# COVID-19 Counts in Washington State and Select Other Locations

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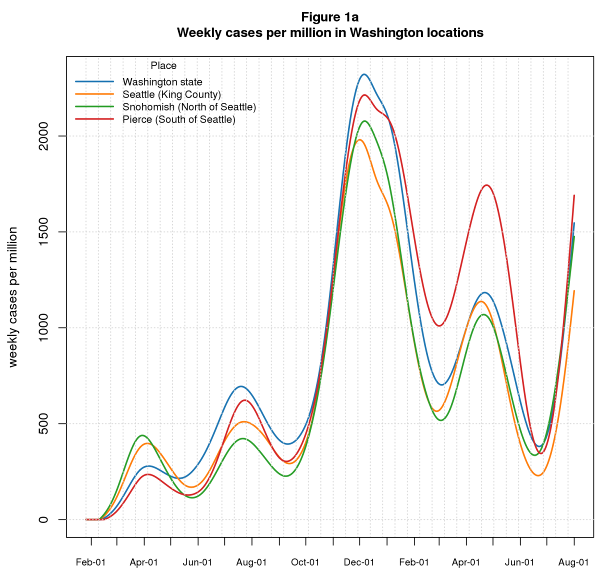
*Counts of cases, hospital admissions, and deaths are key metrics of COVID-19 prevalence and burden, and are the basis for model-based estimates and predictions of these statistics. I present here graphs showing these metrics over time in Washington state and a few other USA locations of interest to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

The first several figures (1a-2d) show *case* and *death* counts per million for several Washington and non-Washington locations using data from Johns Hopkins Center for Systems Science and Engineering (JHU), described below. 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) show smoothed *case* counts (See below for details on the smoothing method). Figures 1c-d (the bottom row) overlay raw data onto the smoothed since May 1 to help explain recent trends.

When comparing the Washington and non-Washington graphs, please note the difference in y-scale: the current raw counts for Washington locations are about 1650-2200 per million; non-Washington raw counts are about 600-2300 per million.



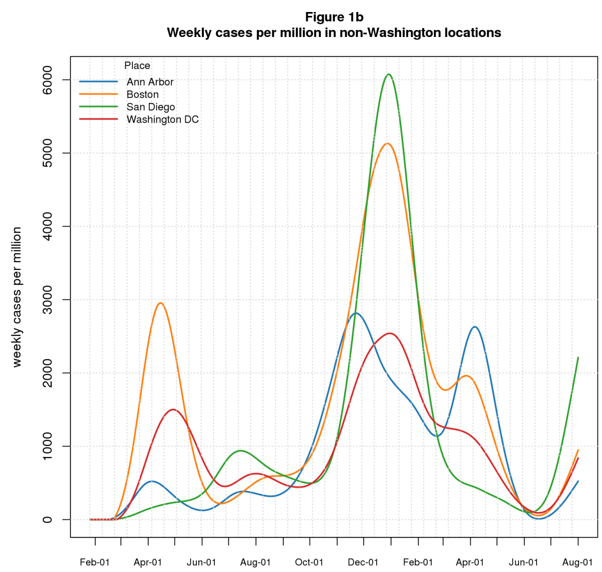



**Figure 1c**
**Weekly cases per million in Washington locations showing recent raw data**

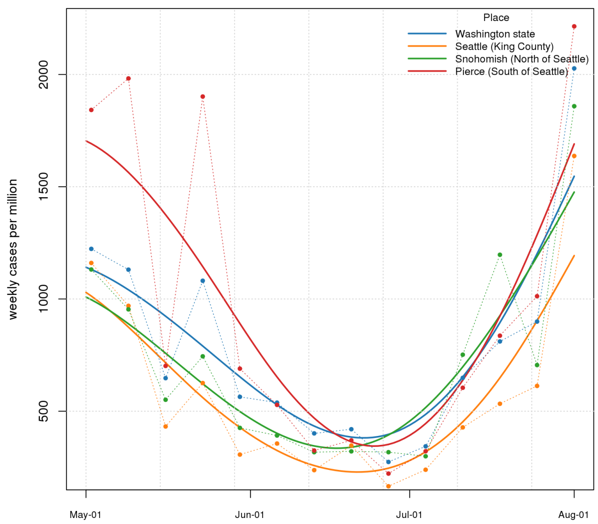
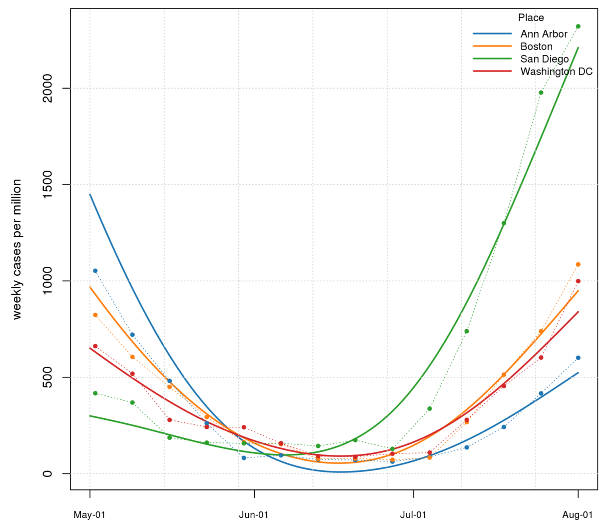



**Figure 1d**
**Weekly cases per million in non-Washington locations showing recent raw data**




The smoothed graphs for Washington and non-Washington locations (Figures 1a-b) show rates increasing in all locations. The raw data and trend analysis concur. Rates in all Washington locations have soared beyond all previous peaks except winter 20/21. Rates in non-Washington locations, though climbing rapidly, remain below their recent peaks.

Figures 2a-d show *deaths* per million for the same locations. As with the *cases* graphs, the top row (Figures 2a-b) show smoothed data (see details below) and the bottom row (Figures 2c-d) overlays raw data onto the smoothed since May 1.

When comparing the Washington and non-Washington graphs, again please note the difference in y-scale: the current Washington rates are 2-6 per million and non-Washington rates are 0-4 per million.

**Figure 2a**
**Weekly deaths per million in Washington locations**

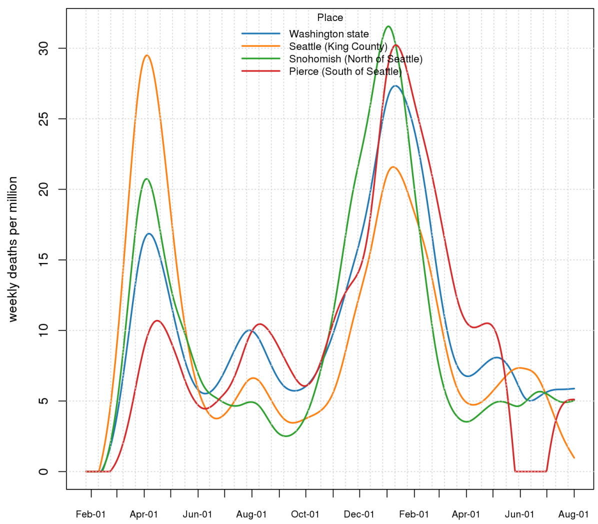



**Figure 2b**
**Weekly deaths per million in non-Washington locations**

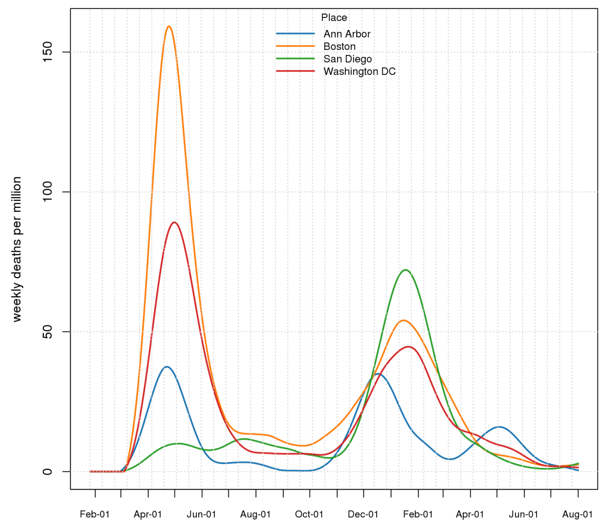


**Figure 2c**
**Weekly deaths per million in Washington locations showing recent raw data**

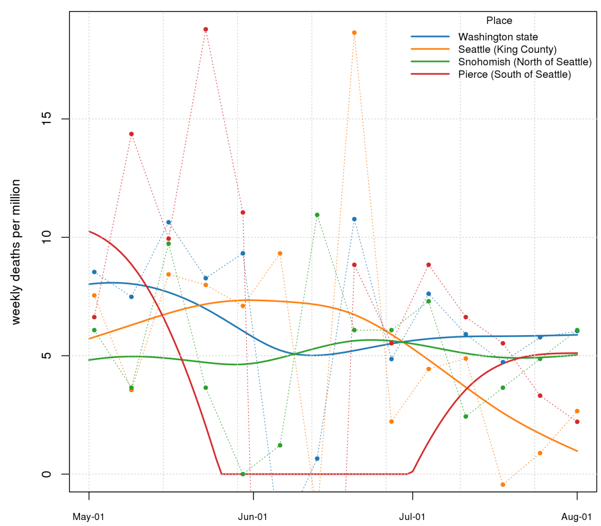
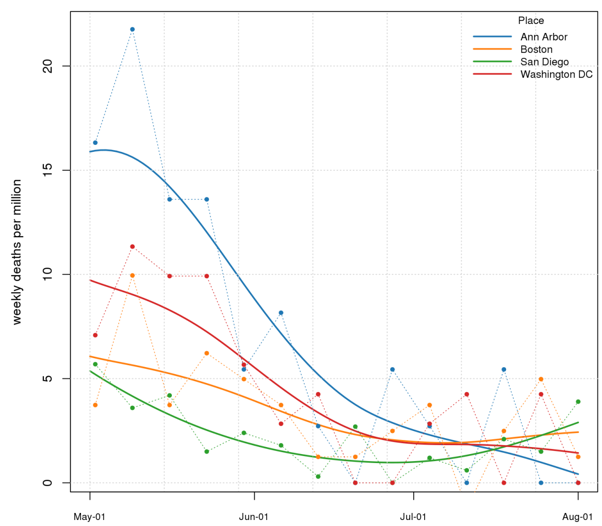



**Figure 2d**
**Weekly deaths per million in non-Washington locations showing recent raw data**




The smoothed graphs for Washington and non-Washington locations (Figures 2a-b) show rates bouncing around. Trend analysis and raw data (Figures 2c-d) suggest that rates everywhere are variable but the trend is flat. The long flat line for Pierce in late May-June 2021 is due to negative counts for two weeks in early June: this arises when JHU discovers they overcounted previous weeks and are catching up; my software clamps the fit to zero reasoning that negative counts are meaningless.

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. A further caveat is that DOH *deaths* have been consistently lower than JHU since mid-May (see Figure 5b below).

Figure 3 is *cases* and figure 4 shows hospital admissions (*admits*) and *deaths*.

**Figure 3**
**Weekly cases per million by age in Washington state**

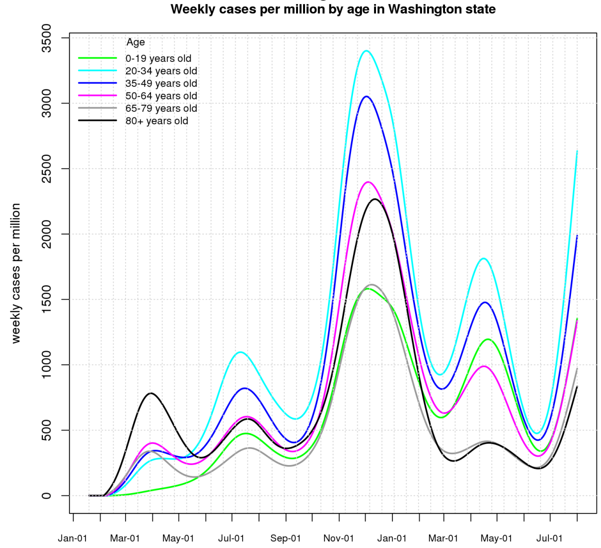
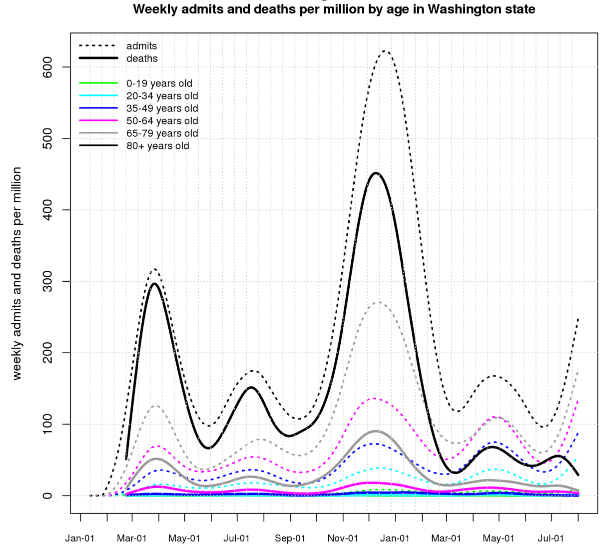



**Figure 4**
**Weekly admits and deaths per million by age in Washington state**




Early on, the pandemic struck older age groups most heavily, but *cases* quickly spread into all age groups, even the young. Rates are heading up again in all age groups. Young adults (20-34 years) are leading the way, with the next older group (35-49 years) close behind. Though not apparent in the graph, the youngest group (0-19) is also increasing rapidly and is now at about the same level as pre-seniors (50-64). The oldest age groups (65-79 and 80+ years) are doing best, perhaps due to the high vaccination coverage in these people, but they too are climbing fast.

Throughout the pandemic, the death rate for the 80+ group was much higher than any other group, but thankfully deaths even in this group have dropped to near zero.

*Admits* are increasing for all age groups, even the young, and are now above their spring 2021 levels. *Admit* rates vary with age groups exactly as one would expect: lowest in the young and increasing with age.

It remains to be seen whether the increasing *case* and *admit* rates will lead to higher *deaths* in the coming weeks.

## Caveats

1. The term *case* means a person with a detected COVID infection. In some data sources, this includes "confirmed cases", meaning people with positive molecular COVID tests, as well as "probable cases". I believe JHU only includes "confirmed cases" based on the name of the file I download.
2. Detected *cases* undercount actual cases by an unknown amount. When testing volume is higher, it's reasonable to expect the detected count to get closer to the actual count. 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 data by week before graphing.
6. I truncate data to the last full week prior to the week reported here.

## 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. Now that *death* counts are low, the smoothing method seems not to be working well.
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. In past, I created models for each Washington location and age group but had to change when DOH changed its age groups on March 14, 2021 (see below). I now create a single model for the state as a whole and all age groups summed together, then blithely apply that model to all locations and ages.
3. The trend analysis computes a linear regression (using R's `lm`) over the most recent four, six, or eight weeks of data and reports the computed slope and the p-value for the slope. I also compute a regression using daily data over the most recent 7-42 days. 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 0.15 indicate convincing trends; this cutoff is arbitrary, of course.

4. In most versions before March 17, 2021, I showed counts broken down by age (as in Figures 3 and 4) for each Washington location. Now I only show the statewide graphs: the other locations are similar.
5. In past, DOH reported results in 20 year age groups starting with 0-19, with a final group for 80+. As of the March 14, 2021 data release (corresponding to document version March 17), DOH changed age groups. The new groups are 0-19, followed by 15 year ranges (20-34, 35-49, 50-64, 65-79) with a final group for 80+.

## 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 DOH download reports data by age group. In past, the groups were 20-year ranges starting with 0-19, with a final group for 80+. As of March 14, 2021, they changed the groups to an initial 20-year range (0-19), then several 15-year ranges (20-34, 35-49, 50-64, 65-79), with a final group for 80+.

### Issues with DOH Undercounting

Figures 5a-b compare DOH and JHU *cases* and *deaths* for Washington state to illustrate the undercount in the raw DOH data. The *cases* data matches well except for a few periods spanning several weeks, including most of May 2020. The *deaths* data matches less well and is presently much lower than JHU. I have no explanation for the discrepancies.

Figure 5a
Weekly fitted and raw cases per million: DOH and JHU (Washington state)

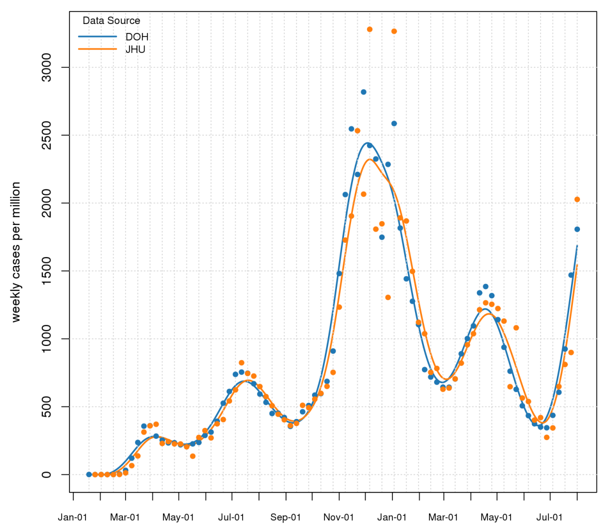
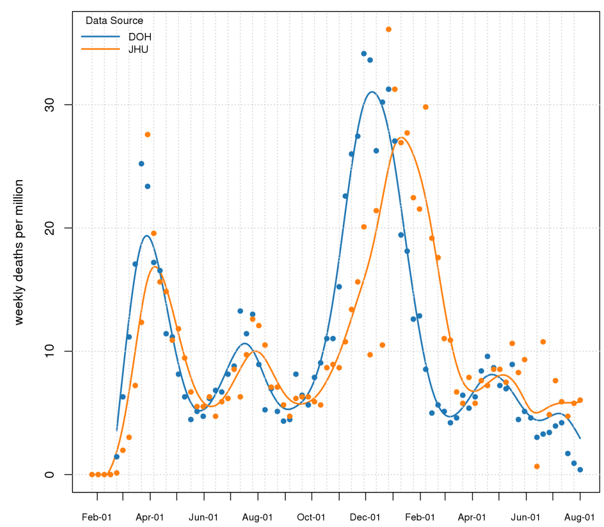



Figure 5b
Weekly fitted and raw deaths per million: DOH and JHU (Washington state)




### 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

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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