

## **Average detection rate of SARS-CoV-2 infections has improved since our last estimates but is still as low as nine percent on March 30th**

Two weeks ago, we have used the estimates of Verity et al. (2020) for age-specific COVID-19 infection fatality rates and time to death to calculate detection rates of SARS-CoV-2 infections for the 40 most affected countries based on the number of COVID-19 deaths. Combining age-specific COVID-19 infection fatality rates from Verity et al. (2020) and United Nations population shares for each age group we have calculated expected infection fatality rates for each country. We prefer not to incorporate differences in health systems or populations' health status in the model, because we are lacking credible evidence to do so without imposing new assumptions. We have estimated the number of SARS-CoV-2 infections on March 17th dividing the number of COVID-19 deaths on March 31st by the expected infection fatality rate. We then compare the estimated SARS-CoV-2 infections on March 17th to the cases that were officially reported on the same day to calculate the share of detected infections on March 17th. The rationale behind this calculation is simple: Verity et al. (2020) estimate on average 18 days from first symptoms to deaths through COVID-19. We allow four days from first symptoms before a patient appears as a confirmed case in the statistics yielding a two-week lag between confirmed cases and deaths. The average detection rate on March 17th was six percent.

We have shown how many people would have been infected by March 31st if the detection rates had stayed the same from March 17th. These numbers have to be understood as a thought experiment rather than a prediction, because there are various reasons for detection rates to either increase or decrease over time. Detection rates could decrease in a growing epidemic because it gets more and more difficult to discover all infections as case numbers increase exponentially. Conversely, detection rates could increase when few new infections occur, for instance as a consequence of social distancing. Countries that initially did not detect many cases but increased testing capacity in response to emerging COVID-19 death numbers could also substantially increase their detection rates. We mentioned Turkey and the United States as possible examples for this.

As new data are becoming constantly available, we can update our estimates of detection rates for March 23rd and March 30th. We use the same methodology as described above. Expected infection fatality rates and numbers of deaths on April 6th and April 13th are used to estimate number of infections two weeks before. We find that the average detection rate has increased to on average eight percent on March 23rd and nine percent on March 30th. We refrain from estimating current infection numbers based on these updated detection rates because the findings show that the assumption of constant detection rates is not valid. The calculation of the detection rate rests on the assumption that death reporting is quite accurate. We know that also death reporting is neither flawless nor perfectly comparable across countries, but it plausibly comes with less uncertainty than reporting of confirmed cases.

We can show that reported case and death numbers do not add up with the currently available evidence on COVID-19 fatality and that the share of undetected cases on average is high. Population representative studies are needed to provide reliable estimates of infection fatality rates by country and also to monitor detection rates more closely. We are currently aware of one representative study at the national level in Austria that did PCR tests and one locally representative study within the German district of Heinsberg that did antibody tests.

Although on average detection rates improved by a few percentage points within two weeks that were largely characterized by social distancing, the overall level on March 30th was still very low. Much more effort is needed to identify infections, contain the spread of SARS-CoV-2 and ultimately save lives.

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## References and data sources

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Austria study:

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Heinsberg study:

[https://www.land.nrw/sites/default/files/asset/document/zwischenenergebnis\\_covid19\\_case\\_study\\_gangelt\\_0.pdf](https://www.land.nrw/sites/default/files/asset/document/zwischenenergebnis_covid19_case_study_gangelt_0.pdf) [accessed April 14<sup>th</sup>, 2020, 10 am CET]

| Country     | Expected infection fatality rate | Number of deaths (March 31 <sup>st</sup> ) | Number of confirmed cases (March 17 <sup>th</sup> ) | Estimated number of infections (March 17 <sup>th</sup> ) | Estimated detection rate (March 17 <sup>th</sup> ) | Number of deaths (April 6 <sup>th</sup> ) | Number of confirmed cases (March 23 <sup>rd</sup> ) | Estimated number of infections (March 23 <sup>rd</sup> ) | Estimated detection rate (March 23 <sup>rd</sup> ) | Number of deaths (April 13 <sup>th</sup> ) | Number of confirmed cases (March 30 <sup>st</sup> ) | Estimated number of infections (March 30 <sup>st</sup> ) | Estimated detection rate (March 30 <sup>st</sup> ) |
|-------------|----------------------------------|--|---|--|--|---|---|--|--|--|---|--|--|
| Algeria     | 0.43%                            | 44   | 60  | 10,323   | <b>0.58%</b>                                       | 173                                       | 230   | 40,588   | <b>0.57%</b>                                       | 313  | 584   | 73,433   | <b>0.80%</b>                                       |
| Argentina   | 0.67%                            | 27   | 68  | 4,024  | <b>1.69%</b>                                       | 48  | 301   | 7,153  | <b>4.21%</b>                                       | 97   | 820   | 14,455   | <b>5.67%</b>                                       |
| Austria     | 1.15%                            | 128  | 1,332   | 11,129   | <b>11.97%</b>                                      | 220                                       | 4,474   | 19,127   | <b>23.39%</b>                                      | 368  | 9,618   | 31,995   | <b>30.06%</b>                                      |
| Belgium     | 1.14%                            | 705  | 1,243   | 62,019   | <b>2.00%</b>                                       | 1,632                                     | 3,743   | 143,567  | <b>2.61%</b>                                       | 3,903                                      | 11,899  | 343,347  | <b>3.47%</b>                                       |
| Brazil      | 0.59%                            | 201  | 321   | 33,848   | <b>0.95%</b>                                       | 564                                       | 1,924   | 94,978   | <b>2.03%</b>                                       | 1,328                                      | 4,579   | 223,635  | <b>2.05%</b>                                       |
| Canada      | 1.05%                            | 101  | 478   | 9,651  | <b>4.95%</b>                                       | 339                                       | 2,088   | 32,394   | <b>6.45%</b>                                       | 779  | 7,398   | 74,440   | <b>9.94%</b>                                       |
| Czechia     | 1.09%                            | 31   | 396   | 2,837  | <b>13.96%</b>                                      | 78  | 1,236   | 7,137  | <b>17.32%</b>                                      | 143  | 3,001   | 13,085   | <b>22.93%</b>                                      |
| Denmark     | 1.14%                            | 90   | 1,025   | 7,912  | <b>12.95%</b>                                      | 187                                       | 1,572   | 16,440   | <b>9.56%</b>                                       | 285  | 2,755   | 25,056   | <b>11.00%</b>                                      |
| Domin. Rep. | 0.48%                            | 51   | 21  | 10,621   | <b>0.20%</b>                                       | 86  | 245   | 17,911   | <b>1.37%</b>                                       | 177  | 901   | 36,863   | <b>2.44%</b>                                       |
| Ecuador     | 0.47%                            | 75   | 58  | 15,809   | <b>0.37%</b>                                       | 191                                       | 981   | 40,261   | <b>2.44%</b>                                       | 355  | 1,962   | 74,830   | <b>2.62%</b>                                       |
| Egypt       | 0.34%                            | 46   | 196   | 13,423   | <b>1.46%</b>                                       | 85  | 366   | 24,804   | <b>1.48%</b>                                       | 164  | 656   | 47,857   | <b>1.37%</b>                                       |
| France      | 1.20%                            | 3,532                                      | 7,715   | 294,205  | <b>2.62%</b>                                       | 8,926                                     | 20,123  | 743,509  | <b>2.71%</b>                                       | 14,986                                     | 45,170  | 1,248,289  | <b>3.62%</b>                                       |
| Germany     | 1.30%                            | 775  | 9,257   | 59,407   | <b>15.58%</b>                                      | 1,810                                     | 29,056  | 138,744  | <b>20.94%</b>                                      | 3,194                                      | 66,885  | 244,833  | <b>27.32%</b>                                      |
| Greece      | 1.34%                            | 49   | 387   | 3,660  | <b>10.57%</b>                                      | 79  | 695   | 5,901  | <b>11.78%</b>                                      | 99   | 1,212   | 7,396  | <b>16.39%</b>                                      |
| India       | 0.41%                            | 35   | 142   | 8,462  | <b>1.68%</b>                                       | 136                                       | 499   | 32,881   | <b>1.52%</b>                                       | 358  | 1,251   | 86,555   | <b>1.45%</b>                                       |
| Indonesia   | 0.42%                            | 136  | 172   | 32,694   | <b>0.53%</b>                                       | 209                                       | 579   | 50,243   | <b>1.15%</b>                                       | 399  | 1,414   | 95,919   | <b>1.47%</b>                                       |
| Iran        | 0.43%                            | 2,898                                      | 16,169  | 672,755  | <b>2.40%</b>                                       | 3,739                                     | 23,049  | 867,989  | <b>2.66%</b>                                       | 4,585                                      | 41,495  | 1,064,383  | <b>3.90%</b>                                       |
| Iraq        | 0.23%                            | 50   | 154   | 21,858   | <b>0.70%</b>                                       | 64  | 266   | 27,978   | <b>0.95%</b>                                       | 78   | 630   | 34,098   | <b>1.85%</b>                                       |
| Ireland     | 0.84%                            | 71   | 223   | 8,469  | <b>2.63%</b>                                       | 174                                       | 1,125   | 20,754   | <b>5.42%</b>                                       | 365  | 2,910   | 43,536   | <b>6.68%</b>                                       |
| Italy       | 1.38%                            | 12,428                                     | 31,506  | 899,426  | <b>3.50%</b>                                       | 16,523                                    | 63,927  | 1,195,785  | <b>5.35%</b>                                       | 20,465                                     | 101,739   | 1,481,071  | <b>6.87%</b>                                       |
| Japan       | 1.60%                            | 56   | 878   | 3,490  | <b>25.16%</b>                                      | 85  | 1,128   | 5,297  | <b>21.30%</b>                                      | 123  | 1,866   | 7,665  | <b>24.34%</b>                                      |
| South Korea | 0.96%                            | 162  | 8,320   | 16,818   | <b>49.47%</b>                                      | 186                                       | 8,961   | 19,310   | <b>46.41%</b>                                      | 217  | 9,661   | 22,528   | <b>42.88%</b>                                      |
| Malaysia    | 0.45%                            | 43   | 673   | 9,495  | <b>7.09%</b>                                       | 62  | 1,518   | 13,690   | <b>11.09%</b>                                      | 77   | 2,626   | 17,003   | <b>15.44%</b>                                      |
| Mexico      | 0.48%                            | 28   | 82  | 5,777  | <b>1.42%</b>                                       | 94  | 316   | 19,396   | <b>1.63%</b>                                       | 296  | 993   | 61,075   | <b>1.63%</b>                                       |
| Morocco     | 0.47%                            | 36   | 38  | 7,589  | <b>0.50%</b>                                       | 80  | 143   | 16,865   | <b>0.85%</b>                                       | 126  | 556   | 26,563   | <b>2.09%</b>                                       |
| Netherlands | 1.14%                            | 1,040                                      | 1,711   | 91,126   | <b>1.88%</b>                                       | 1,874                                     | 4,764   | 164,201  | <b>2.90%</b>                                       | 2,833                                      | 11,817  | 248,230  | <b>4.76%</b>                                       |
| Norway      | 1.01%                            | 39   | 1,463   | 3,874  | <b>37.76%</b>                                      | 76  | 2,621   | 7,550  | <b>34.72%</b>                                      | 134  | 4,445   | 13,312   | <b>33.39%</b>                                      |
| Pakistan    | 0.29%                            | 26   | 236   | 8,911  | <b>2.65%</b>                                       | 53  | 875   | 18,164   | <b>4.82%</b>                                       | 93   | 1,717   | 31,873   | <b>5.39%</b>                                       |
| Panama      | 0.54%                            | 30   | 69  | 5,551  | <b>1.24%</b>                                       | 54  | 345   | 9,992  | <b>3.45%</b>                                       | 87   | 989   | 16,099   | <b>6.14%</b>                                       |
| Peru        | 0.54%                            | 30   | 117   | 5,585  | <b>2.09%</b>                                       | 92  | 395   | 17,128   | <b>2.31%</b>                                       | 216  | 950   | 40,213   | <b>2.36%</b>                                       |
| Philippines | 0.36%                            | 88   | 187   | 24,457   | <b>0.76%</b>                                       | 163                                       | 462   | 45,301   | <b>1.02%</b>                                       | 315  | 1,546   | 87,544   | <b>1.77%</b>                                       |
| Poland      | 1.06%                            | 33   | 238   | 3,101  | <b>7.68%</b>                                       | 107                                       | 749   | 10,054   | <b>7.45%</b>                                       | 245  | 2,055   | 23,022   | <b>8.93%</b>                                       |
| Portugal    | 1.32%                            | 160  | 448   | 12,123   | <b>3.70%</b>                                       | 311                                       | 2,060   | 23,565   | <b>8.74%</b>                                       | 535  | 6,408   | 40,537   | <b>15.81%</b>                                      |
| Romania     | 1.09%                            | 82   | 184   | 7,525  | <b>2.45%</b>                                       | 176                                       | 576   | 16,152   | <b>3.57%</b>                                       | 331  | 2,109   | 30,377   | <b>6.94%</b>                                       |
| Spain       | 1.21%                            | 8,464                                      | 11,748  | 701,030  | <b>1.68%</b>                                       | 13,341                                    | 35,136  | 1,104,967  | <b>3.18%</b>                                       | 17,756                                     | 87,956  | 1,470,639  | <b>5.98%</b>                                       |
| Sweden      | 1.15%                            | 180  | 1,190   | 15,601   | <b>7.63%</b>                                       | 477                                       | 2,046   | 41,342   | <b>4.95%</b>                                       | 919  | 4,028   | 79,651   | <b>5.06%</b>                                       |
| Switzerland | 1.13%                            | 433  | 2,700   | 38,229   | <b>7.06%</b>                                       | 765                                       | 8,795   | 67,540   | <b>13.02%</b>                                      | 1,138                                      | 15,922  | 100,472  | <b>15.85%</b>                                      |
| Turkey      | 0.55%                            | 214  | 47  | 38,770   | <b>0.12%</b>                                       | 649                                       | 1,529   | 117,579  | <b>1.30%</b>                                       | 1,296                                      | 10,827  | 234,795  | <b>4.61%</b>                                       |
| US          | 0.96%                            | 3,873                                      | 6,421   | 404,390  | <b>1.59%</b>                                       | 10,783                                    | 43,847  | 1,125,882  | <b>3.89%</b>                                       | 23,529                                     | 161,831   | 2,456,726  | <b>6.59%</b>                                       |
| UK          | 1.09%                            | 1,793                                      | 1,960   | 164,727  | <b>1.19%</b>                                       | 5,385                                     | 6,726   | 494,731  | <b>1.36%</b>                                       | 11,347                                     | 22,453  | 1,042,472  | <b>2.15%</b>                                       |