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 though 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.

Christian Bommer & Sebastian Vollmer, University of Goettingen. We have no competing interests.

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