Daily report 06-07-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

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Foreword
The present report aims to provide a comprehensive picture of the pandemic situation of COVID-19 in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an empirical model, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the evaluation of the quality of control measures made in each state and a short-term prediction of trends. Note, however, that the effects of the measures’ control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- $a$: the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- $K$: the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the short-term predictions for different countries and regions. We are adjusting the model to countries and regions with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The predicted period of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as long-term predictions for some of them, when possible. These long-term predictions are evaluated without different weights to data-points. We also discuss a specific issue every day.

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PJC and MC received funding from “la Caixa” Foundation (ID 100010434), under agreement LCF/PR/GN17/50300003; CP, DL, SA, MC, received funding from Ministerio de Ciencia, Innovación y Universidades and FEDER, with the project PGC2018-095456-B-I00;

Disclaimer: These reports have been written by declared authors, who fully assume their content. They are submitted daily to the European Commission, but this body does not necessarily share their analyses, discussions and conclusions.
(0) Executive summary – Dashboard
Situation and highlights

The UK continues with the ongoing revision of historical data that has lead to a decreased number of cases. Data will be retro-corrected accordingly. However, this decrease affects the global evaluation of EU+EFTA+UK. Therefore, the cumulative figure for today does not include the UK and it shows only EU+EFTA. For the same reason, the individual report of the UK is only included till 1st July.

The number of daily new cases in the EU+EFTA is during the last days going below the 5,000 cases keeping a basal value of new cases. The UK is on the revision of the data and Sweden seems not to report during the weekend, since there is no upload of new cases, similar to France, which last reports show around 800 new cases. Germany shows a continuous decrease from the 450 of the last report to values around 200 new cases for the last two days. This data corresponds to the weekend, and therefore may change in the next few days. Spain oscillates around the 300 while Italy slowly goes down, now with around 200 new cases.

Outside Europe the numbers are highly negative. The USA is growing inside a second wave with around 45,000 new cases daily. Brazil shows large oscillations around the 35,000 new cases, and it is not clear if it has stopped its growth. India shows almost 25,000 new cases within an exponential growth. On the other hand, Chile and Perú, after weeks of growing and slightly below the 4,000 new cases daily, have stopped their growing dynamics and show values of $\rho$ below 1 during the last week.
## Situation and trends per country

Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) form worst (red) situations according to each of the variables. Last column (EPGEST) is assessed with estimated real 14-day attack rate (see report from 22/04 for details). EPGREP is calculated with data reported by countries. EPGREP and EPGEST cannot be compared between them because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively. Data from 2nd July.

<table>
<thead>
<tr>
<th>Country</th>
<th>Cumulative cases</th>
<th>Attack rate /10^3 inh.</th>
<th>Cumulative deaths</th>
<th>Mortality /10^3 inh.</th>
<th>Active cases (last 14 days)</th>
<th>14-day attack rate /10^3 inh.</th>
<th>Estimated active cases (last 14 days)</th>
<th>Estimated 14-day attack rate /10^3 inh.</th>
<th>P_7</th>
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<th>EPGEST</th>
<th>Biocon-Cov degree</th>
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**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1 % (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher)

(1) P_7 is the average of 7 consecutive p, but can still fluctuate. (2,3) EPG stands for Effective Growth Potential. EPGREP is the product of attack-rate of last 14 days per 10^5 inhabitants by P_7 (empiric reproduction number). EPGEST is the product of estimated real attack-rate of last 14 days per 10^5 inhabitants and P_7. Biocon-Cov degree is an epidemiological situation scale based on the level of last week’s mean daily new cases (https://upcommons.upc.edu/handle/2117/189661, https://upcommons.upc.edu/handle/2117/189808).
Analysis: Local containment of outbreaks. A report on the epidemiological evolution in the city of Lleida (I).

Last weekend, a containment perimeter was established around the city of Lleida and its surroundings in Catalonia (Spain). Citizens can no longer move in and out of the region for leisure. Visits and tourism in and out of the area are forbidden. Only the movement related to work is allowed. You can enter and leave the city on the same day if you work inside and live outside. If you live in the city and work outside and your physical presence is needed, you can also move in and out.

It is a confinement perimeter affecting 200,000 inh., 200 km from Barcelona. The same week, the same type of perimeter was established in a smaller area in Galicia (A Mariña), in the North-West of Spain. Both areas had reached a rather high level of incidence, way higher than any of its surrounding. For example, Barcelona right now has an attack rate of 15 reported active cases per 100,000 people while Lleida it is around 200. Allowing the normal flux of people between Lleida and Barcelona would certainly increase the risk of new cases in a heavily populated and dense area such as Barcelona (10,000 inh./km²).

It is important to assess here what has been the evolution in Lleida because it is a very good example of the type of behavior that we can encounter in the following weeks all around Europe. The general situation of Spain and Catalonia on average has been good during the last weeks. To make this assessment, we use Risk Diagrams (RD) that we have developed in our group and discussed in previous assessments. Each point is a different day and the X-axis shows the number of active cases (reported cases in the last 14 days per 100,000 inh.), while the Y-axis shows the empiric growth rate averaged for a week.

The more important feature of our RD is the color code behind the dot. We have carefully established that for Daily Testing Levels slightly below 100 (tests per day per 100,000 inh.), such as the case for Spain and Catalonia, the color code indicated how difficult is for the health professional to diagnose test and trace the contacts of those with a positive PCR. In green, normal PCR testing levels are more than enough to track the new cases. The effort in terms of hours for this job is also manageable. The low level of cases in the green zone also makes it rather difficult to encounter multiple small outbreaks of more than 3 people where the effort in test and tracing increases. In yellow and orange, the complexity of test and trace increases, more PCRs are needed, and more hours of health professionals are also required. The complexity of the case encounter can easily require also an increase in social services.

Thanks to the open data portal of the Generalitat de Catalunya, who provides properly anonymized data of positive cases with geolocalization, we have been able to monitor the situation properly in Lleida during the

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2 http://governobert.gencat.cat/ca/dades_obertes/dades-obertes-covid-19/
last month. As we can see, at the end of May and in June the region was no longer in the green area. Some outbreaks were particularly large which seemed to have a particularly complex network of contacts.

The complex nature of the outbreaks can be observed in the **double loop of our risk diagram**. The situation seems complex but is controlled, to reappear again in secondary outbreaks. In mid-June, the situation seems to be improving, but the situation gets worse again. On the 1st-2nd July, public data gives a worrisome picture of the last week of June. Next table and figures (up, whole epidemic; down, last month) illustrate this evolution.

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<tr>
<td>7/1/2020</td>
<td>1.93</td>
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</table>
It is important to understand that **PCR+ tests and its tracking provide information delayed by 4-8 days**, given the delays between the development of symptoms, going to the doctor, ordering the PCR, getting the results and introducing them in the information systems with its proper verification takes this amount of time. **An absolute clear picture is only achieved one week later.**

Another good indicator is the level of hospitalization in the hospital in the area. Spain has not carried out the process of anonymization required to obtain this local data. Governments only give the information upon request using a standard average for a whole week so that the people involved cannot be re-identified. No systematic process is in place for the autonomous governments in Spain. The public data was available for Lleida last Friday indicating a relatively low entrance in the hospital that was increasing systematically for a couple of weeks. On Saturday, the perimeter was established.

To control the situation in the area and reduce the incidence, the population was requested to increase its vigilance, and gatherings of more than 10 in any type of place were banned. There was also a call not to do the small gatherings allowed in consecutive days. This is, people were requested not to do a meeting of 5 people on Friday and another 10 on Saturday, in a clear effort to contain the number of contacts, especially those on a problematic setting like indoor gatherings of family members where mask uses might be low and vocal activity and the emission of droplets high.

**If the number of contacts in dangerous settings is reduced in four-seven days, we should see a reduction in the number of people with symptoms since important tertiary outbreaks would not appear.** In any case, public health and social services should be reinforced in the area to short-circuit any other major clustering propagations.

Indeed, the structure of the outbreak in Lleida is another example of the low dispersion of this disease. We cannot have access to the network of contacts of those involved in the major outbreaks given the private nature of these networks, but news reports indicate that those networks were very complex, associated with **common areas where temporary workers of the agricultural sector who share common space live.** There have been also other clusters in the area associated with the major ones³. As a consequence, **following the subsequent community propagation was difficult and the incidence increased.** Given the information we have, **these kinds of outbreaks will become problematic for policymakers.** Once in the red zone, it is quite clear that a reduction of contacts is needed. However, this information comes with a delay, so it would be epidemiologically better to introduce some measure earlier. Still, introducing measures when the outbreaks can still be controlled might have an economic and political cost.

A possible policy solution that requires some research regarding its possible outcome is to inform the population publicly and clearly of those regions that are in the yellow or orange level and inform them that distance measures should be increased. The problem of these announcements is that they, again, can have effects on the economics of the area with, maybe, no clear benefit due to differential attachment to the rules. **A public warning system might not increase compliance if those less attached to following the guidelines do not perceive a clear threat.** In this sense, **Germany has proposed clear-cut measures.** The population knows exactly under which conditions there will be closure and people are informed of the present level. It is certainly a policy that might be interesting to observe and analyze to test if it works better than a warning level.

---

### Situation and trends in other countries

**Table of current situation in a sample of non-EU countries.** Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. EPG<sub>REP</sub> and EPG<sub>EST</sub> cannot be compared between them because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively. **Data from 2<sup>nd</sup> July.**

<table>
<thead>
<tr>
<th>Country</th>
<th>Reported data</th>
<th>Indexes</th>
<th>Biocom-Cov degree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cumulative cases</td>
<td>Attack rate /10&lt;sup&gt;6&lt;/sup&gt; inh.</td>
<td>Cumulative deaths</td>
</tr>
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</tr>
<tr>
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<td>754.2</td>
<td>64,876</td>
</tr>
<tr>
<td>India</td>
<td>697,413</td>
<td>51.5</td>
<td>19,693</td>
</tr>
<tr>
<td>Russia</td>
<td>681,251</td>
<td>466.8</td>
<td>10,161</td>
</tr>
<tr>
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<td>302,716</td>
<td>918.1</td>
<td>10,589</td>
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<tr>
<td>Chile</td>
<td>295,542</td>
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</tr>
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<td>30,639</td>
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<td>11,571</td>
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<tr>
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<td>231,816</td>
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</tr>
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<td>1,916</td>
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</table>

**Scale:**
- **Worst:** 0-2
- **Best:** 1000

<table>
<thead>
<tr>
<th>Country</th>
<th>Scale</th>
<th>Indexes</th>
<th>Biocom-Cov degree</th>
</tr>
</thead>
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<td>Worst</td>
<td>Worst</td>
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<tr>
<td>Ecuador</td>
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<td>7</td>
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</table>

**Disclaimer:** estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1% (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher).

(1) ρ<sub>T</sub> is the average of 7 consecutive ρ, but can still fluctuate. (2,3) EPG stands for Effective Growth Potential. EPG<sub>REP</sub> is the product of attack-rate of last 14 days per 10<sup>6</sup> inhabitants by ρ<sub>T</sub> (empiric reproduction number). EPG<sub>EST</sub> is the product of estimated real attack-rate of last 14 days per 10<sup>6</sup> inhabitants and ρ<sub>T</sub>. Biocom-Cov degree is an epidemiological situation scale based on the level of last week’s mean daily new cases ([https://upcommons.upc.edu/handle/2117/189661](https://upcommons.upc.edu/handle/2117/189661), [https://upcommons.upc.edu/handle/2117/189808](https://upcommons.upc.edu/handle/2117/189808)).
Time indicators by country

These tables summarize a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of $1/10^5$ inhabitants and an attack rate of $10/10^5$ inhabitants, and time interval between attack rates of 10 to 100 per $10^5$ inhabitants (only for countries that have overtaken this threshold). **Data from 2nd July.**

**EU+EFTA+UK countries**

<table>
<thead>
<tr>
<th>Countries</th>
<th>Days since the first 100 cases</th>
<th>Time interval between 1 and 10 cases / $10^5$ inh. (days)</th>
<th>Time interval between 10 and 100 cases / $10^5$ inh. (days)</th>
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<td>Days since the first 100 cases</td>
<td>Time interval between 1 and 10 cases / $10^5$ inh. (days)</td>
<td>Time interval between 10 and 100 cases / $10^5$ inh. (days)</td>
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<tr>
<td>Belarus</td>
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<td>10</td>
<td>18</td>
</tr>
</tbody>
</table>
Long-term predictions

Evaluated with the whole historical series. Up-left: Predictions of maximum incidences per country at the end of the first wave (total final expected attack rate per 10^9 inh.). Up-right: Predictions of maximum absolute number of cases per country at the end of the first wave (K, in log scale). Blue lines indicate current situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.

Final expected value for EU+EFTA+UK as a whole is not shown any more, since we are in the tail (see Analysis section in Report #87, https://upcommons.upc.edu/handle/2117/190497).
### Situation and trends in Italian and Spanish regions

#### Italy

Data from 06\textsuperscript{th} July

<table>
<thead>
<tr>
<th>Country</th>
<th>Cumulative cases</th>
<th>Attack rate /10\textsuperscript{5} inh.</th>
<th>Cumulative deaths</th>
<th>Mortality /10\textsuperscript{5} inh.</th>
<th>Active cases (last 14 days)</th>
<th>14-day attack rate /10\textsuperscript{5} inh.</th>
<th>Estimated active cases (last 14 days)</th>
<th>Estimated 14-day attack rate /10\textsuperscript{5} inh.</th>
<th>p\textsubscript{7} /1 / 1</th>
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</thead>
<tbody>
<tr>
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<td>186.3</td>
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</tr>
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<td>NA</td>
<td>NA</td>
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</table>

#### Spain

Data from 29\textsuperscript{th} June, series built with the day of symptoms' onset

<table>
<thead>
<tr>
<th>Autonomous regions</th>
<th>Cumulative cases</th>
<th>Attack rate /10\textsuperscript{5} inh.</th>
<th>Active cases (last 14 days)</th>
<th>14-day attack rate /10\textsuperscript{5} inh.</th>
<th>p\textsubscript{7} /1 / 1</th>
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<tbody>
<tr>
<td>Madrid</td>
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<td>1,084.7</td>
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<td>164.1</td>
<td>2</td>
<td>2.4</td>
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</tbody>
</table>

#### Disclaimer:

Estimated active cases and estimated 14-day attack rate are assessed by assuming a lethality of 1\% (see report from 20 to 24 April, #37-41). This value can change in countries where suspicious deaths are reported as well (real values would be lower) and in countries where incidence among elderly people was minor (real values would be higher).

\( p\textsubscript{7} \) is the average of 7 consecutive \( p\), but can still fluctuate. EPG stands for Effective Growth Potential. \( EPG_{\text{REP}} \) is the product of attack-rate of last 14 days per 10\textsuperscript{5} inhabitants by \( p\textsubscript{7} \) (empiric reproduction number). \( EPG_{\text{EST}} \) is the product of estimated real attack-rate of last 14 days per 10\textsuperscript{5} inhabitants and \( p\textsubscript{7} \). Biocom-Cov degree is an epidemiological situation scale based on the level of last week's mean daily new cases [https://upcommons.upc.edu/handle/2117/189661, https://upcommons.upc.edu/handle/2117/189808].

**Long-term predictions** are not shown any more, since all Italian and Spanish regions are in the tail (see Analysis section in Report #87, https://upcommons.upc.edu/handle/2117/190497).
Legend: Countries’ reports details

Reported cumulative cases (blue) and deaths (brown), together with predictions (red)

Estimated and reported cases.

Incident observed cases and predictions.

Incident observed cases in a logarithmic scale, with Biocom-Cov degree.

Evolution of empiric reproductive number $\rho_7$

Case fatality rate

Risk diagram of last 15 days

Risk diagram
(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

UK 01-07-2020. Pop: 67.9M. Cumulative incidence: 462/10^5
Spain 04-07-2020. Pop: 47.0M. Cumulative incidence: 533/10^5

![Graphs showing cumulative confirmed cases and deaths, number of cases, and cases per 10^5 inhabitants over time.]

Actual $\rho_f = 0.9$

![Graphs showing incident observed cases and incident cases per 10^5 inh. over time.]

BIOCOM-Cov2 Degree = 3

![Graphs showing incident observed cases per 10^5 inh. over time.]

Risk diagram

![Graph showing risk diagram with points indicating dates: July 04 and March 12.]

Risk diagram (last 15 days)

![Graph showing risk diagram for the last 15 days with points indicating dates: July 04 and June 19.]
Italy 05-07-2020. Pop: 60.5M. Cumulative incidence: 400/10^5
Germany 05-07-2020. Pop: 83.8M. Cumulative incidence: 235/10⁵
Belgium 05-07-2020. Pop: 11.6M. Cumulative incidence: 535/10^5

Graphs showing cumulative confirmed cases and deaths, number of cases, confirmed and estimated cases, incident observed cases and incident cases per 10^6 inh., actual p_2 = 1.4, and risk diagrams.

Cumulative confirmed cases vs. time (days)

Cumulative confirmed deaths vs. time (days)

Number of cases vs. time (days)

Cases per 10^7 inhabitants vs. time (days)

Incident observed cases vs. time (days)

Incident cases per 10^5 inh. vs. time (days)

BIOCOM-Cov2 Degree = 2

Actual p_f = 0.8

Case fatality rate (%) vs. time (days)

Risk diagram

Risk diagram (last 15 days)
Poland 05-07-2020. Pop: 37.8M. Cumulative incidence: 95/10^5
Switzerland 05-07-2020. Pop: 8.7M. Cumulative incidence: 372/10^5
Romania 05-07-2020. Pop: 19.2M. Cumulative incidence: 151/10^5

---

**Cumulative confirmed cases**

- Cases: Blue line
- Deaths: Red line
- Predictions: Yellow line

**Cumulative confirmed deaths**

- Number of cases: Green line
- Cases per 10^6 inhabitants: Blue line

**Incident observed cases**

- Confirmed: Blue line
- Predicted: Red line

**Actual p_j = 1.1**

**BIOCOCM-Cov2 Degree = 4**

**Case fatality rate (%)**

**Risk diagram**

- July 05
- March 31

**Risk diagram (last 15 days)**

- July 05
- June 20
Ireland 05-07-2020. Pop: 4.9M. Cumulative incidence: 517/10^5

Cumulative confirmed cases vs Time (days)

Cumulative confirmed deaths vs Time (days)

Number of cases vs Time (day)

Cases per 10^4 inhabitants vs Time (day)

Incident observed cases vs Time (day)

Incident cases per 10^5 inh. vs Time (day)

Incident observed cases per 10^5 inh. vs Time (day)

Actual $R_T = 1.3$

Case fatality rate (%) vs Time (days)

Risk diagram

Risk diagram (last 15 days)
Denmark 05-07-2020. Pop: 5.8M. Cumulative incidence: 222/10^5

- Cumulative confirmed cases vs. Time (days)
- Cumulative confirmed deaths vs. Time (days)
- Number of cases vs. Time (Day)
- Cases per 10^5 inhabitants vs. Time (Day)
- Incident observed cases vs. Time (Day)
- Incident cases per 10^3 inh. vs. Time (Day)
- Incident observed cases vs. Time (Day)
- Incident cases per 10^3 inh. vs. Time (Day)

Actual $\rho_f = 0.8$

- Risk diagram
- Risk diagram (last 15 days)

- Cumulative confirmed cases vs time (days)
- Cumulative confirmed deaths vs time (days)
- Number of cases vs time (day)
- Cases per 10^4 inhabitants vs time (day)

- Incident observed cases vs time (day)
- Incident observed cases per 10^3 inh. vs time (day)

- Actual $p_f = 1.2$

- Risk diagram
  - July 05
  - March 22

- Risk diagram (last 15 days)
  - July 05
  - June 20
Norway 05-07-2020. Pop: 5.4M. Cumulative incidence: 164/10^5
Finland 05-07-2020. Pop: 5.5M. Cumulative incidence: 131/10^5

- Cumulative confirmed cases vs. time (days)
- Cumulative deaths vs. time (days)
- Number of cases vs. time (days)
- Cases per 10^5 inhabitants vs. time (days)

- Incident observed cases vs. time (days)
- Incident cases per 10^5 inh. vs. time (days)

- Actual $\rho_7 = 1.0$

- Case fatality rate (8%)

- Risk diagram
- Risk diagram (last 15 days)

Actual $p_2 = 1.3$
Luxembourg 05-07-2020. Pop: 0.6M. Cumulative incidence: 722/10^5

BIOCOM-Cov2 Degree = 7

Actual $p_2 = 2.3$

Risk diagram

Risk diagram (last 15 days)
Greece 05-07-2020. Pop: 10.4M. Cumulative incidence: 34/10^5

Actual $\rho_\gamma = 1.3$

Risk diagram

Risk diagram (last 15 days)
Croatia 05-07-2020. Pop: 4.1M. Cumulative incidence: 77/10^5

- Cumulative confirmed cases vs. Time (days)
- Cumulative confirmed deaths vs. Time (days)
- Number of cases vs. Time (day)
- Cases per 10^7 inhabitants vs. Time (day)
- Incidence observed cases vs. Time (day)
- Incidence observed cases per 10^5 inh. vs. Time (day)
- Actual p2 = 1.3
- Case fatality rate (%) vs. Time (day)

Risk diagram
- Risk diagram (last 15 days)
Iceland 05-07-2020. Pop: 0.3M. Cumulative incidence: 546/10^5

Cumulative confirmed cases vs Time (days)

Incident observed cases vs Time (days)

Actual $\beta_2 = 1.5$

Risk diagram

Risk diagram (last 15 days)
Lithuania 05-07-2020. Pop: 2.7M. Cumulative incidence: 67/10^5

Cumulative confirmed cases and deaths over time.

Incident observed cases and predicted cases.

Actual $p_2 = 1.3$.

Risk diagram showing active cases per 10^5 inh. (last 14 days).

Risk diagram (last 15 days).
Slovenia 05-07-2020. Pop: 2.1M. Cumulative incidence: 82/10^5

Cumulative confirmed cases vs Time (days)

Cumulative confirmed deaths vs Time (days)

Number of cases vs Time (day)

Cases per 10^5 inhabitants vs Time (day)

Incident observed cases vs Time (day)

Incident cases per 10^5 inh. vs Time (day)

Incident observed cases vs Time (day)

Incident observed cases per 10^5 inh. vs Time (day)

Actual ργ = 1.6

Case Fatality rate (%) vs Time (day)

Risk diagram

Risk diagram (last 15 days)
Latvia 05-07-2020. Pop: 1.9M. Cumulative incidence: 60/10^5

BIOCOM-Cov2 Degree = 1

Actual \( \rho_f = \text{NA} \)

Case fatality rate (%)
Cyprus 05-07-2020. Pop: 1.2M. Cumulative incidence: 83/10^5

Actual $\rho_7 = 1.1$

Risk diagram

Risk diagram (last 15 days)
Malta  05-07-2020. Pop: 0.4M. Cumulative incidence: 152/10^5

[Graphs and diagrams showing data on cumulative confirmed cases, incidence observed cases, actual \( \rho_f \) = NA, and risk diagrams.]

Not enough data

BIOCOM-Cov2 Degree = 1

Incident observed cases per 10^5 inh.

Incident observed cases per 10^5 inh.

Actual \( \rho_f \) = NA

Case Fatality rate (%)

Risk diagram

Risk diagram (last 15 days)
(2) Analysis and prediction of COVID-19 for other countries

USA 05-07-2020. Pop: 331.0M. Cumulative incidence: 873/10^5

Cumulative confirmed cases

Cumulative confirmed deaths

Number of cases

Cases per 10^5 inhabitants

Incident observed cases

Incident cases per 10^5 inh.

Incident observed cases per 10^5 inh.

Actual $R_\gamma = 1.2$

Case Fatality rate (%)

Risk diagram

Risk diagram (last 15 days)
Brazil 05-07-2020. Pop: 212.6M. Cumulative incidence: 754/10^5

- Cumulative confirmed cases
- Cumulative confirmed deaths
- Number of cases
- Cases per 10^6 inhabitants

Incident-observed cases

Actual $r_f = 1.0$

Case fatality rate (%)

Risk diagram

Risk diagram (last 15 days)
Peru 05-07-2020. Pop: 33.0M. Cumulative incidence: 918/10^5

- Cumulative confirmed cases vs. Time (days)
- Cumulative confirmed deaths vs. Time (days)
- Number of cases vs. Time (day)
- Cases per 10^3 inhabitants vs. Time (day)
- Incident observed cases vs. Time (day)
- Incident cases per 10^3 inh. vs. Time (day)
- Incident observed cases per 10^3 inh. vs. Time (day)

Actual $p_2 = 0.9$

- Case fatality rate (%) vs. Time (day)
- Risk diagram
- Risk diagram (last 15 days)
Chile 05-07-2020. Pop: 19.1M. Cumulative incidence: 1546/10^5

- Cumulative confirmed cases
- Cumulative confirmed deaths

- Number of cases
- Cases per 10^3 inhabitants

Incident observed cases

Actual P_j = 0.8

Confirmed, Prediction

BIOCOM-Cov2 Degree = 9

Incident observed cases per 10^3 inh.

Case Fatality Rate (R)_j

Risk diagram

Risk diagram (last 15 days)
Pakistan 05-07-2020. Pop: 220.9M. Cumulative incidence: 105/10⁵
Turkey  05-07-2020. Pop: 84.3M. Cumulative incidence: 244/10^5

[Graphs showing cumulative confirmed cases, number of cases, and incident observed cases over time.]

Actual $r_0 = 0.9$

Risk diagram

Risk diagram (last 15 days)
South Africa 05-07-2020. Pop: 59.3M. Cumulative incidence: 332/10^5
Qatar 05-07-2020. Pop: 2.9M. Cumulative incidence: 3464/10^5

Actual $p_2 = 1.4$

Risk diagram

Risk diagram (last 15 days)

---

- **Cumulative confirmed cases**
  - Time (days)
  - Number of cases
  - Cases per 10^5 inhabitants

- **Incident observed cases**
  - Time (day)
  - Incident cases per 10^5 inhab.
  - Incident observed cases per 10^5 inhab.

- **Actual P_2 = 1.2**

- **Risk diagram**
  - Active cases per 10^5 inhab. (last 14 days)

- **Risk diagram (last 15 days)**
  - Active cases per 10^5 inhab. (last 14 days)
Israel 05-07-2020. Pop: 8.7M. Cumulative incidence: 346/10^5

- Cumulative confirmed cases
- Cumulative confirmed deaths
- Number of cases
- Cases per 10^5 inhabitants

BIOCOM-Cov2 Degree = 8

Incident observed cases

Actual \( \rho_2 = 1.7 \)

Risk diagram

Risk diagram (last 15 days)
Japan 05-07-2020. Pop: 126.5M. Cumulative incidence: 15/10^5

Cumulative confirmed cases vs time (days)

Cumulative confirmed deaths vs time (days)

Number of cases vs time (days)

Cases per 10^5 inhabitants vs time (days)

Incident observed cases vs time (day)

Incident cases per 10^5 inh. vs time (day)

Incident observed cases per 10^5 inh. vs time (day)

Actual \( r_f = 1.7 \)

Case fatality rate (%) vs time (day)

Risk diagram

Risk diagram (last 15 days)
Malaysia 05-07-2020. Pop: 32.4M. Cumulative incidence: 27/10^5

Actual $\rho_7 = 0.7$
Australia 05-07-2020. Pop: 25.5M. Cumulative incidence: 33/10^5

- Cumulative confirmed cases
- Cumulative confirmed deaths
- Number of cases
- Cases per 10^5 inhabitants

- Incident observed cases
- Incident cases per 10^5
- Incident observed cases per 10^5

Actual $r_2 = 2.5$

Risk diagram
Risk diagram (last 15 days)
Andorra 05-07-2020. Pop: 0.1M. Cumulative incidence: $1107/10^5$
(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

Data updated on 6th July, data series built with the day of the symptoms’ onset, reliable until 29th June.

Spain 29-06-2020. Pop: 47.0M. Cumulative incidence: 581/10^5

Deaths series currently under revision

BIOCOM-Cov2 Degree = 3

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)

Deaths series currently under revision

BIOCOM-Cov2 Degree = 3

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)

Deaths series currently under revision

BIOCOM-Cov2 Degree = 5

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Castilla Leon 29-06-2020. Pop: 2.4M. Cumulative incidence: 1113/10^5

Deaths series currently under revision

BIOMIC-Cov2 Degree = 2

Actual ρy = 0.6

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Castilla-La Mancha  29-06-2020. Pop: 2.0M. Cumulative incidence: 1100/10^5

Deaths series currently under revision

BIOCOM-Cov2 Degree = 2

Incident observed cases

Incident cases per 10^5 inh.

Actual p_f = 0.7

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)

Deaths series currently under revision

Actual \( \rho_y = 0.6 \)

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
C Valenciana  29-06-2020. Pop: 5.0M. Cumulative incidence: 298/10⁵

Deaths series currently under revision

Actual $p_2 = 1.5$

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Euskadi 29-06-2020. Pop: 2.2M. Cumulative incidence: 662/10^5

Deaths series currently under revision

BIOCOM-Cov2 Degree = 2

Actual $p_2 = 0.8$

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)

Deaths series currently under revision

BIOCOM-Cov2 Degree = 3

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Navarra 29-06-2020. Pop: 0.7M. Cumulative incidence: 1210/10^5

Deaths series currently under revision

Actual $p_f = 0.7$

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Aragon 29-06-2020. Pop: 1.3M. Cumulative incidence: 533/10^5

Deaths series currently under revision

BIOCOM-Cov2 Degree = 4

Incident cases per 10^5 inh.

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
La Rioja  29-06-2020. Pop: 0.3M. Cumulative incidence: 1261/10^5

Deaths series currently under revision

BIOCOM-Cov2 Degree = 2

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Canarias 29-06-2020. Pop: 2.2M. Cumulative incidence: 117/10^5

Deaths series currently under revision

BIOCOM-Cov2 Degree = 1

Risk diagram

Risk diagram (last 15 days)
Murcia 29-06-2020. Pop: 1.5M. Cumulative incidence: 167/10^5

Deaths series currently under revision

Actual $p_f = 1.6$

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)

Deaths series currently under revision

Actual $p_Y = 1.6$

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Cantabria 29-06-2020. Pop: 0.6M. Cumulative incidence: 406/10^5

Deaths series currently under revision

Actual ρ_y = 0.7

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Ceuta 29-06-2020. Pop: 0.1M. Cumulative incidence: 262/10^5

Deaths series currently under revision

Actual $\rho_I = NA$

Deaths series currently under revision

Risk diagram

Risk diagram (last 15 days)
Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale
Italy 06-07-2020. Pop: 60.5M. Cumulative incidence: 400/10^5

Cumulative confirmed cases vs Time (days)

Cumulative confirmed deaths vs Time (days)

Incident observed cases vs Time (day)

Incident cases observed per 10^5 inh. vs Time (day)

Actual \(\rho_2 = 1.1\)

Case fatality rate (%) vs Time (day)

Risk diagram

Risk diagram (last 15 days)
Toscana 06-07-2020. Pop: 3.7M. Cumulative incidence: 276/10^5

Cumulative confirmed cases over time.

Cumulative confirmed deaths over time.

Number of cases per 10^5 inhabitants.

Cases per 10^5 inhabitants.

Incident observed cases over time.

Incident cases per 10^5 inh.

BIOCOM-Cov2 Degree = 2

Actual $p_2 = 1.2$

Case fatality rate (%) over time.

Risk diagram.

Risk diagram (last 15 days).
Liguria 06-07-2020. Pop: 1.6M. Cumulative incidence: 645/10^5

- Cumulative confirmed cases vs. time (days)
- Cumulative confirmed deaths vs. time (days)
- Number of cases vs. time (day)
- Cases per 10^5 inhabitants vs. time (day)
- Incident observed cases vs. time (day)
- Incident cases per 10^5 inh. vs. time (day)
- Incident observed cases vs. time (day)
- Incident observed cases per 10^5 inh. vs. time (day)
- Actual p_I = NA
- Case fatality rate (%) vs. time (day)

Risk diagram
Risk diagram (last 15 days)
Puglia 06-07-2020. Pop: 4.0M. Cumulative incidence: 113/10^5

Cumulative confirmed cases over time (left). Cumulative confirmed deaths over time (top right). Number of cases over time (bottom right).

Incident observed cases over time (left). Incident cases per 10^3 inh. over time (top right). Incident observed cases per 10^3 inh. over time (bottom right).

Actual ρ_y = NA

Case fatality rate (%) over time (right).

Risk diagram (left). Risk diagram (last 15 days) (right).

- Cumulative confirmed cases
- Cumulative deaths
- Predictions

- Number of cases
- Cases per 10^5 inhabitants

- Incident observed cases
- Incident cases per 10^3 inh.

- Actual ρ_f = NA

- Case fatality rate (%)

- Risk diagram
- Risk diagram (last 15 days)
Sicilia 06-07-2020. Pop: 5.0M. Cumulative incidence: 62/10^5

Cumulative confirmed cases vs Time (days)

Number of cases vs Time (day)

Incident observed cases vs Time (day)

Incident cases per 10^3 inh. vs Time (day)

Confirmed and Prediction vs Time (day)

BIOCOM-Cov2 Degree = 1

Actual $\rho_\gamma = 3.7$

Case fatality rate (%) vs Time (day)

Risk diagram

Risk diagram (last 15 days)
Bolzano 06-07-2020. Pop: 0.5M. Cumulative incidence: 508/10^5
Sardegna 06-07-2020. Pop: 1.6M. Cumulative incidence: 84/10^5

[Graphs showing cumulative confirmed cases, number of cases, incident observed cases, incident cases per 10^3 inh., and case fatality rate.]

Actual $p_2 = 1.0$

Risk diagram

Risk diagram (last 15 days)
Valle d’Aosta 06-07-2020. Pop: 0.1M. Cumulative incidence: 949/10^5

![Graphs showing cumulative confirmed cases, cumulative confirmed deaths, number of cases, and cases per 10^5 inhabitants over time.]

Actual ρ_T = NA

![Graphs showing incident observed cases and incident cases per 10^5 inh. over time.]

Risk diagram

Risk diagram (last 15 days)
Calabria 06-07-2020. Pop: 1.9M. Cumulative incidence: 61/10^5

- Cumulative confirmed cases vs Time (days)
- Cumulative confirmed deaths vs Time (days)
- Incident observed cases vs Time (day)
- Incident cases per 10^3 inh. vs Time (day)
- Actual $p_2 = 0.8$
- Case Fatality rate (%) vs Time (days)
- Risk diagram
- Risk diagram (last 15 days)
Molise 06-07-2020. Pop: 0.3M. Cumulative incidence: 145/10^5

Actual $\rho_\gamma = NA$

BIOCOM-Cov2 Degree = 0

Risk diagram

Risk diagram (last 15 days)
Basilicata 06-07-2020. Pop: 0.6M. Cumulative incidence: 72/10^5

**Cumulative Confirmed Cases**

**Cumulative Confirmed Deaths**

**Number of Cases**

**Cases per 10^4 Inhabitants**

**Incident Observed Cases**

**Incident Cases per 10^3 inh.**

**Incident Observed Cases per 10^3 inh.**

**Actual ρ_f = NA**

**Case Fatality Rate (%)**

**Risk Diagram**

**Risk Diagram (last 15 days)**
Methods
Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports⁴, from European Centre for Disease Prevention and Control (ECDC)⁵ and from Ministerio de Sanidad⁶. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

✓ Number of cumulated confirmed cases, in blue dots
✓ Number of reported new cases
✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
✓ ρ: this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report (t-1):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day $t$.

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

(I) an initial period where most of the cases are imported;
(II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

• Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
• Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
• Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

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⁴ https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model\(^7\) correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

\[
N(t) = K e^{-\ln\left(\frac{K}{N_0}\right)} e^{-a(t-t_0)}
\]

where \(N(t)\) is the cumulated number of confirmed cases at \(t\) (in days), and \(N_0\) is the number of cumulated cases the day at day \(t_0\). The model has two parameters:

- \(a\) is the velocity at which specific spreading rate is slowing down;
- \(K\) is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day \(t_0\) is chosen as that one at which \(N(t)\) overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab’s Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters \((a\) and \(K)\) and the \(R^2\) of the fitting. At the initial stages the dynamics is exponential and \(K\) cannot be correctly evaluated. In fact, at this stage the most relevant parameter is \(a\). Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- Evolution of fitted \(a\) with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- Evolution of fitted \(K\) with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings’ confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as “Not enough data” if \(a>0.2 \text{ day}^{-1}\), if \(K>10^6\) or if the error in \(K\) overpasses \(10^6\).

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

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\(^7\) Madden LV. Quantification of disease progression. Protection Ecology 1980; 2: 159-176.
• Group A: prediction of expected cumulated cases for the following 3-5 days;
• Group B: prediction of expected cumulated cases for the following 2 days;
• Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

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8 At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.