model. Estimates of excess deaths presented in this webpage were calculated using Farrington surveillance algorithms [1,2] to model the number of expected deaths for each jurisdiction and to determine if deaths in recent weeks exceed the observed count and one or two thresholds (either the expected excess count or the upper bound of the 95% CI, by week and jurisdiction.

Provisional death counts are weighted to account for incomplete data. However, data for the most recent week(s) are still likely to be incomplete. Weights are based on the proportion of expected death certificates for each week, based on the number of death certificates received in prior relative to prior years, so the resulting weighted estimates may be too high in some jurisdictions and too low in others. As more information is received, the weighted estimates will be updated to reflect the most recently available data. Because of the nature of the Farrington algorithm, any changes to the methods or weighting will be noted in 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 several different estimates:

- **Number of excess deaths** is a count of excess deaths for the number of excess deaths was calculated as the difference between the observed count and one of two thresholds (either the average expected count or the upper bound of the 95% CI, by week and jurisdiction. Negative values indicate the observed number of deaths was less than expected.
- **Percent excess:** The percent excess was defined as the number of excess deaths divided by the threshold.
- **Total number of excess deaths** is a count of excess deaths for each jurisdiction and cause of death by summing the excess deaths in each week, from February 1, 2020 to present. Similarly, the total number of excess deaths for the US overall was computed as a sum of jurisdiction-specific counts for each week. Confidence intervals for the total number of excess deaths were estimated using the Farrington surveillance algorithms.

A dashboard from the CDC Data team on this URL is "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 show data for that jurisdiction.
- 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 show data for that jurisdiction.
- The third dashboard shows the weekly count of deaths from all causes. Predicted counts (weighted) are shown, along with reported (unweighted) counts, to illustrate the impact of underweighting. Select a jurisdiction from the drop-down menu to show data for that jurisdiction.
- The fourth dashboard shows the total number of excess deaths since early February, 2020. Jurisdictions with one or more excess deaths are shown, sorted by the total number of excess deaths. Hover over a bar to see the number of excess deaths. Select a jurisdiction to 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 due to select cause of death groups (Respiratory diseases, Circulatory diseases, Malignant neoplasms, and Alzheimer disease and Dementia). Use the drop-down menu to select a jurisdiction.
- The eighth dashboard shows weekly counts of death for the selected causes of death with one or more of the larger groups: Respiratory diseases and Circulatory diseases. Use the drop-down menus to select causes of death and certain jurisdictions.
- The ninth dashboard shows weekly counts of death due to select cause of death (Respiratory diseases, COVID-19, cause of death). Use the drop-down menu to select certain jurisdictions.
- The eleventh 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 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 eleventh 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 file formats are available for download for each dataset at Data.CDC.Gov.

Several changes were made to this visualization, effective as of June 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. Weekly counts of deaths by select demographic characteristics, by week, from January 1, 2020 and 2020.
2. Weekly counts of deaths due to select causes of death are presented. Trends are shown for 2015-2019 and 2020.
3. Total numbers of deaths above average levels since 2/1/2020 are shown for select causes of death.

Options

Select a dashboard:

- (selected) Weekly Excess Deaths
- Excess deaths with and without COVID (Update Dashboard)
- Number of Excess Deaths
- Weekly Excess Deaths
- Weekly Number of Deaths by Age
- Weekly Number of Deaths by Cause of Death
- Weekly Number of Deaths by Select Cause Group
- Weekly Number of Deaths by Cause 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 Jurisdiction and Age
- Weekly Deaths by State and Cause of Death

Data.CDC.gov
- National and State Estimates of Excess Deaths
- Weekly Deaths by State and Age
- Weekly Deaths by State and Cause of Death

Select a jurisdiction:
United States

- (selected) United States (Overall)
- Presented deaths from all causes
- Presented deaths from COVID

Weekly numbers of deaths (from all causes)

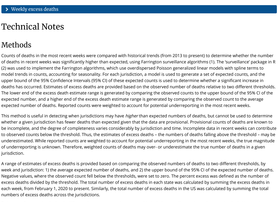

Figure Notes:

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 in that period. Data are incomplete because of the lag in time between when the death occurred and when the death certificate is completed, submitted to NCHS and received for reporting purposes. This delay can occur for 1 week or 8 weeks or more, depending on the jurisdiction and cause of death. See https://www.cdc.gov/nchs/nvss/vsrt10txt/mortcovtxt2020tr3.htm for more information. Data for New York excludes New York City. Data on all deaths including 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, COVID-19 coding rules, data processing and production schedules, and other factors. Weekly counts of deaths are based on the week in which jurisdictions where the timeliness of provisional data has changed in recent weeks (such as jurisdictions where cases between 1 and 8 are suppressed.

The following data series describe the current, displayed dashboard

click the relevant to expand / collapse data series

Weekly excess deaths

Technical Notes

Methods

Counts of deaths in the most recent weeks were compared with historical trends (from 2015 to present) to determine whether the number of deaths in recent weeks exceeded what they would typically be expected to be. Farrington surveillance algorithms (Farrington et al. 1996) [2] were used to implement the Farrington algorithms, which use overdispersed Poisson generalized linear models with spline terms to model the number of deaths expected in each week, accounting for seasonality, long-term mortality trends, and overdispersion in the data relative to the Poisson distribution. Weekly counts of deaths from all causes were modeled for each jurisdiction separately, using data from all deaths to fit the model. Data from 2020 were not included in the data used to fit the models.

Two measures of excess deaths were produced based on the observed number of deaths relative to two different thresholds. The first is the number of excess deaths estimate range is generated by comparing the observed count to the upper bound of the 95% CI of the expected number, and a higher end of the excess death estimate range is generated by comparing the observed count to the average expected number of deaths from the Farrington surveillance algorithms, by week and jurisdiction.

This method is useful in detecting when jurisdictions may have higher than expected numbers of deaths, but cannot be used to determine whether a jurisdiction's historical fewer deaths than expected given the data are proportion of historical counts of deaths are known to be incomplete, and the degree of completeness varies considerably by jurisdiction and time. Incomplete data in recent weeks can contribute to observed counts being lower than expected. Temporal variation in death counts can also be included for such time lags, which may be underestimated. While reported counts are weighted to account for potential underreporting in the most recent weeks, the true magnitude of underreporting is unknown. Therefore, weighted counts of deaths may over- or underestimate the true number of deaths in a given jurisdiction.

A range 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% CI of the expected number of deaths. Negative values, where the observed number of deaths is less than expected, are shown in the figure. Percent excess estimates are shown for excess deaths divided by 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 the US overall was computed by summing the excess deaths in each jurisdiction.

Estimates of excess deaths for the US overall were computed as a sum of jurisdiction-specific numbers of excess deaths (with negative values set to zero), and not directly estimated using the Farrington surveillance algorithms. Summation (rather than estimation) was chosen to account for potential correlation between jurisdictions that could substantially incomplete data while other jurisdictions may report more deaths than expected, these negative and positive values will cancel each other out when estimating excess deaths for the US directly using the Farrington surveillance algorithms. Until this issue is addressed, the US estimate will be set to zero. Close of the data (as of June 5, 2020) is possible to determine whether observed decreases in mortality using provisional data are due to true declines or to incomplete reporting. Thus, when estimating excess deaths, a lower bound of zero is used to ensure that the estimated number of excess deaths is not negative. Confidence intervals are reported in the jurisdiction-specific estimates, but not for the US estimate. Because the US estimate is computed directly for the US using the Farrington algorithms was approximately 23% lower than the number calculated by summing across the jurisdictions with excess deaths, the Farrington algorithm is likely due to several factors including the aggregation of the data, the presence of a few jurisdictions with a large number of underreporting issue declines in mortality in certain areas, or a combination of these factors. In addition, potential discrepancies between the number of excess deaths for the US when estimated directly using the Farrington algorithm and when estimated by summing the individual estimated differences between the expected number of deaths in the US and 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 expected (not the upper bound of the 95% CI) results in larger estimates of excess deaths. The upper bound of the 95% CI more readily identifies excess deaths representing statistically significantly higher than normal mortality, citing the expected counts, by contrast, would include which areas are experiencing higher than average mortality. Expected counts are now provided so that users can calculate 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 impacted mortality patterns in other causes of death, including deaths from other causes of death, for which the pandemic may have indirectly may contribute to excess deaths in some jurisdictions. Future analyses of cause-specific excess mortality may provide additional 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 May 12, 2020. Generally, these updates resulted in estimates of total number of excess deaths that were about 2% smaller than previously estimated. Further details on the updated methodology calculations was reduced.

To account for potential underreporting in the most recent weeks, counts were weighted by the inverse of completeness. Completeness was estimated as follows. Using provisional data from 2018-2019, weekly provisional counts were compared to final data (with final data for 2018 approximated by the 52 week in 2018). For each week, the proportion of death certificates received in the following weeks (0 to 25 weeks) by reporting jurisdiction. Completeness by week, lag, and jurisdiction was modeled using zero-inflated binomial hierarchical Bayesian models with random effects for jurisdiction and smooth penalized splines for time. Completeness was fitted to the most recent 8 weeks of provisional counts, and the lag or reporting delay. These random effects were specified using a type I random walk distribution, where counts in a given time period depend on the value for the prior time period, plus or minus a random error. Posterior predictive means of completeness were obtained from 10 chains, each with 1 warm-up and 1 sample, for a total of 20 posterior samples. These posterior predictive samples were used to provide the most recent estimates of completeness by jurisdiction and lag time were obtained from the models, and the weekly counts for 2020 were adjusted to provide the most recent estimates of completeness by jurisdiction, and lag time. The inverse of these completeness values were applied as weights to adjust for incomplete reporting of provisional mortality data. For example, if completeness was 50% for deaths occurring one week prior to the week of interest, then the weight for deaths occurring one week prior would equal 2, then the weights for deaths occurring two weeks prior would equal 1.5, and so on. For data processed with a 2 week lag, for all cause, these estimates of completeness differ from the estimates provided elsewhere (https://www.cdc.gov/nchs/nvss/vsrt10txt/mortcovtxt2020tr3.htm), only the current week's estimate differed in the current versus previous week.

Weights in the first two weeks following the date of death were highly inflated and variable for some jurisdictions with relatively small numbers of deaths and were consequently unstable. Therefore, weights were capped at 3 for the first two weeks following the date of death. These jurisdictions include: Alaska, Connecticut, Louisiana, North Carolina, Ohio, Puerto Rico, Rhode Island, and West Virginia. To minimize instability in these jurisdictions, weights were trimmed at the 90th percentile for weeks reported with shorter lag times (e.g., 1-4 weeks).

Unweighted estimates are also provided. Unweighted estimates are based on the number of deaths with complete information on reporting jurisdiction, death date, and death certificate completion date. Unweighted estimates are not adjusted for incomplete reporting in recent weeks or other jurisdictions, but may be insufficient to describe reporting patterns in the most recent weeks (for example, if no deaths occurred in some jurisdictions within 4-6 weeks). As an additional step to guard against underreporting, the weighted counts of deaths by week and jurisdiction were compared with counts based on a simple ratio adjustment method described in Ahmad et al. (https://www.medrxiv.org/content/10.1101/2020.04.20.20064223v1). If the ratio adjustment method yielded higher estimates than the Farrington algorithm, the ratio adjustment method was used to calculate the weighted counts of deaths. This approach was typically available prior to the cause of death data, which can take 1 week to 8 weeks or more, depending on the jurisdiction and cause of death. For weeks and jurisdictions where the weighted count of deaths was less than the control count based on the demographic data, the weighted values were replaced with the control count. For example, if the weighted count for a given jurisdiction and week was 400, while the control count for that week and jurisdiction was 500, the weighted count for that week would be 500. Because of the Farrington algorithm's assumptions, this case, the value of 400 would be used, as it represents a more complete estimate of the total number of deaths occurring in that jurisdiction and week.

Data for jurisdictions where counts are between 1 and 9 are suppressed. Additionally, data for weeks where the counts are less than 50% of the expected number are not shown because of the instability of the estimates. Data for jurisdictions with 10 or more deaths but where no deaths were recorded in following estimates with a lag of 1 week for most jurisdictions and the US. For some jurisdictions (Connecticut, North Carolina, Puerto Rico), lag times are longer. Declines in the observed number of deaths for the most recent weeks are expected, because not all deaths occurred in the month of the death. Delays in death certificate completion and submission to NCHS and processing and production schedules can vary by jurisdiction and time. Delays can be due to a variety of factors, including, but not limited to, the COVID-19 response. Delays in receipt of death certificates can result in underestimates of the number of deaths occurring in the most recent weeks. Because of the Farrington algorithm's assumptions, the Farrington algorithm may underestimate the number of deaths in a given jurisdiction and week.

Mortality Outcomes

Weekly counts of deaths from all causes were examined, 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 mentioned on the death certificate), tracking all-cause mortality can provide information about whether an excess number of deaths is observed, even when COVID-19 mortality may be underestimated. These measures can also provide information on deaths that 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** are also presented. Deaths with COVID-19 are also presented for 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 subsequently updated with additional information. Weekly counts of deaths from all causes may underestimate the total number of deaths directly to COVID-19 will be updated in coming weeks with cause-of-death information that includes COVID-19. These analyses will be updated periodically, and the numbers presented will change as more data are received.

Cause of Death

As of June 2, 2020, weekly counts of deaths due to select causes of death are presented. These causes were selected based on analyses of comorbid conditions reported on death certificates where COVID-19 was listed as a cause of death (see https://www.cdc.gov/nchs/nvss/vsrr/covid_weekly/index.htm#CauseofDeath). Some causes will insufficient numbers of deaths by week and jurisdiction were combined into other categories, and cause-specific trends are presented for Alzheimer disease and dementia category (ICD-10 codes G30, G31, F01, F03), Diseases of the heart (I00-I09, I11, I13, I20-I51), Malignant neoplasms (C00-C97), Diseases of the respiratory system (J00-J99), and Diseases of the circulatory system (I00-I99).

- Respiratory diseases
  - Influenza and pneumonia (J09-J18)
  - Chronic lower respiratory diseases (J40-J47)
  - Other diseases of the respiratory system (J00-J06, J20-J39, J60-J70, J80-J86, J90-J94, J95-J99, R09.2, U04)
- Circulatory diseases
  - Hypertensive diseases (I10-I15)
  - Ischemic heart disease (I20-I25)
  - Heart failure (I50)
  - Cerebrovascular diseases (I60-I69)
  - Other disease of the circulatory system (I00-I09, I26-I49, I70-I99)
- Malignant neoplasms (C00-C97)
- Alzheimer disease and dementia (G30, G31, F01, F03)
- Other selected causes
  - 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 (e.g., deaths from other causes occurring in the context of health care shortages or overburdened health care systems). Deaths with an underlying cause of death COVID-19 **are not included** in these estimates of deaths due to other causes, but deaths with COVID-19 listed as a multiple cause of death are included in the cause-specific estimates. Deaths with underlying cause of death, for example, in some cases, COVID-19 may have contributed to the death, but the underlying cause of death was another cause, such as terminal cancer. For the majority of deaths where COVID-19 is reported on the death certificate (approximately 90%), COVID-19 is selected as the underlying cause of death.

Deaths due to all other natural causes were excluded (ICD-10 codes: A00-A39, A42-B99, D00-E07, E15-E68, E70-E90, F00, F02, F04-G25, G27-H93, K00-L00, L89-L90, M00-N15, N20-N98, O00-O95, P00-P96, Q00-Q99). External causes of death (i.e. injuries) were excluded, as COVID-19 is not a plausible cause of death for these causes. Deaths with underlying cause of death COVID-19 (ICD-10 code U07.1) are shown in cause-of-death trends, which is included in the Respiratory Diseases cause of death group. Cause-specific trends for Alzheimer Disease and Dementia category (ICD-10 codes G30, G31, F01, F03) are presented for deaths with underlying cause of death Alzheimer disease and dementia category (ICD-10 codes G30, G31, F01, F03). These estimates 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:

Limitations

These estimates are based on provisional data, which are incomplete. The weighting method applied may not fully account for reporting lags if there are large changes in death rates in place for reporting lags, or if the distribution of reporting lags are considerably longer than they have been in past years, and death counts for 2020 are therefore underestimated. Conversely, the weighting method may over-adjust for incomplete reporting if there are large changes in death rates in place for reporting lags, or if the distribution of reporting lags are considerably shorter than in previous years. However, these unexpected 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 the reporting lag is sufficiently long-term that it may be an early indication of excess mortality related to COVID-19, but should be interpreted with caution, until confirmed by other data sources such as state or local health departments. It is possible that recent improvements in the timeliness of death data could also contribute to large upward shifts in jurisdiction-specific estimates. Weekly counts of deaths are based on the week of death, not the week death certificates are received. Conversely, recent increases may be missed in jurisdictions with historically low levels of completeness (e.g., Connecticut, North Carolina, Puerto Rico) if the lag in receipt of death certificates is longer than the lag in other jurisdictions.

The completeness of provisional data varies by cause of death and by age group. However, the weights applied do not account for this variability. Therefore, the proportion of deaths for specific causes of death or for some age groups and causes of death, for example, provisional data on deaths among younger age groups is typically less complete than among older age groups. Predicted counts may therefore be too low among the younger age groups. Since the weights were based on the overall completeness of death certificates received in provisional data in past years, the weighted estimates for specific causes of death are likely too low, as reporting lags are typically longer 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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