GETTING TO ACCURACY:
MEASURING COVID-19
BY MORTALITY RATES AND
PERCENTAGE CHANGES

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The views expressed in this report are those of the author and are not necessarily those of the Federal Reserve Bank of Cleveland or the Board of Governors of the Federal Reserve System.
Comparing the trajectory of the COVID-19 epidemic in the United States to that of other countries can provide important insights into how the virus is progressing in the United States and the effectiveness of our response. The quality of those insights depends on the data we choose to compare and how we conduct that comparison. This report argues that cumulative mortality rates and their percentage changes are the best available measures for comparing the trajectory of the epidemic in different countries. Based on these measures, the epidemic in the United States has a similar mortality rate to those in Europe and is more deadly than in China and South Korea.

A number of broadly used sources report counts of confirmed COVID-19 cases and deaths. These sources typically focus primarily on case counts, which have the advantage of being the earliest indicator of an epidemic. However, case counts have two significant limitations when comparing across countries. First, case counts depend on the size of a country’s population—all else equal, the higher the population, the greater the number of cases. Second, case counts depend on the breadth, accuracy, reporting, and speed of testing—all of which have varied across nations. The first concern can be addressed by dividing case counts by population to get case rates, but the second concern remains.

Mortality rates are better suited for comparison because they are scaled by population size and fairly consistently measured across geography and time. This advantage is evident in the cumulative COVID-19 case and mortality rates in Spain and Switzerland on April 5, 2020. Spain and Switzerland have similar case rates (2,818 per million and 2,478 per million, respectively), but Spain’s mortality rate is more than triple Switzerland’s (271 per million and 84 per million, respectively).

The definition of the mortality rate for this report is the cumulative reported number of COVID-19 deaths per 1 million residents. While mortality rates are the best available measure for comparing COVID-19 epidemics, they may not be perfect—some countries may have unreported deaths.

COVID-19 spreads at different rates in different countries. As a result, it can be misleading to compare data by calendar days. Aatish Bhatia makes this point clear in his graph, which shows the relationship between the cumulative number of cases and number of cases in the prior week for many countries. The following graphs build on Bhatia’s work by using mortality rates and examining the 1-week percentage changes in these rates. Looking at the percentage change makes it easier to see changes in the rate of growth and to understand how fast an epidemic is growing.

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4 The log approximation of the percentage change is used here to keep scale of graphs readable. Specifically, percentage change = 100*(ln(cumulative mortality rate today) – ln(cumulative mortality rate 7 days ago)).
Graph 1 shows the mortality rate on the horizontal axis and the 1-week percentage change in the rate on the vertical axis. The mortality rate is cumulative and, within a country, time is moving left to right. The last data point for each country is April 5, 2020.

The mortality rates show how deadly the epidemic has been for each nation. Note that this axis has a log scale, so values rise rapidly from left to right. To lend context to this scale, on April 5, 2020, the cumulative mortality rate was 4 per million in South Korea and 271 per million in Spain. Based on these mortality rates, the epidemics in China and South Korea have been much less deadly than those in Italy, Spain, the United Kingdom, and the United States. The latest mortality rate for the United States is 29 per million.

When a nation’s percentage change is 100 percent or more (represented by the dashed line), the mortality rate has more than doubled in the prior 7-day period: During this stage of a nation’s epidemic, COVID-19 is growing exponentially. This is the stage that the United Kingdom and United States are in right now. The next phase of an epidemic is when the mortality rate is still rising, but no longer growing exponentially. Italy and Spain reached this milestone on March 25, 2020, and April 1, 2020, respectively. China and South Korea have reached the third phase of the epidemic, during which the mortality rate changes little from day to day.

Graph 1. COVID-19 has grown more slowly in the United States than it did in Italy and Spain, but our epidemic has been more deadly than those in China and South Korea.

Note: Data from Jan. 22, 2020 through Apr. 5, 2020
Source: FRBC calculations, The Center for Systems Science and Engineering at Johns Hopkins Univ., and the World Bank
Another way to get a sense of how the United States’ epidemic compares to that of other countries is to look at changes over time. The beginning of each country’s epidemic is unique (and missing for China because the earliest data point is from January 22, 2020). Therefore, graph 2 shows the 1-week percentage changes from the first day the mortality rates exceeded 1 per million, for up to 35 days.

The most important lesson to take from this graph is that COVID-19 epidemics do not always slow down smoothly over time. For example, both South Korea and the United Kingdom had periods during which the rate of change was little changed for a week or more. I hope the United States will follow the more common trend and our epidemic will continue to decelerate in the weeks ahead.

An upcoming report will present similar trends for US states, particularly those of the Federal Reserve Bank of Cleveland’s Fourth District. The report further illuminates the United States’ epidemic, including why its beginning had an atypical trajectory.

**Graph 2. Both South Korea and the United Kingdom have had periods of more than a week without deceleration in the growth rate of COVID-19**

Note: Graph 3 is a supplemental graph that shows the cumulative COVID-19 mortality rate and the 1-week percentage change in that rate for each of 28 countries with population of more than 10 million and at least 75 COVID-19 deaths as of April 5, 2020.

Graph 3. COVID-19 Epidemic Trajectories in 28 Countries

Cumulative COVID-19 Mortality Rate and 1-week Percentage Change
Countries with population above 10 million and at least 75 COVID-19 deaths on April 5, 2020

Source: FRBC calculations, The Center for Systems Science and Engineering at Johns Hopkins Univ., and the World Bank
Note: Data from Jan. 22, 2020 through Apr. 5, 2020