

Monitoring the COVID-19 Pandemic in Scotland

20 May, 2020

Numbers of new cases and new deaths, as reported by Health Protection Scotland (HPS), have been monitored on a daily basis (see Figure 1). To assess the rate of spread of COVID-19 in Scotland, we have considered the ratio of the sum of these metrics in the past week compared to their respective sums in the previous week. A similar ratio has been used to measure changes in the number of patients in hospital by comparing daily numbers of patients in hospital and ICU to those one week ago (see Figure 3). However, these statistics are potentially subject to biases and we list several caveats which should be considered when interpreting their values.

Data

The cumulative numbers of cases and deaths have been reported by HPS every day since the start of the epidemic in Scotland. The numbers include deaths which have been registered with National Records of Scotland (NRS) where a laboratory confirmed report of COVID-19 in the 28 days prior to death exists. These numbers are expected to capture the majority of deaths occurring in hospitals, but a lower proportion of those in care homes and the community.

The NRS also provide a weekly report of all deaths where COVID-19 is mentioned on the death certificate (not just those confirmed by a test as provided by HPS). The report provides information by place of death, location, age and gender.

The number of COVID-19 patients in hospital and Intensive Care Units (ICUs) are reported on a daily basis. The terms used in this report refer to the number of patients with confirmed or suspected COVID-19 who are registered as being under that department's care at midnight (see Figure 2).

Weekly comparisons

We have used ratios of both cases and deaths in the past week compared to the previous week (i.e. the total over the 7 days as a ratio of the total over the previous 7 days) to monitor the weekly rate of spread of COVID-19 (see Figures 3, 5, 6 and Table 1). Weekly totals are considered as they are less prone to week day variations than the daily values (see Caveats below).

Ratios for patients in hospital are calculated as the number of patients in hospital (or ICU) on a given day compared to the number of patients in hospital (or ICU) one week before (e.g. the ratio for May 20th is 'number of patients on May 20th' divided by 'number of patients on May 13th').

Further detail on the datasets and code used to produce this report, along with the method used to calculate confidence intervals for the ratios, is available on GitHub at [gcalder/COVID-19](https://github.com/gcalder/COVID-19).

Caveats and Interpretational Notes

We list several caveats which should be borne in mind when considering the statistics presented.

Daily numbers of cases and deaths are affected by:

- Changes in testing policy which in turn is affected by the availability of tests and laboratory facilities for their analysis. For example, if testing is increased then less severe cases of COVID-19 are likely to be detected.
- Variations in hospital admission policy, e.g. if admission criteria are relaxed then a higher proportion of COVID-19 patients are admitted and tested, and then included in the daily case and (HPS) death statistics.

- Variations in reporting of deaths and test results across week days (see Figure 7) and due to public holidays.

An increase in testing is likely to cause an increased number of less severe cases to be included and this may make comparisons of case numbers over time unreliable. Nevertheless, a decrease in cases would still provide strong evidence of a reducing rate of infection.

HPS death numbers include individuals who have positive tests but are not in hospital. Increased testing in the community (particularly in care homes) will cause more deaths to be counted and make HPS death numbers difficult to compare over time. The NRS death numbers are expected to provide a more consistent comparison, and also to allow care home and other non-hospital deaths to be considered separately. However, these data are only issued on a weekly basis and they will be less up-to-date than the data from HPS. The latest weekly ratio for NRS deaths, 0.80 (95% CI 0.69-0.92), is lower than the equivalent value for HPS deaths 0.85 (95% CI 0.72-1.01) and might be expected to be a more accurate reflection of the change in death rate (based on NRS data up to 17/05/2020; see Figures 5 and 6).

Given the later availability of NRS data and the variable factors affecting both the number of cases and HPS deaths, some consideration might be given to hospital data (see Figure 3). However, these data will not reflect deaths in care homes. They will also be affected by any change in the guidance for admission and discharge during the two week period considered for the ratio. Recent changes to the guidance for care home residents may be causing a greater proportion of these cases to be admitted to hospital and for longer stays. The ratios by place of death (see Figure 5) will also be subject to any variation in hospital admission policy. For example, if the proportion of care home residents being admitted to hospital has increased over a two week period, this would affect the ratios for deaths in care homes and in hospitals.

The confidence intervals indicate the accuracy of the observed ratio of the two particular weeks considered. However, there are many factors which influence the ratios other than the true underlying rate of spread of COVID-19. Some of these will be systematic (as described in the above caveats) and others may be more random. The caveats should all be considered when interpreting the ratios, particularly when the confidence interval does not include 1.

There is some analogy between the ratios presented and the R number, and values of less than (or greater than 1) might be expected to correspond to R numbers of less than (or greater than 1). However, their values will not be identical and this analogy is based on unchanged policies for testing and hospitalisation over the two week period used to calculate each ratio. Furthermore it should be borne in mind that each statistic reflects a different manifestation of the virus, and none will adequately estimate true underlying rate of spread of infection in the full population. Death ratios are heavily influenced by the rate of spread to and within the older age group, and hence take less account of the rate of spread in the younger age group. Similarly cases and hospital in-patient ratios predominantly include those with more severe symptoms, and so do not capture the rate of infection spread within the whole population. Nevertheless these statistics are still helpful for determining the impact of the virus on health service requirements. A survey of the population would provide a more definitive estimate of the true underlying rate of spread of the virus.

The use of weekly ratios helps to smooth out variations occurring across week days, however they will still be affected by public holidays. For example, a lower number of deaths were registered on 4th May (Spring bank holiday), followed by a higher number on Tuesday 5th May. This caused the ratio for Monday 4th May to be artificially low, the ratio the following Monday (11th May) to be artificially high, and that on the Monday two weeks later (18th May) to be artificially low. This was due to the separation of the (low and high) numbers for Monday 4th and Tuesday 5th May in the weeks used to calculate ratios for these dates. A similar pattern in the death numbers was noticed for 10th/11th April (Good Friday), 13th/14th April (Easter Monday) and 18th/19th May (Victoria Day), which would be expected to affect the holiday dates and two subsequent Mondays in the same way. Consideration will be given to making an adjustment to the ratios for affected dates in future reports.

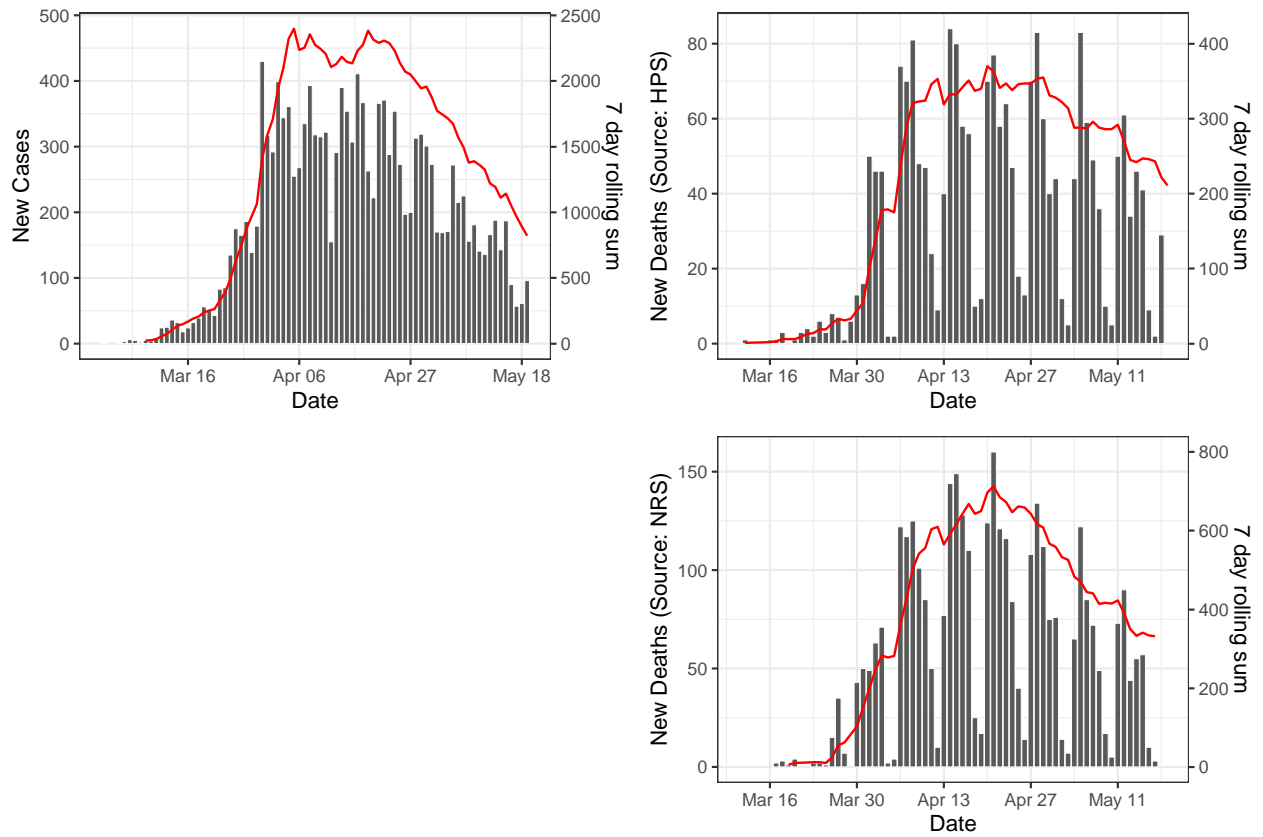


Figure 1: Daily cases and deaths and 7 day rolling sum

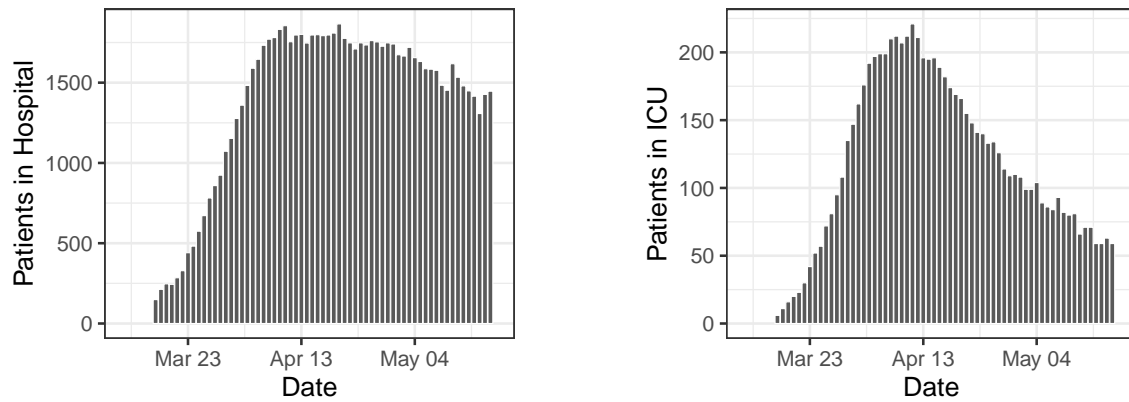


Figure 2: Number of patients in hospital and ICU at midnight. Daily totals include both confirmed and suspected COVID-19 cases.

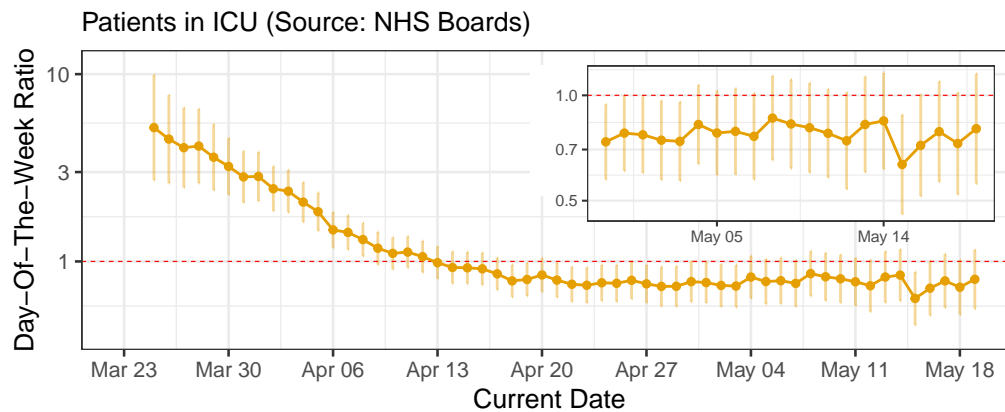
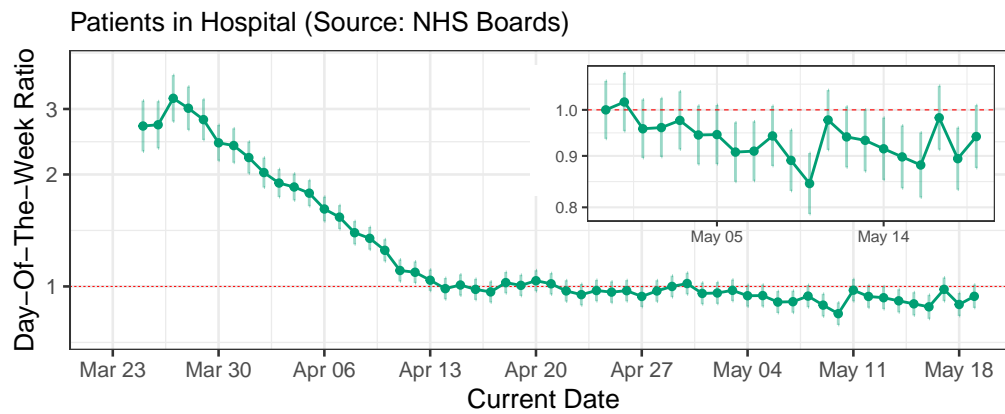
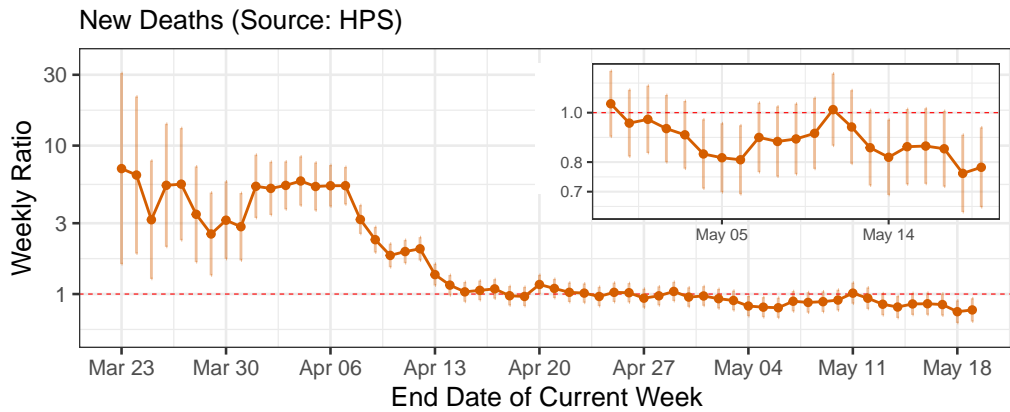
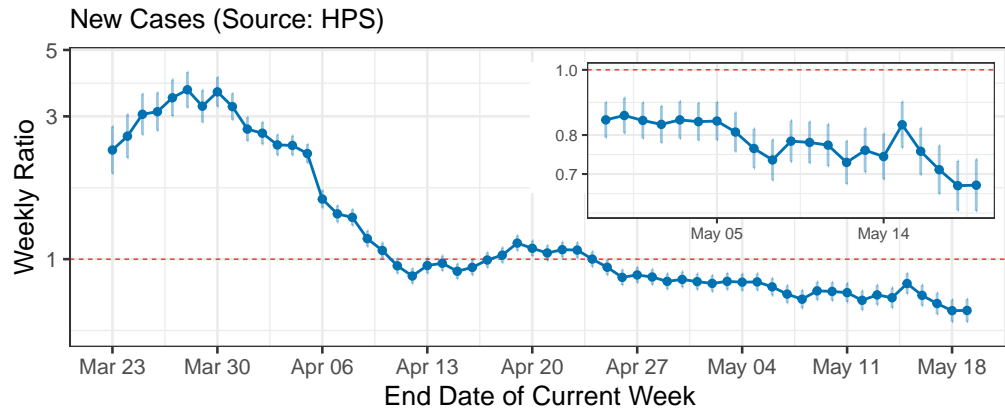


Figure 3: Weekly ratios for new cases and new deaths are ratios of weekly sums, plotted on a log10 scale. Day-of-the-week ratios for patients in hospital and ICU are ratios of daily counts, measured 7 days apart and plotted on a log10 scale. Figure insets highlight ratios and trends for the last 21 days.

Table 1: Most recent estimates of ratios and their 95% confidence intervals (CI). Weekly ratios for new cases and new deaths are ratios of weekly sums. Day-of-the-week ratios for number of patients in hospital and ICU are ratios of daily counts, measured 7 days apart. Date: 19/05/2020.

Measure	Ratio	95% CI
New Cases (Source: HPS)	0.67	0.62-0.74
New Deaths (Source: HPS)	0.78	0.65-0.94
Patients in Hospital (Source: NHS Boards)	0.94	0.88-1.01
Patients in ICU (Source: NHS Boards)	0.80	0.56-1.15

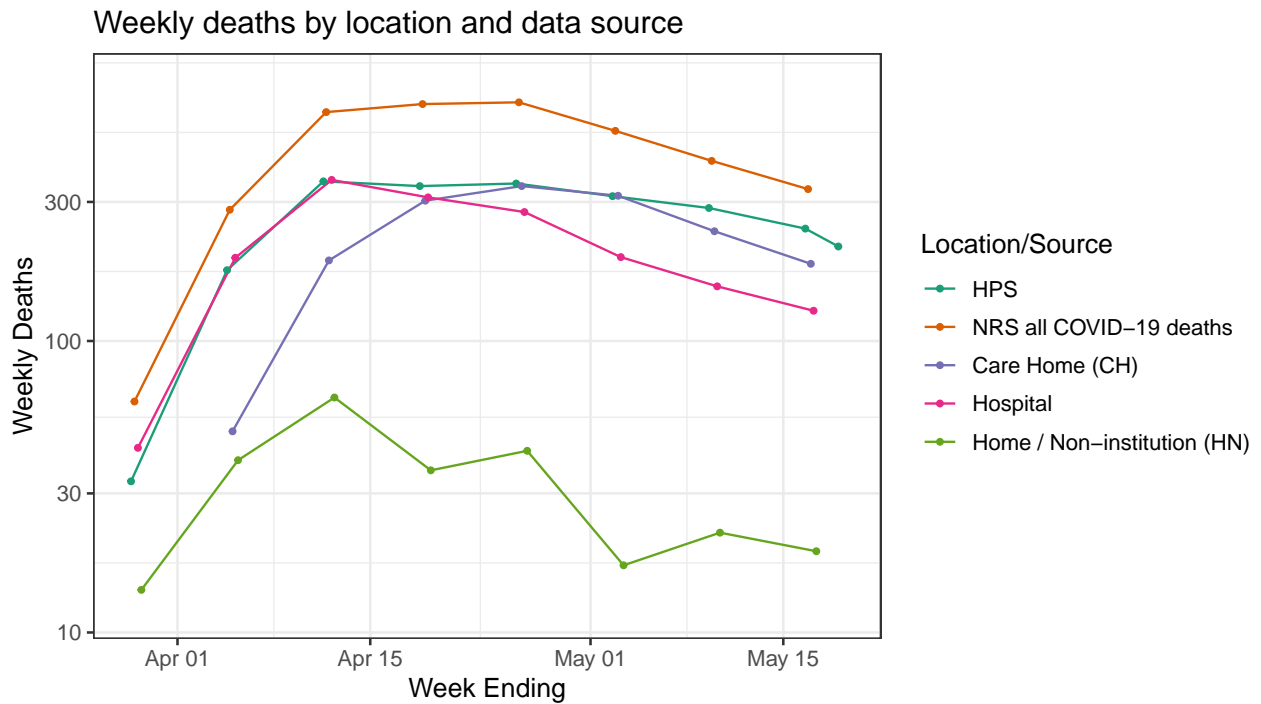


Figure 4: Number of deaths per week, compared by location and data source

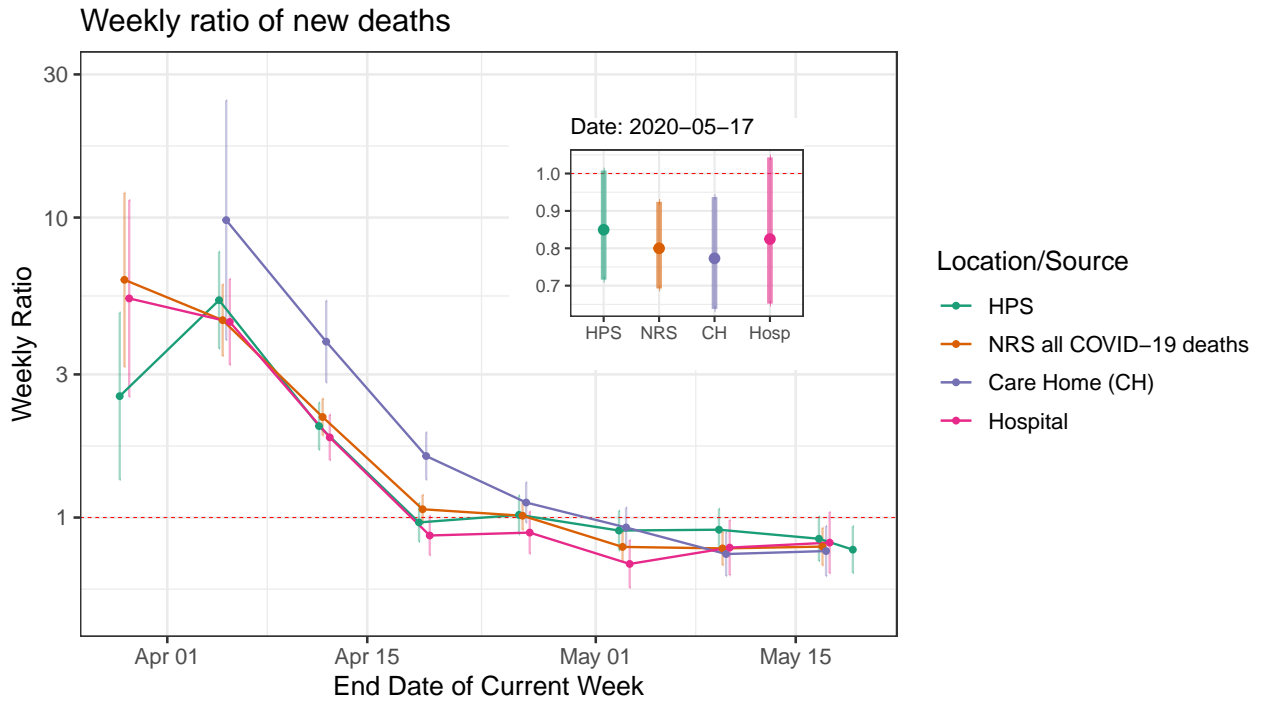


Figure 5: Ratio of new deaths during current week vs previous week, compared by location and data source. Figure inset highlights the last date that both HPS and NRS data are available for.

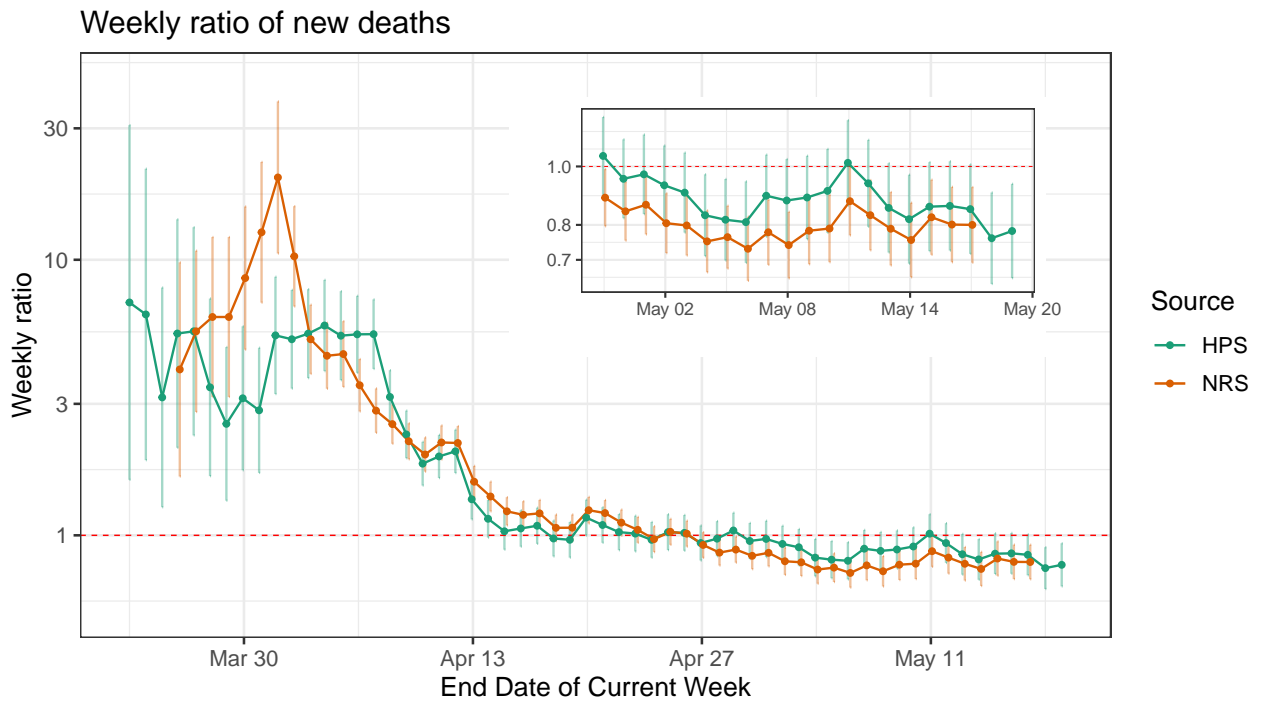


Figure 6: Ratio of new deaths during current week vs previous week, compared by data source

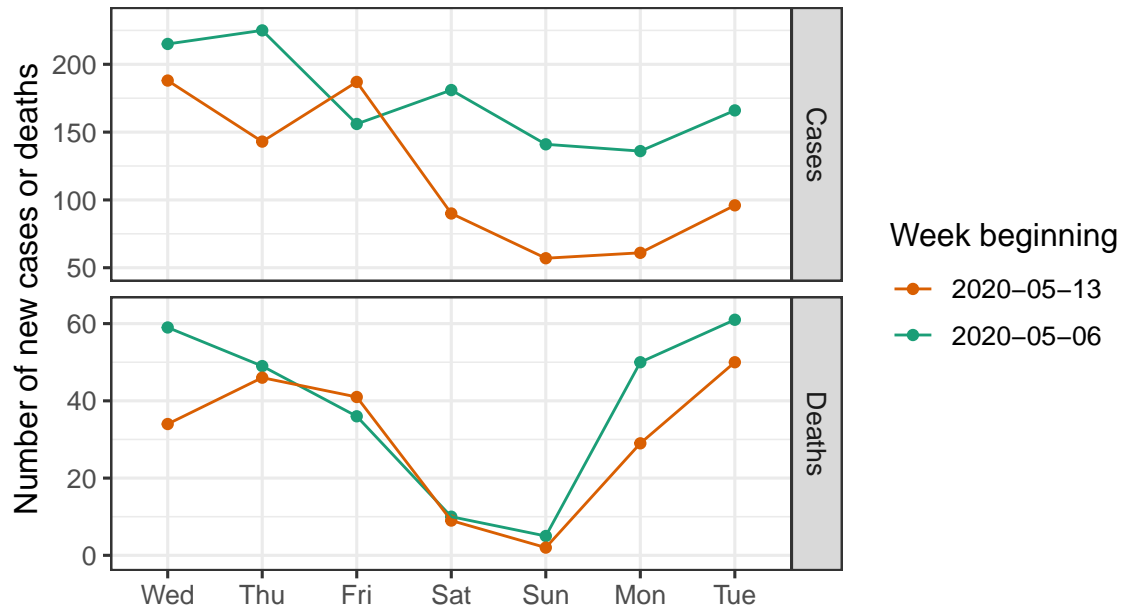


Figure 7: Number of cases and deaths by week day, shown for the last two weeks. Data source: HPS

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