Daily report 24-05-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries
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 datapoints. We also discuss a specific issue every day.

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**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
**Attack rate and short-term predictions in EU+EFTA+UK**

**Short-term predictions**, based on **last 15 points** with increased weight on last 3:

### Highlights and/or warnings

- **UE+EFTA+UK** new cases are shown in the figure. They have decreased again to the level of 3,300, since the one-day sudden increase in Spain and UK has been left behind.
- All countries maintain trends from previous days.
- There are several countries at $p_7 \geq 1$ but with low $A_{14}$ (see table). These cases are not worrying if a significant increase is not observed in the next days.

### Long-term predictions

**Long-term predictions**, evaluated with the **whole historical series**. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per $10^5$ inh.). Up-right: Predictions of maximum absolute number of cases per country ($K$, 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 K for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown.
Situation and trends per country

Maps. The map in the left shows current \( \mathbf{A}_{14} \). The map in the right shows current \( \mathbf{EPG} \).

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) from worst (red) situations according to each of the variables. \( \mathbf{EPG}_{\text{REP}} \) and \( \mathbf{EPG}_{\text{EST}} \) 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.

(1) \( \rho_7 \) is the average of 7 consecutive \( \rho \), but can still fluctuate. (2,3) \( \mathbf{EPG} \) stands for Effective Growth Potential. \( \mathbf{EPG}_{\text{REP}} \) is obtained by multiplying attack rate of last 14 days per 10^5 inhabitants (i.e. density of cases) by \( \rho_7 \) (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). \( \mathbf{EPG}_{\text{EST}} \) is obtained by multiplying estimated real attack rate of last 14 days per 10^5 inhabitants by \( \rho_7 \).

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).
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\textsuperscript{REP} and EPG\textsuperscript{EST} 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.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|c|}
\hline
Country & Cumulative cases & Attack rate /10^5 inh. & Cumulative deaths & Mortality /10^5 inh. & Active cases (last 14 days) & 14-day attack rate /10^5 inh. & Estimated active cases (last 14 days) & Estimated 14-day attack rate /10^5 inh. & \(\rho_7\) \textsuperscript{(1)} & EPG\textsuperscript{REP} \textsuperscript{(2)} & EPG\textsuperscript{EST} \textsuperscript{(3)} \\
\hline
United States of America & 1,022,070 & 490.2 & 97,087 & 29.3 & 313,129 & 94.6 & 2,059,000 & 622.0 & 1.00 & 95 & 672 \\
Brazil & 347,398 & 163.4 & 22,013 & 10.4 & 191,459 & 90.1 & 1,556,724 & 732.4 & 1.41 & 127 & 1,031 \\
Russia & 335,882 & 230.2 & 3,388 & 2.3 & 137,206 & 94.0 & NA & NA & 0.90 & NA & NA \\
Argentina & 11,340 & 25.1 & 445 & 1.0 & 5,577 & 12.3 & 28,366 & 62.8 & 1.56 & 19 & 98 \\
Belarus & 35,244 & 373.0 & 194 & 2.1 & 13,192 & 139.6 & NA & NA & 0.99 & NA & NA \\
Peru & 115,754 & 351.1 & 3,373 & 10.2 & 50,739 & 153.9 & 173,075 & 524.9 & 1.14 & 176 & 599 \\
Canada & 83,610 & 221.5 & 6,355 & 18.8 & 15,908 & 42.1 & 145,057 & 384.3 & 0.97 & 41 & 371 \\
Mexico & 65,856 & 51.1 & 7,179 & 5.6 & 32,396 & 25.1 & 430,623 & 334.0 & 1.24 & 31 & 414 \\
Chile & 65,393 & 342.1 & 673 & 3.5 & 38,174 & 199.7 & 51,389 & 268.8 & 1.48 & 296 & 398 \\
Ecuador & 36,258 & 205.5 & 3,096 & 17.5 & 7,187 & 40.7 & 63,319 & 358.9 & 1.33 & 54 & 477 \\
Saudi Arabia & 70,161 & 201.5 & 379 & 1.1 & 33,025 & 94.9 & NA & NA & 1.20 & NA & NA \\
Pakistan & 54,601 & 24.7 & 1,133 & 0.5 & 25,136 & 11.4 & 62,316 & 28.2 & 1.24 & 14 & 35 \\
Qatar & 42,231 & 1,465.2 & 21 & 0.7 & 20,882 & 724.8 & NA & NA & 1.09 & 789 & NA \\
India & 131,868 & 8.7 & 3,867 & 0.3 & 68,929 & 5.1 & 248,441 & 18.4 & 1.34 & 7 & 23 \\
Iran & 133,521 & 159.0 & 7,359 & 8.8 & 27,301 & 32.5 & 161,311 & 192.1 & 1.19 & 39 & 228 \\
\hline
\end{tabular}
\caption{Situation in non-EU countries.}
\end{table}

\textsuperscript{(1)} \(\rho_7\) is the average of 7 consecutive \(\rho\), but can still fluctuate. \textsuperscript{(2,3)} EPG stands for Effective Growth Potential. EPG\textsuperscript{REP} is obtained by multiplying attack rate of last 14 days per 10^5 inhabitants (i.e. density of cases) by \(\rho_7\) (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG\textsuperscript{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10^5 inhabitants by \(\rho_7\).

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## Time indicators by country

This table summarizes 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).

### 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>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
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### Other countries

<table>
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<tr>
<th>Countries</th>
<th>Days since the first 100 cases</th>
<th>Time interval between 1 and 10 cases / 10^3 inh. (days)</th>
<th>Time interval between 10 and 100 cases / 10^3 inh. (days)</th>
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</table>

### Situation, trends and long-term predictions in Italian regions

#### Situation and trends

<table>
<thead>
<tr>
<th>Country</th>
<th>Cumulative cases</th>
<th>Attack rate /10^3 inh.</th>
<th>Cumulative deaths /10^4 inh.</th>
<th>Active cases (last 14 days) /10^3 inh.</th>
<th>14-day attack rate /10^3 inh.</th>
<th>Estimated active cases (last 14 days) /10^3 inh.</th>
<th>Estimated 14-day attack rate /10^3 inh.</th>
<th>ρ⁰</th>
<th>EPG⁰</th>
<th>EPGEST⁰</th>
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<td>Lombardia</td>
<td>673 132</td>
<td>137.7</td>
<td>15 134</td>
<td>150.7</td>
<td>5 928</td>
<td>-53.0</td>
<td>259 177</td>
<td>1 031 80</td>
<td>0.82</td>
<td>0.96</td>
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<td>Toscana</td>
<td>52 565</td>
<td>131.9</td>
<td>5 055</td>
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<td>70.1</td>
<td>944</td>
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<td>289.4</td>
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<td>Veneto</td>
<td>32 611</td>
<td>130.1</td>
<td>2 103</td>
<td>99.0</td>
<td>1088</td>
<td>-7.9</td>
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<td>273.2</td>
<td>0.75</td>
<td>0.59</td>
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<td>1 013</td>
<td>77.2</td>
<td>1108</td>
<td>-5.3</td>
<td>13 570</td>
<td>273.2</td>
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<td>0.59</td>
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<td>Abruzzo</td>
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<td>130.0</td>
<td>1 003</td>
<td>98.2</td>
<td>1089</td>
<td>-4.9</td>
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<td>273.2</td>
<td>0.75</td>
<td>0.59</td>
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<td>982</td>
<td>99.0</td>
<td>1108</td>
<td>-4.9</td>
<td>13 570</td>
<td>273.2</td>
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<td>0.59</td>
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<td>99.0</td>
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<td>273.2</td>
<td>0.75</td>
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<td>0.36</td>
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<td>24</td>
<td>114.1</td>
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<td>2.2</td>
<td>10 373</td>
<td>214.4</td>
<td>0.56</td>
<td>0.36</td>
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</table>

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1 ρ⁰ is the average of 7 consecutive ρ, but can still fluctuate. EPG stands for Effective Growth Potential. EPG⁰ is obtained by multiplying attack rate of last 14 days per 10^3 inhabitants (i.e. density of cases) by ρ⁰ (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPGEST is obtained by multiplying estimated real attack rate of last 14 days per 10^3 inhabitants by ρ⁰.

2 Spain: Historical series have not been updated. Therefore, regional analysis is not shown.
Long-term predictions

Evaluated with the whole historical series. See figure in the next page. Up-left: Predictions of maximum incidences per country (total final expected attack rate per $10^5$ inh.). Up-right: Predictions of maximum absolute number of cases per country ($K$, 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.

Maps

The map in the left shows current $A_{14}$. The map in the right shows current EPG.
Legend: Countries’ reports details

Confirmed cases:
data (blue), model fitted (dashed line), predictions (red points and table)

Fitted $\alpha$ value using points prior to each date

Estimated cases using death rate (see Methods)

Fitted $K$ value using points prior to each date

Evolution of $\rho$, a parameter related with Reproduction number (see Methods)

Deaths / cumulated reported cases

Reported and predicted new cases

Reported deaths
(1) Analysis and prediction of COVID-19 for EU+EFTA+UK


Predictions for next days:

<table>
<thead>
<tr>
<th>Date</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-05-2020</td>
<td>235087 (±6001)</td>
<td>235209 - 235367</td>
</tr>
<tr>
<td>22-05-2020</td>
<td>276702 (±1001)</td>
<td>276901 - 276702</td>
</tr>
<tr>
<td>23-05-2020</td>
<td>273500 (±1001)</td>
<td>273500 - 273500</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

Cumulative cases per 10^5:

- Confirmed cases
- Estimated cases

Cases per 10^5 inhabitants:

Actual ρ₀ = 1.0

Cumulative observed deaths:

Cumulative deaths per 10^5 inhabitants:

Case fatality rate (%):

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>interval</th>
</tr>
</thead>
<tbody>
<tr>
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<td>[56650 - 57853]</td>
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<tr>
<td>25-03-2020</td>
<td>57960 (+253)</td>
<td>[56650 - 57853]</td>
</tr>
<tr>
<td>26-03-2020</td>
<td>57960 (+253)</td>
<td>[56650 - 57853]</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

Cumulative confirmed cases

Cumulative cases per 10^5

Number of cases

Cases per 10^5 inhabitants

Actual $\rho_g = 0.8$

Incident observed cases

Incident cases per 10^5 inhabitants

Cumulative observed deaths

Cumulative deaths per 10^5 inhabitants

Case fatality rate (%)

[Graphs showing cumulative confirmed cases, cumulative number of cases per 10^5 inhabitants, incident observed cases, incident cases per 10^5 inhabitants, cumulative observed deaths, and case fatality rate (%).]

Actual $\rho_s = 1.1$

Not enough data

Actual $\rho_2 = \text{NaN}$

- Number of cases
- Prediction

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-05-2020</td>
<td>639+67</td>
<td>[600-675]</td>
</tr>
<tr>
<td>25-05-2020</td>
<td>623+67</td>
<td>[600-675]</td>
</tr>
<tr>
<td>26-05-2020</td>
<td>629+64</td>
<td>[600-650]</td>
</tr>
</tbody>
</table>

Not enough data

Actual ρ = 1.4

Cumulative observed deaths

Cumulative deaths per 10^5 inhabitants

Case fatality rate (%)
(2) Analysis and prediction of COVID-19 for other countries


<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-05-2020</td>
<td>128981 (9-79)</td>
<td>116574-129925</td>
</tr>
<tr>
<td>25-05-2020</td>
<td>141097 (9-79)</td>
<td>135754-141097</td>
</tr>
<tr>
<td>26-05-2020</td>
<td>146313 (9-79)</td>
<td>141656-146313</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

Predictions for next days

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-05-2020</td>
<td>146571+22540</td>
<td>[14601, 14715]</td>
</tr>
<tr>
<td>25-05-2020</td>
<td>147551+22080</td>
<td>[14695, 14815]</td>
</tr>
<tr>
<td>26-05-2020</td>
<td>148301+21277</td>
<td>[14754, 14834]</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

Cumulative confirmed cases

Cumulative cases per 10^5

Number of cases

Cases per 10^6 inhabitants

Actual $\rho_f = 1.2$

Incident observed cases

Incident cases per 10^5 inhabitants

Confirmed
Prediction

Cumulative observed deaths

Cumulative deaths per 10^6 inhabitants

Case fatality rate (%)

Predictions for next days:

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-05-2020</td>
<td>12000 (102)</td>
<td>[1190, 1210]</td>
</tr>
<tr>
<td>25-05-2020</td>
<td>12700 (107)</td>
<td>[1190, 1230]</td>
</tr>
<tr>
<td>26-05-2020</td>
<td>12900 (109)</td>
<td>[1190, 1230]</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

Cumulative confirmed cases

Cumulative cases per 10^5

Number of cases

Cases per 10^6

Actual ρ₀ = 0.9

Incident observed cases

Incident cases per 10^5

Cumulative observed deaths

Cumulative deaths per 10^5

Case fatality rate (%)
(3) 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 24-05-2020. Population: 60.5M. Current cumulated incidence: 380/10^5
Trento 24-05-2020. Population: 0.5M. Current cumulated incidence: 819/10^5

Predictions for next days

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>23-05-2020</td>
<td>323 (+16)</td>
<td>320 - 326</td>
</tr>
<tr>
<td>24-05-2020</td>
<td>323 (+14)</td>
<td>320 - 326</td>
</tr>
<tr>
<td>25-05-2020</td>
<td>323 (+14)</td>
<td>320 - 326</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction
Molise 24-05-2020. Population: 0.3M. Current cumulated incidence: 141/10^5

Predictions for next days:

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-05-2022</td>
<td>434±2</td>
<td>142 - 458</td>
</tr>
<tr>
<td>26-05-2022</td>
<td>451±2</td>
<td>142 - 458</td>
</tr>
<tr>
<td>27-05-2022</td>
<td>477±2</td>
<td>142 - 458</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

Cumulative confirmed cases vs Time (day)

Cumulative cases per 10^5 vs Time (day)

Number of cases vs Time (day)

Cases per 10^7 inhabitants vs Time (day)

Actual ρ = 0.5

Incident observed cases vs Time (day)

Incident cases per 10^5 inhabitants vs Time (day)

Cumulative deaths vs Time (day)

Cumulative deaths per 10^7 inhabitants vs Time (day)

Case fatality (%) vs Time (days)
Basilicata 24-05-2020. Population: 0.6M. Current cumulated incidence: 71/10^5

- Predictions for next days

<table>
<thead>
<tr>
<th>Day</th>
<th>Number of cases</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-05-2020</td>
<td>399 ± 0</td>
<td>[396 - 422]</td>
</tr>
<tr>
<td>26-05-2020</td>
<td>400 ± 1</td>
<td>[396 - 422]</td>
</tr>
<tr>
<td>27-05-2020</td>
<td>401 ± 1</td>
<td>[396 - 423]</td>
</tr>
</tbody>
</table>

- Number of cases
- Prediction

- Cumulative confirmed cases
- Cumulative cases per 10^5

- Actual $\rho = 1.1$

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

- Cumulative observed deaths
- Cumulative deaths per 10^5 inhabitants

- Case fatality rate (%)
Methods
Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports\(^2\), from European Centre for Disease Prevention and Control (ECDC)\(^3\) and from Ministerio de Sanidad\(^4\). 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.
- \( \rho(t) \): 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 (\(t-1\)):

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

where \( N_{\text{new}}(t) \) 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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\(^2\) https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
\(^4\) https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm
(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model\(^5\) 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:

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

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:

- \(\alpha\) 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 (\(\alpha\) 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 \(\alpha\). 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 \(\alpha\) 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 \(\alpha>0.2\) \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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• 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\(^7\) 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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\(^6\) 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.