Temporal variation in transmission during the COVID-19 outbreak in Italy

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Summary

Aim: To identify changes in the reproduction number, rate of spread, and doubling time during the course of the COVID-19 outbreak in Italy whilst accounting for potential biases due to delays in case reporting.

Latest estimates as of the 2020-03-19

Region map

Figure 1: Regional map of the expected change in daily cases based on data from the 2020-03-19.

Summary of latest reproduction number and case count estimates

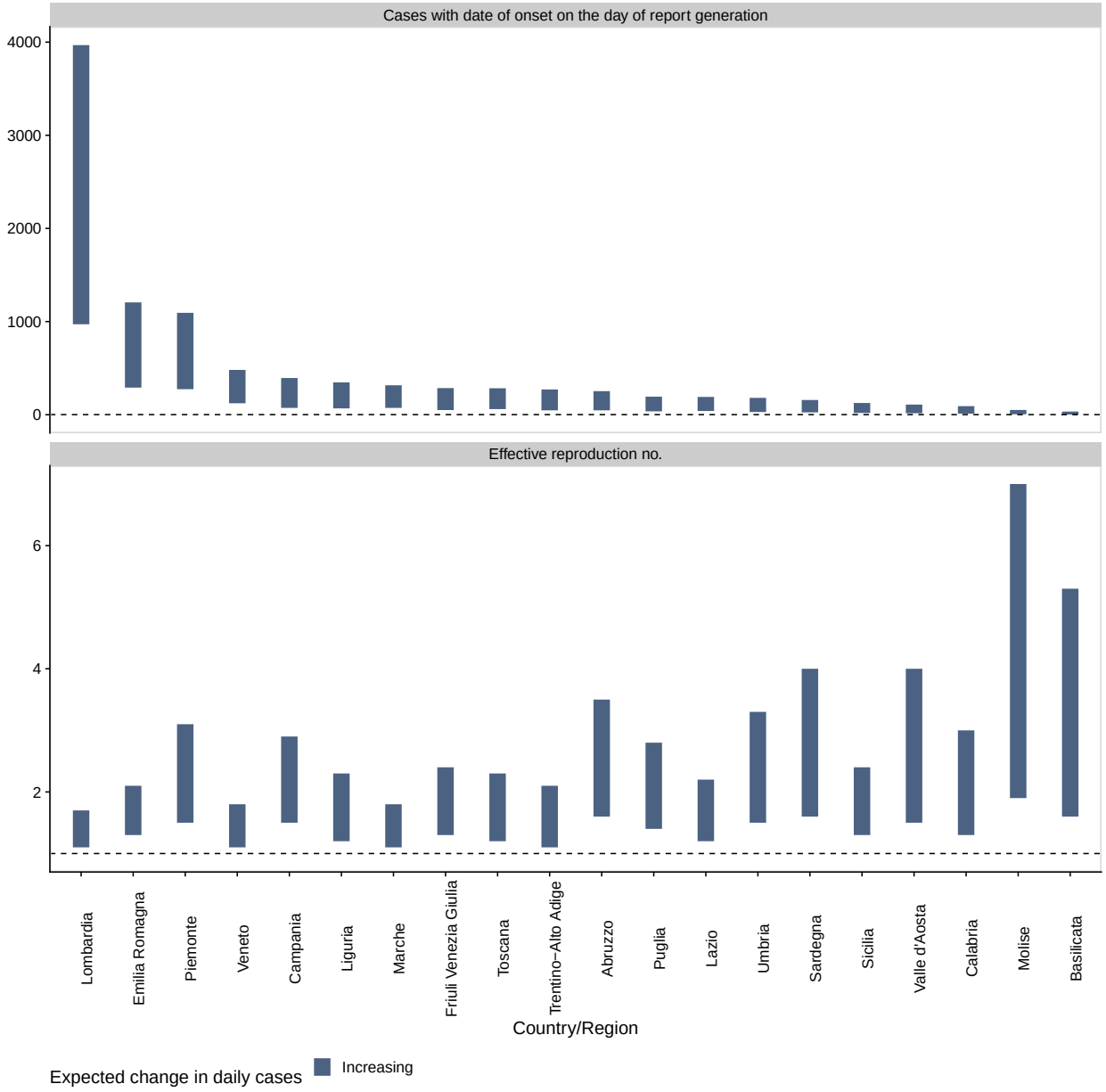

Figure 2: Cases with date of onset on the day of report generation and the time-varying estimate of the effective reproduction number (bar = 95% credible interval) based on data from the 2020-03-19. Regions are ordered by the number of expected daily cases and shaded based on the expected change in daily cases. The dotted line indicates the target value of 1 for the effective reproduction no. required for control and a single case required fror elimination.

Reproduction numbers over time in the 5 regions with the most cases currently and nationally

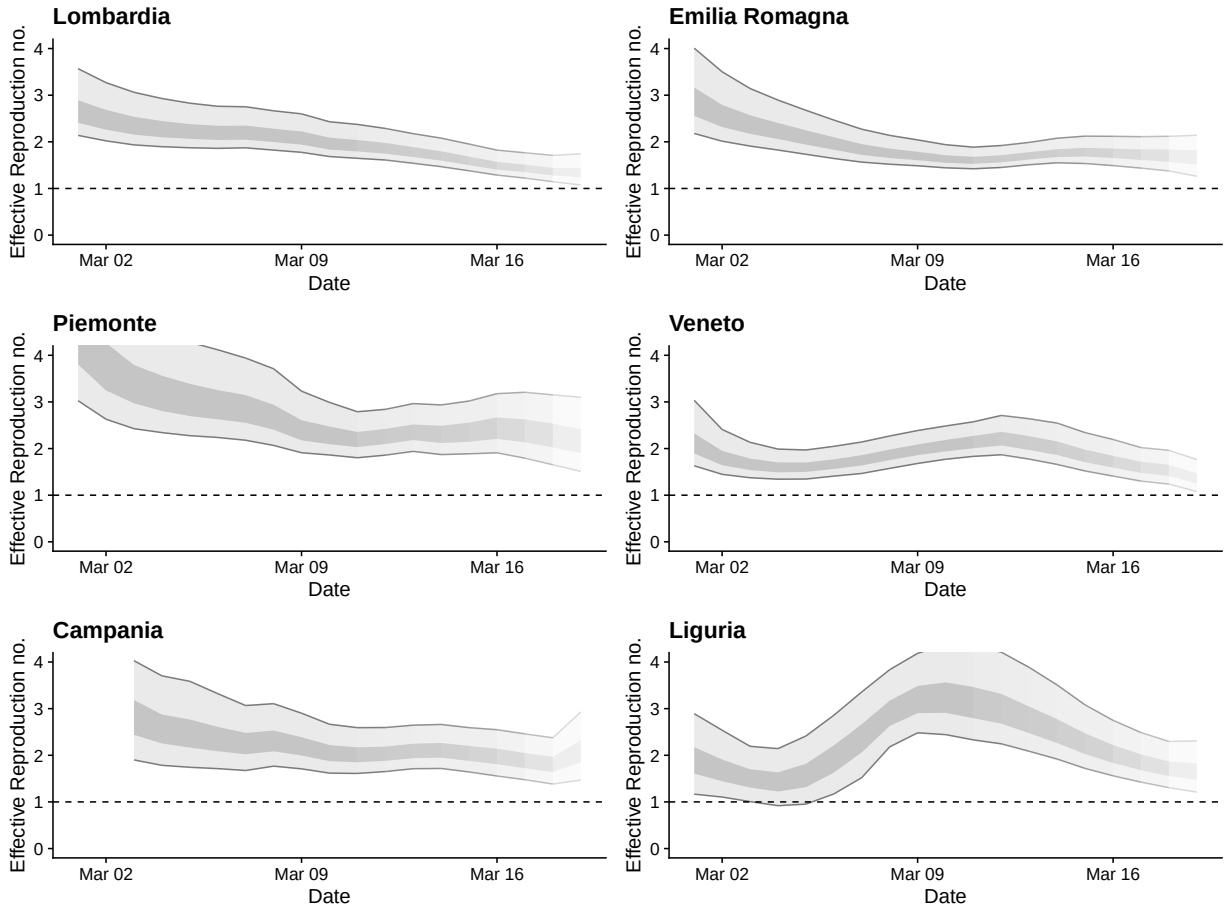

Figure 3: Time-varying estimate of the effective reproduction number (light grey ribbon = 95% credible interval; dark grey ribbon = the interquartile range) based on data from the 2020-03-19 in the regions expected to have the highest number of incident cases. Confidence in the estimated values is indicated by shading with reduced shading corresponding to reduced confidence. The dotted line indicates the target value of 1 for the effective reproduction no. required for control.

Latest estimates summary table

Table 1: Latest estimates of the number of cases by date of onset, the effective reproduction number, and the doubling time for the 2020-03-19 in each region included in the analysis. Based on the last 7 days of data. The 95% credible interval is shown for each numeric estimate.

Country/Region	Cases with date of onset on the day of report generation	Expected change in daily cases	Effective reproduction no.	Doubling time (days)
Lombardia	971 – 3968	Increasing	1.1 – 1.7	6.1 – Cases decreasing
Emilia Romagna	291 – 1206	Increasing	1.3 – 2.1	4.1 – Cases decreasing
Piemonte	274 – 1094	Increasing	1.5 – 3.1	2.3 – 9.5
Veneto	123 – 481	Increasing	1.1 – 1.8	5.6 – Cases decreasing
Campania	73 – 394	Increasing	1.5 – 2.9	2.8 – 27
Liguria	68 – 347	Increasing	1.2 – 2.3	4 – Cases decreasing
Marche	73 – 316	Increasing	1.1 – 1.8	5.7 – Cases decreasing
Friuli Venezia Giulia	50 – 286	Increasing	1.3 – 2.4	2.6 – Cases decreasing
Toscana	60 – 284	Increasing	1.2 – 2.3	3.3 – Cases decreasing
Trentino-Alto Adige	47 – 271	Increasing	1.1 – 2.1	2.4 – Cases decreasing
Abruzzo	47 – 253	Increasing	1.6 – 3.5	2.2 – 7.2
Puglia	36 – 194	Increasing	1.4 – 2.8	1.9 – Cases decreasing
Lazio	40 – 191	Increasing	1.2 – 2.2	3.4 – Cases decreasing
Umbria	29 – 181	Increasing	1.5 – 3.3	2 – 76
Sardegna	25 – 158	Increasing	1.6 – 4	1.6 – Cases decreasing
Sicilia	19 – 126	Increasing	1.3 – 2.4	3.2 – 27
Valle d'Aosta	16 – 109	Increasing	1.5 – 4	2.1 – Cases decreasing
Calabria	12 – 92	Increasing	1.3 – 3	2.1 – 46
Molise	5 – 51	Increasing	1.9 – 7	0.19 – Cases decreasing
Basilicata	2 – 34	Increasing	1.6 – 5.3	0.15 – Cases decreasing

Methods

Summary

- Case counts by date, stratified by region, were constructed from daily datasets made publically available by the Dipartimento della Protezione Civile [1,2].
- Case onset dates were estimated using case counts by date of report and a distribution of reporting delays fitted to a European line-list.
- Censoring of cases was adjusted for by assuming that the number of cases is drawn from a binomial distribution.
- Time-varying effective reproduction estimates were made with a 7-day sliding window using *EpiEstim* [3,4] adjusted for imported cases and assuming an uncertain serial interval with a mean of 4.7 days (95% CrI: 3.7, 6.0) and a standard deviation of 2.9 days (95% CrI: 1.9, 4.9) [5].
- Time-varying estimates of the doubling time were made with a 7-day sliding window by iteratively fitting an exponential regression model.
- The methods in this report are based on our previous study of the global temporal variation during the COVID-19 outbreak [6].

Limitations

- The estimated onset dates are based on current European data for the delay in reporting and are mostly from the beginning of the outbreak. This means that these data may not be representative of the underlying delay distribution.
- The estimate of not-yet-confirmed cases to scale up recent numbers is uncertain and relies on the observed delays to confirmation to remain constant over the course of the outbreak.
- All data used is at a national/regional level; diagnostic capabilities may vary in different parts of each region, adding uncertainty to the reported numbers. The true number of infections reflected in a given number of confirmed cases probably varies substantially geographically.
- Trends identified using our approach are robust to under-reporting assuming it is constant but absolute values may be biased by reporting rates. Pronouced changes in reporting rates may also impact the trends identified.
- Data on imported cases was not available (either international imports or between region imports).
- As our estimates are made at the date of symptom onset any changes in the time-varying parameters will be delayed by the incubation period.

Detail

Data

We used a European line-list that contained the date of symptom onset, date of confirmation and import status (imported or local) for each case [2,7] where available. Daily case counts by date of report and region were extracted from daily datasets made publically available by the Dipartimento della Protezione Civile [1,2].

Statistical analysis

We used the same approach as in our previous global study of the temporal variation in transmission during the COVID-19 outbreak [6]. However, due to a limited line-list of Italian cases we used a combined linelist of cases from Germany, France, Italy, Austria, the Netherlands, Belgium, and Spain to estimate the report delay. We could also not account for imported cases (either international or between region) due to a shortage of data. Code and results from this analysis can be found here and here.

References

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