Supplements to *COVID-19 Confirmed Cases Prediction*
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This document contains material supplementing the prediction analysis in a daily report published on https://er.ethz.ch/Covid-19. In particular, in each daily report, we focus on the number of confirmed cases, which is the single metric that is **available** on a daily basis for a wide range of countries and regions. We have mentioned, however, that for a thorough understanding of the Covid-19 epidemic, it is essential to

1. keep track of other variables such as **hospitalizations**, **ICU admittance** and **mortality**;
2. and make a serious effort to relate **reported** to **actual** numbers (which, for the confirmed number of cases indicates a careful consideration of testing rates).

Contents:

-Figure 1 reports the daily growth rate of hospitalization, ICU admittance and mortality in Belgium. Looking at the data on confirmed cases only, Belgium seems to be still far from the inflection point.[1] However, its daily growth rate of hospitalization, ICU admittance and mortality are decreasing, indicating a positive sign that Belgium may soon approach the peak of the epidemic.

-Figure 2 relates the number of confirmed positive cases in the US to the number of tests conducted.[2] In particular, we normalize the number of reported cases with the number of tests to get a better understanding of the growth rate of actual infections in the population. We find that a large part of the exponential growth of reported cases may be due to an exponential increase in testing. To make such an analysis more reliable, random testing (polling) in the general population would be necessary (and is highly recommended).

-Figure 3 presents deaths per million population for selected countries, which are subjectively divided into 4 groups: Rich North countries, Hot North countries, Southern Hemisphere countries, and the East Block countries (Russia, China and East Europe). This view provides a view of the severity of the epidemic in different regions. It seems that the epidemic mainly lies in Rich North countries, while Hot North, East Block countries and southern hemisphere countries do not have large scale epidemics yet. There are several possible (and highly speculative) explanations for this, see the detailed break down below.

[1] Assuming logistic growth, the inflection point indicates the peak of the daily increase.
[2] Using data from https://covidtracking.com.

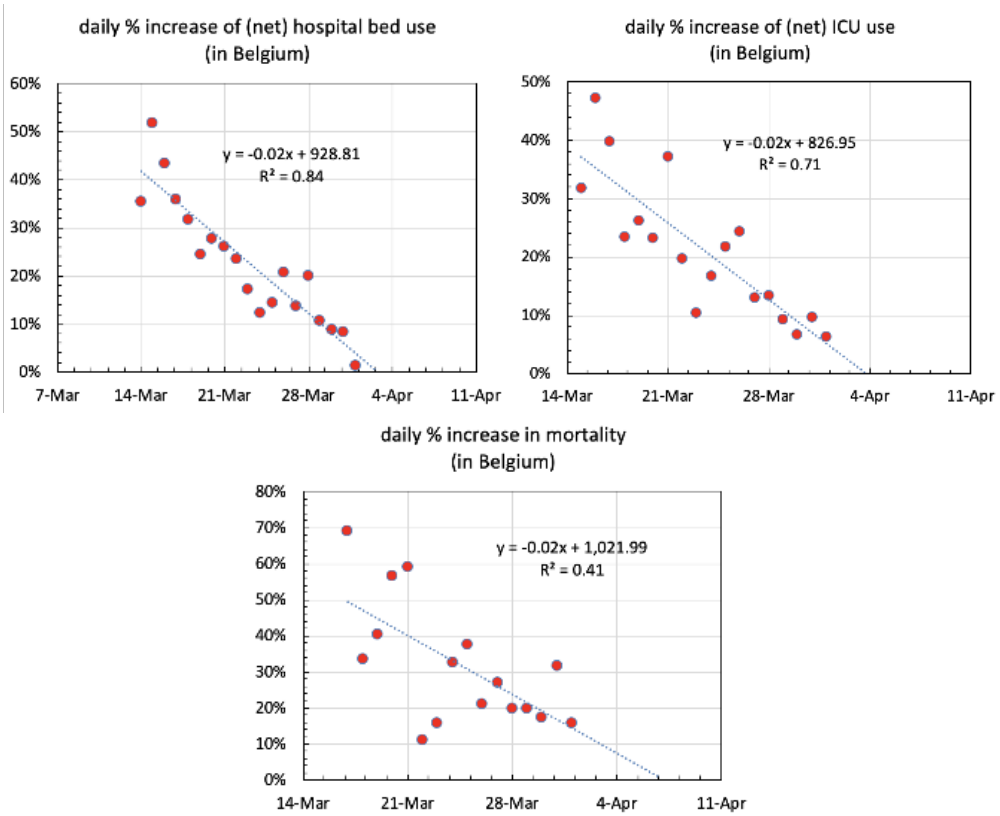

Figure 1. Daily growth rate of hospitalization, ICU admittance and mortality in Belgium.

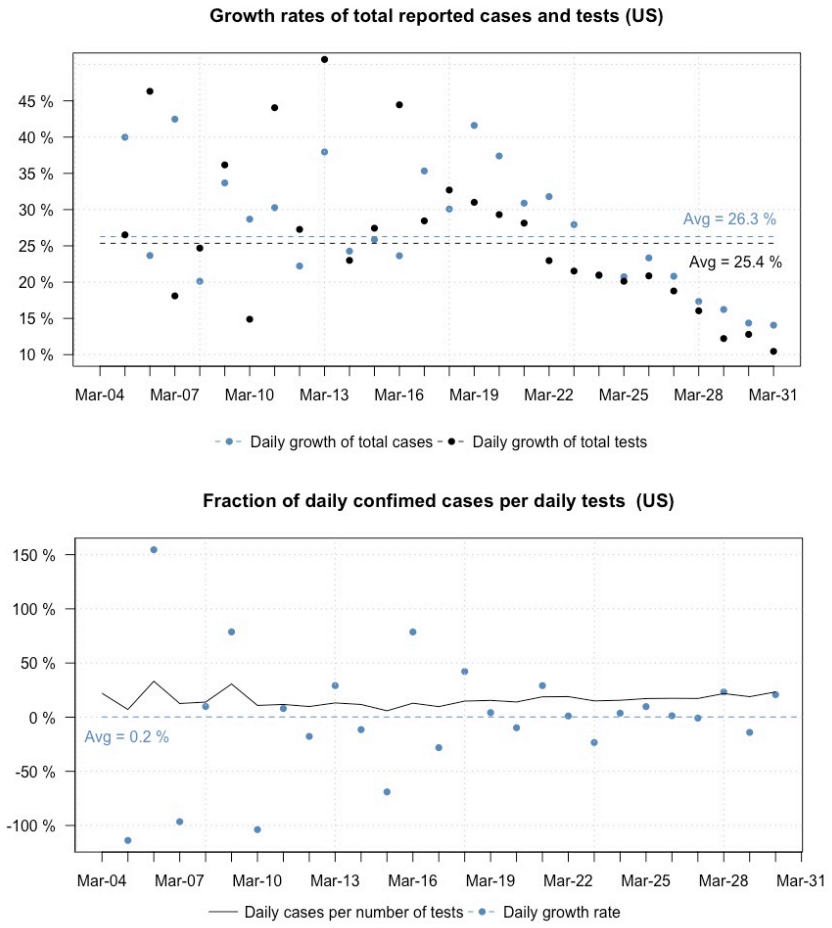

Figure 2. Growth rates of confirmed cases and total tests in the US (upper) and daily fraction of confirmed cases per number of tests (lower).

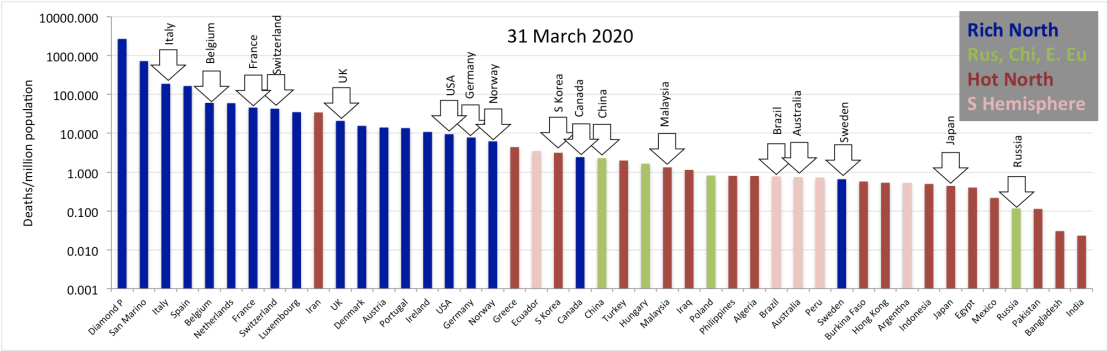

Figure 3. Selected countries are ranked by deaths per million population as of 31 March. The distribution shows some clear trends and the data are subjectively divided into 4 groups: Rich North countries (blue), Hot North countries (dark red), Southern Hemisphere countries (pink), and East Block countries including Russia, China and East Europe (green).

A quick look at the death per capita in countries from different regions of the world

1. All countries to the right of Malaysia have <1.33 deaths per million population.
2. The Hot North countries do not have large epidemics yet. The worst case is Greece with 4.41 deaths / million. Iran is a special case (see below).
3. The East Block countries do not have large epidemics yet either. The worst Countries are China 2.3 deaths / million and Hungary with 1.66 deaths / million. Many of these countries have climates similar to West Europe. There are three options to explain this.
    - The early lock down prevented the spread of the disease;
    - They are simply at an earlier stage and a larger epidemic is coming (no applicable to China);
    - They are using a different reporting standard, for example recording cause of death as pneumonia.
4. The S Hemisphere doesn't have a large epidemic yet either. The worst hit country is Ecuador with 3.51 deaths / million. If the epidemic comes in their winter they will have time to prepare.
5. The large epidemic lies in Rich north countries where San Marino (735) and Italy (192) are worst hit. In the group San Marino to Norway (6.3), Norway is least hit. Canda and Sweden are currently exceptions. The order of this group likely reflects the stage of epidemic and most countries in the group Italy to Norway should expect to end up something like Italy. There is an indication that the daily increase in deaths in Italy is slowing. There is little difference in the spread of disease in this group. The reason that rich north countries have been hit so hard could be due to the cold climate and aging populations, as well as a remarkably mild winter with a much smaller death rate due to the “normal” influenza in the vulnerable elderly cohort.
6. Iran is the only hot north country to have a large epidemic. We think it was cold over Teheran during the early stage. And we speculate that old men sharing bubble pipes may have spread the virus among the vulnerable who then imported it to the family home.
7. Sweden is also a huge anomaly, with 0.66 deaths per million people. We know that the disease arrived late in Sweden but also that they have only very light lockdown. Sweden appears to be moving left through the ranks as the disease spreads. Canada (1.62) is also somewhat anomalous like Sweden. It’s possible that being big, low population density and very cold helps. But the Swedish numbers currently look suspect. It shares a very long border with neighboring Norway but has only 1/10 of the deaths. But it is also possible that they have a different reporting standard.
8. India, Pakistan and Bangladesh are all big countries that should have been in the thick of it early on given their location. They might not have enough resources to test and find the cause of death. But they appear to be seeing something going on now since India and Pakistan have gone into lockdown. We speculate that the very low death rate in India, Pakistan and

Bangladesh is because there populations lack large cohorts in the over 65 groups where most deaths in the Rich North occur (Figure 4).

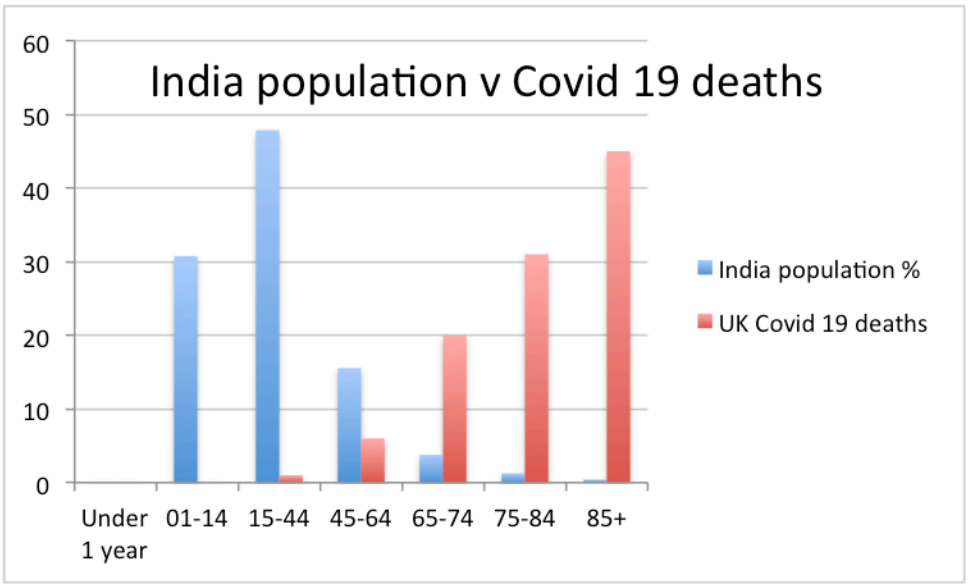

Figure 4 The population structure of India (Wikipedia) compared with the structure of Covid 19 deaths in the UK (UK office for National statistics). The population structures of India, Pakistan and Bangladesh may make them more immune to Covid 19 compared with other countries.