COVID-19 Counts in Washington State and Select Other Locations

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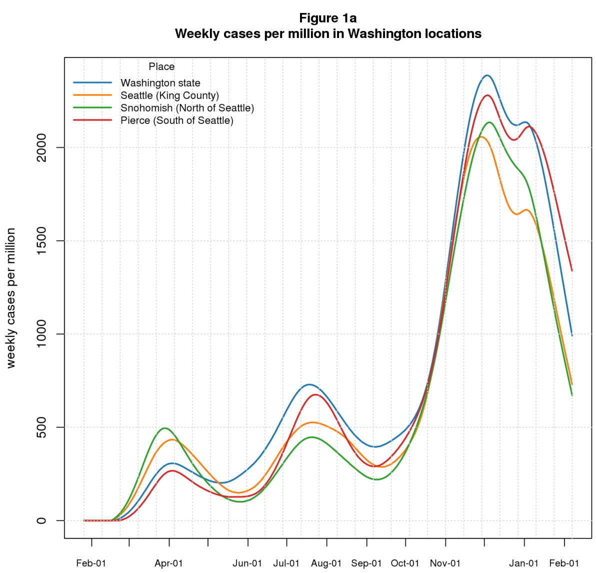
Counts of cases and deaths are key metrics of COVID-19 prevalence and burden, and are the basis for model-based estimates and predictions of these statistics. I present here graphs showing these metrics over time in Washington state and a few other USA locations of interest to me. I update the graphs and this write-up weekly. Previous versions are here.

See below for caveats and details. I originally posted updates on Mondays but have switched to Wednesdays to accommodate the current Washington DOH data release schedule.

Figures 1a-d show *case* counts per million for several Washington and non-Washington locations. The Washington locations are the entire state, the Seattle area where I live, and the adjacent counties to the north and south (Snohomish and Pierce, resp.). The non-Washington locations are Ann Arbor, Boston, San Diego, and Washington DC.

Figures 1a-b (the top row) shows smoothed data (see details below); Figures 1c-d (the bottom row) overlay raw data onto the smoothed. The figures use data from Johns Hopkins Center for Systems Science and Engineering (JHU), described below. When comparing the Washington and non-Washington graphs, please note the difference in y-scale: the highest current Washington rate (about 1400 per million in Pierce) is similar to the rates in Ann Arbor and Washington DC, and somewhat below the rates in Boston and San Diego.



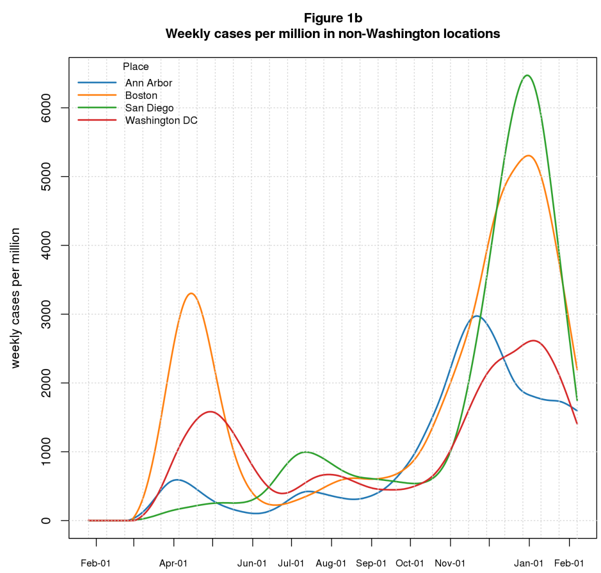


Figure 1c
Weekly cases per million in Washington locations showing raw data

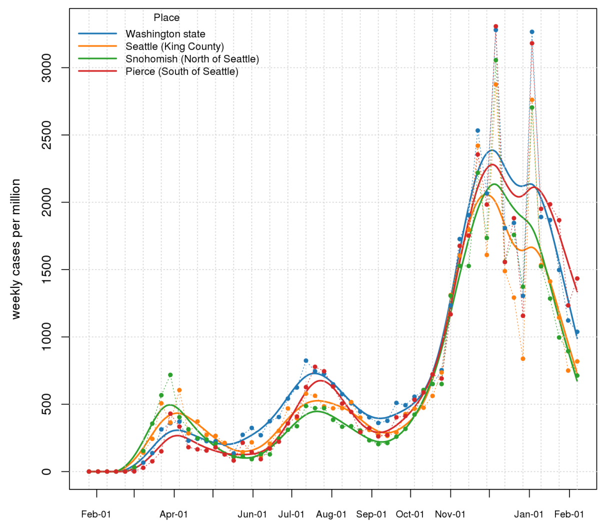
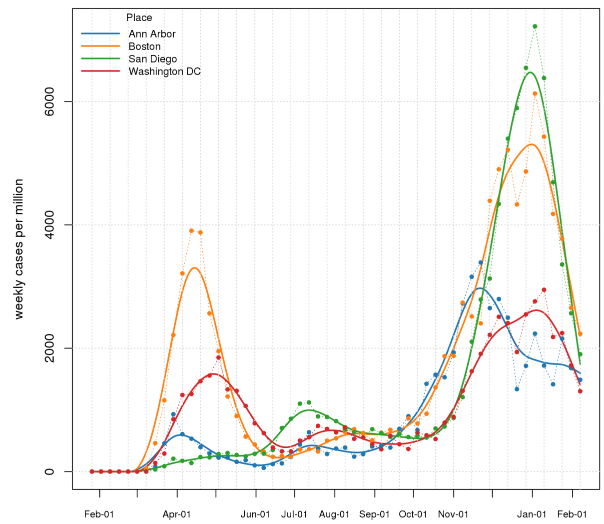


Figure 1d
Weekly cases per million in non-Washington locations showing raw data



The graphs for Washington (Figures 1a,c) suggest that cases have hit their peak and are heading down. Simple trend analysis (described below) supports this view except for Pierce (south of Seattle) where the data is too variable to be confident in the trend. The graphs for non-Washington locations (Figures 1b,d) suggest that cases everywhere except Ann Arbor have hit their peaks and are heading down, while Ann Arbor is flattening. Trend analysis concurs.

Figures 2a-d show *deaths* per million for the same locations. When comparing the Washington and non-Washington graphs, again please note the difference in y-scale: the current Washington rates (15-30 per million) are similar to Ann Arbor (22 per million) and well below the other non-Washington rates (45-62 per million)

Figure 2a
Weekly deaths per million in Washington locations

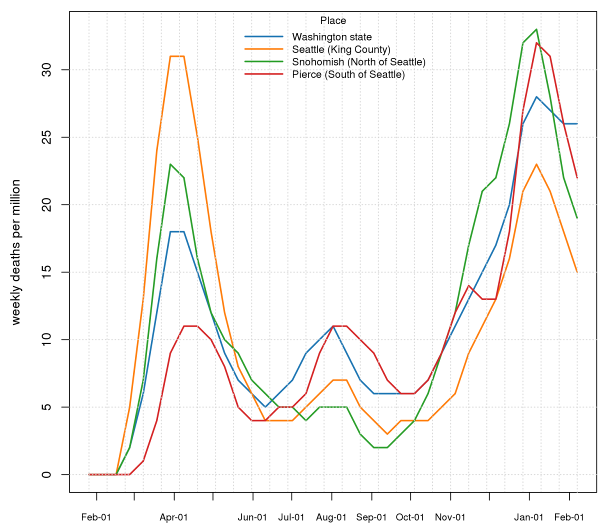


Figure 2b
Weekly deaths per million in non-Washington locations

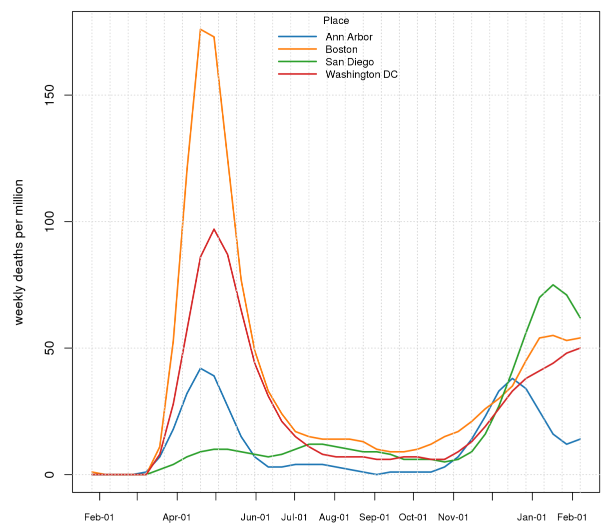


Figure 2c
Weekly deaths per million in Washington locations showing raw data

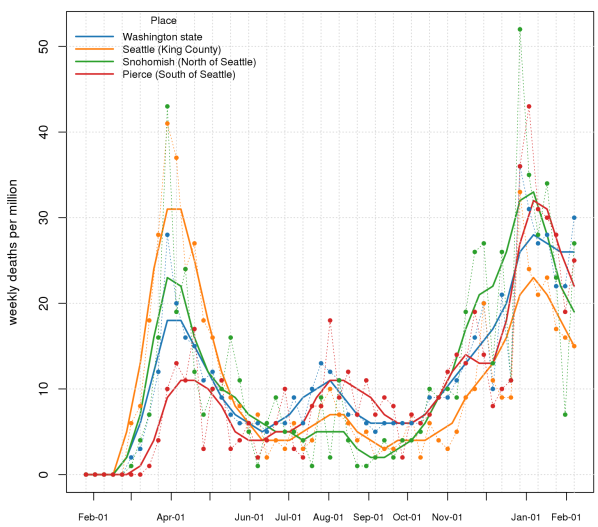
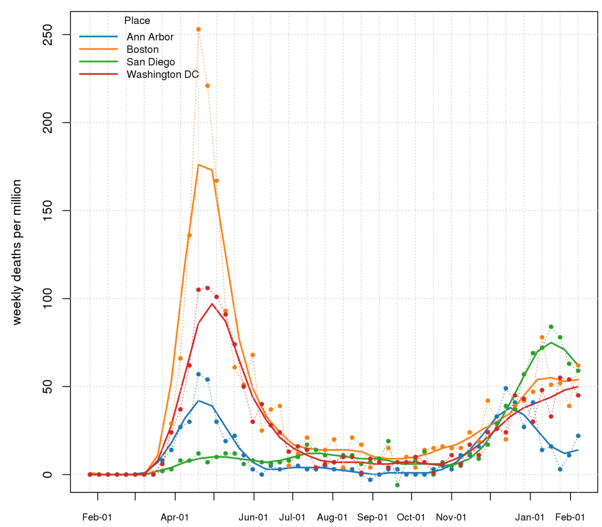


Figure 2d
Weekly deaths per million in non-Washington locations showing raw data



The smoothed Washington data (Figure 2a) shows three waves. The second peak was thankfully lower than the first; the third wave exceeded the first in all areas except Seattle (King County). The graphs are heading down now, but the raw data (Figure 2c) remains quite variable and trend analysis (described below) suggests the trends are weak except in Seattle (King County). The smoothed non-Washington data (Figure 2b) shows early peaks in most location, followed by a long trough, followed by a second wave starting in November. Last week the raw data suggested that rates were declining everywhere except Washington DC, although the trend analysis was weak. This week the raw data (Figure 2d) and trend analysis suggest rates are declining in San Diego but are basically flat everywhere else.

The next graphs show the Washington results broken down by age. This data is from Washington State Department of Health (DOH) weekly downloads, described below. An important caveat is that the DOH download systematically undercounts events in recent weeks due to manual curation. I extrapolate data for late time points as discussed below. In previous versions, I showed graphs for each Washington location. Here I only show the statewide graphs; the other locations are similar.

Figure 3 is *cases* split into 20-year age ranges starting with 0-19, with a final group for 80+. Figure 4 is *deaths*; this graph aggregates 0-59 into a single group, since the death rate in these ages is near 0.

Figure 3
Weekly cases per million by age in Washington state

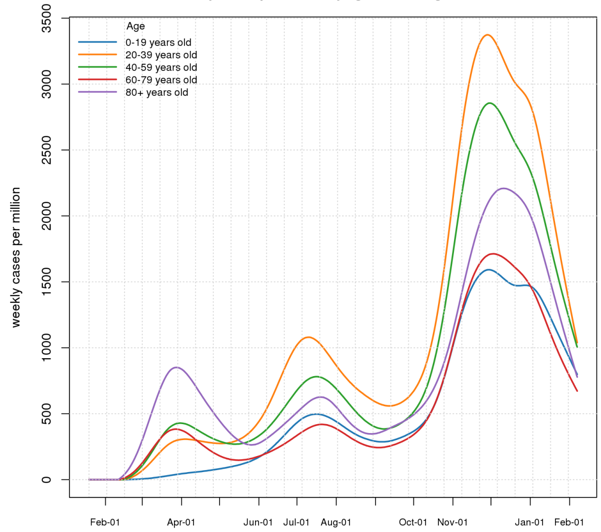
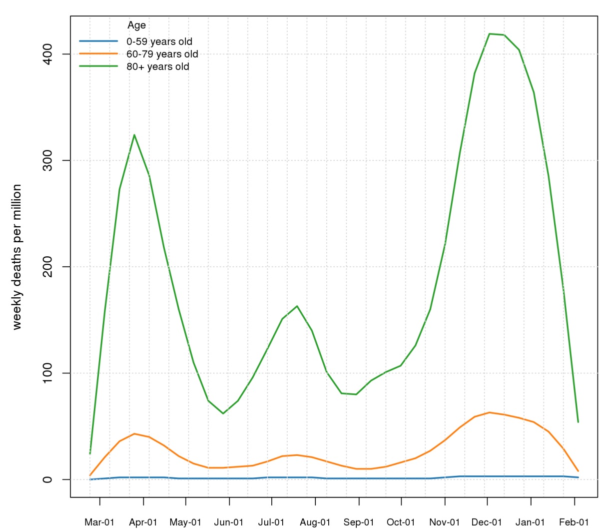


Figure 4
Weekly deaths per million by age in Washington state



Early on, the pandemic struck older age groups most heavily. Over time, *cases* spread into all age groups, even the young. During the second wave, older groups did better in most locations with young adults (20-39 years) becoming the most affected group. The third wave swept into all age groups with young and middle aged adults (20-39 and 40-59 years) leading the surge. As the wave has grown, the oldest people (80+) are again strongly affected. The curves are heading down in all age groups, but caution is in order because the decline we see in the Washington DOH data is more pronounced than in the JHU data shown in Figures 1a,c.

The shocking devastation of the 80+ age group jumps off the page in Figure 4. The death rate in this age group shows three waves. The third wave seems to have reached its peak but again caution is in order: the decline we see here is much greater than in the JHU data shown in Figures 2a,c.

Caveats

1. The term *case* means a person with a detected COVID infection. Until the recent reporting change, Washington DOH data limited this to “confirmed cases”, meaning people with positive molecular COVID tests, but going forward they plan to separate out “probable cases”. Other states already do this, but the data source I use here only includes “confirmed cases” (or so I believe based on the name of the file I download).
2. Detected *cases* undercount actual cases by an unknown amount. As testing volume increases over time, it’s reasonable to expect the detected count to get closer to the actual count. Some of the increase in *cases* we see in the data is due to this artifact. Modelers attempt to correct for this. I don’t include any such corrections here.
3. The same issues apply to *deaths* to a lesser extent, except perhaps early in the pandemic.
4. The geographic granularity in the underlying data is *state* or *county*. I refer to locations by city names reasoning that readers are more likely to know “Seattle” or “Ann Arbor” than “King” or “Washtenaw”.
5. The date granularity in the graphs is weekly. The underlying JHU data is daily; I sum the data by week before graphing.
6. I truncate the data to the last full week prior to the week reported here. Thus, data for the January 13 update includes counts through the first week of January, ending January 9.

Technical Details

1. I smooth the graphs using a smoothing spline (R's `smooth.spline`) for visual appeal. This is especially important for the *deaths* graphs where the counts are so low that unsmoothed week-to-week variation makes the graphs hard to read. In versions of the document prior to December 30, 2020, I used a 3-week rolling mean for this purpose.
2. The Washington DOH data (used in Figures 3 and 4 to show counts broken down by age) systematically undercounts events in recent weeks due to manual curation. I attempt to correct this undercount through a linear extrapolation function (using R's `lm`). I have tweaked the extrapolation repeatedly, even turning it off for a few weeks. The current version uses a model that combines date and recentness effects.
3. The trend analysis mentioned above computes a linear regression (using R's `lm`) over the most recent four weeks of data and reports the computed slope and the p-value for the slope. In essence, this compares the trend to the null hypothesis that the true counts are constant and the observed points are randomly selected from a normal distribution. After looking at trend results across the entire time series, I determined that p-values below 0.1 indicate convincing trends; this cutoff is arbitrary, of course.

Data Sources

Washington State Department of Health (DOH)

DOH provides three COVID data streams.

1. Washington Disease Reporting System (WDRS) provides daily "hot off the presses" results for use by public health officials, health care providers, and qualified researchers. It is not available to the general public, including yours truly.
2. COVID-19 Data Dashboard provides a web graphical user interface to summary data from WDRS for the general public. (At least, I think the data is from WDRS - they don't actually say).
3. Weekly data downloads (available from the Data Dashboard web page) of data curated by DOH staff. The curation corrects errors in the daily feed, such as, duplicate reports, multiple test results for the same incident (e.g., initial and confirmation tests for the same individual), incorrect reporting dates, incorrect county assignments (e.g., when an individual crosses county lines to get tested).

The weekly downloads lag behind the daily feed causing data for the last few weeks to be incomplete. I attempt to correct this undercount through a linear extrapolation function (described [above]{#techdetails}).

The weekly DOH download reports data by age group: 20-year ranges starting with 0-19, with a final group for 80+.

The DOH download includes data on hospital admissions in addition to *cases* and *deaths*, although I don't show this data here.

In past, DOH updated the weekly data on Sundays, but as of December 22, 2020 they switched to Mondays. When Monday is a holiday, they release data on Tuesdays.

Johns Hopkins Center for Systems Science and Engineering (JHU)

JHU CSSE has created an impressive portal for COVID data and analysis. They provide their data to the public through a GitHub repository. The data I use is from the csse_covid_19_data/csse_covid_19_time_series directory: time_series_covid19_confirmed_US.csv for *cases* and time_series_covid19_deaths_US.csv for *deaths*.

JHU updates the data daily. I download the data the same day as the DOH data (now Tuesdays) for operational convenience.

Other Data Sources

I use two other COVID data sources in my project although not in this document.

- New York Times COVID Repository. The file I download is us-counties.csv. Like Washington DOH and JHU, NYT has county-level data. Unlike these, it includes “probable” as well as “confirmed” cases and deaths; I see no way to separate the two categories.
- COVID Tracking Project. This project reports a wide range of interesting statistics (negative test counts, for example), but I only use the *case* and *death* data. It does not provide county-level data so is not useful for the non-Washington locations I show. The file I download is https://covidtracking.com/data/download/washington-history.csv. I use this only as a check on the state-level Washington data from the other sources.

The population data used for the per capita calculations is from Census Reporter. The file connecting Census Reporter *geoids* to counties is the Census Bureau Gazetteer.

Comments Please!

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