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BARCELONATECH
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IGTP Germans Trias i Pujol Research Institute

Daily report 06-04-2020

Analysis and prediction of COVID-19 for different regions and countries

Situation report 21

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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 tendencies**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 5-7 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.

Next, we show a report with 8 graphs and a table with the short-term predictions for (1) European Union and its countries, (2) other countries, (3) Spain and its autonomous communities.

We are currently 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:

- ✓ Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more → 3-5 days prediction;
- ✓ Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days → 2 days prediction;
- ✓ Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days → 1 day prediction.

We have introduced a change in fittings, that are now weighted at some points. The whole methodology employed in the inform is explained in the last pages of this document.

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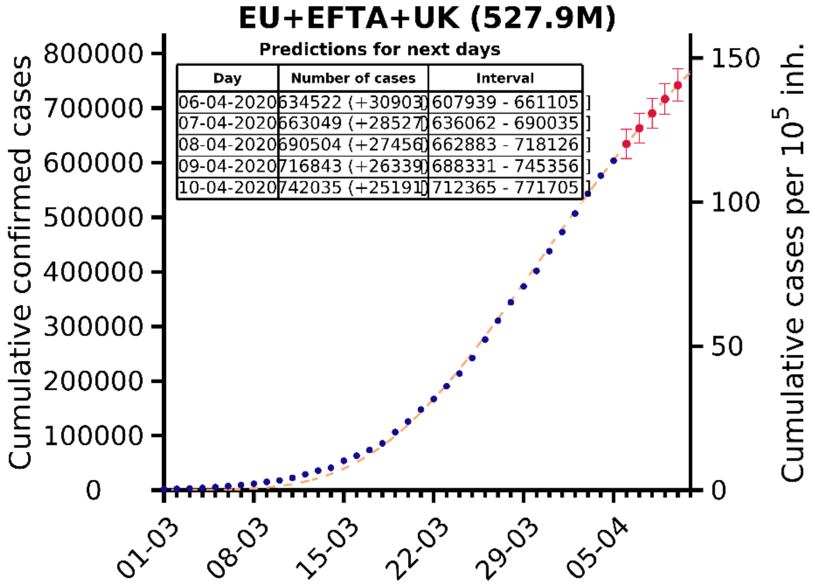
(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs

We have extended our analysis to the EU+EFTA+UK group of countries. Therefore, absolute numbers should not be compared with those from the previous reports.

Globally, EU+EFTA+UK account for 603,619 reported cases, with an attack rate of 114/10^5 inhabitants. From those cases, **75% correspond to Spain, Italy Germany, France and UK**. These countries are also expected to provide 80 % of the new cases in the following days, which are estimated to be around 25,000-30,000 daily for the whole EU+EFTA+UK.



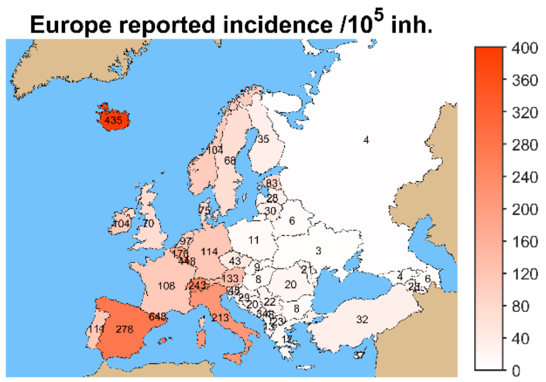
Spreading rate (ρ) has not significantly changed with the inclusion of new countries, and **remains on the threshold between growth and control** (ρ ≈1). This would suggest that, globally, EU+EFTA+UK could be on the top of the peak, but that it has not started the decreasing phase. It is expected that we observe **fluctuations** around predicted new cases for a few days, walking on the top of this mountain chain, until the final descent hopefully starts.

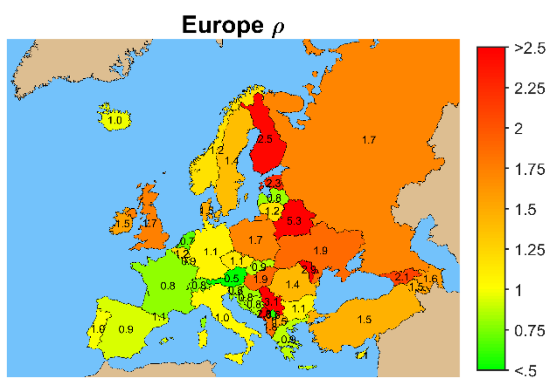
In this report, we analyse the meaning of observed diversity in mortalities among countries.

Trends for specific countries

Spain is still leading the classification of total cases (130759), followed by **Italy** (128948), **Germany** (95391), **France** (70478), **UK** (47806) and **Switzerland** (21065). Among these countries, only **Italy** seems to almost have overtaken the peak, although it presents a small rise the last days that still could revert this tendency. **Spain** seems to be on the right way, although the dynamics on the next days should confirm it. Germany and France keep showing a quite fluctuating dynamics, while **UK** is clearly in an alarming growth phase. **Switzerland** data suggest an epidemiological stage similar to that of Spain. Highest ρ (mean of last 3 days) is observed in **Estonia** (1.84, with intermediate incidence and thus at moderate risk) and **Hungary** (1.72, with low incidence). Other medium and small countries that should be closely tracked are **Ireland**, **Portugal** and **Denmark** (intermediate EPG values). High reported attack rate in **Iceland** combined with an extremely low case fatality rate suggests a high diagnostic percentage, therefore not reflecting a real risk.

The following maps show current situation country by country. Note that **incidence's color scale has been updated** and it is not comparable with that from previous reports.





Situation and tendencies per country

Table of current situation in EU countries, according to data published by ECDC on April 6th. 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. Colour scale in ρ has been changed. Indexes EPG and EPG2 have a new formulation since 5th April (see below).

	Reported data						Indexes		
Country	Cumulated cases	Attack rate / 10^5 inh.	Cumulated death	Mortality /10^5 inh.	Active cases (last 10 days)	Active cases (last 10 days) /10^5 inh.	Mean ρ[1]	EPG[2]	EPG2[2]
Spain	130,759	282.1	12,418	26.8	74,571	160.9	1.01	162.2	163.6
Italy	128,948	217.0	15,889	26.7	48,409	81.5	0.92	75.2	69.4
Germany	95,391	116.5	1,434	1.8	53,103	64.8	1.22	78.9	96.0
France	70,478	108.9	8,078	12.5	41,323	63.8	0.96	61.6	59.3
United Kingdom	47,806	72.0	4,934	7.4	36,148	54.4	1.68	91.4	153.5
Switzerland	21,065	245.8	715	8.3	10,351	120.8	0.93	112.6	104.9
Belgium	19,691	173.4	1,447	12.7	13,456	118.5	1.01	119.6	120.8
Netherlands	16,627	97.9	1,651	9.7	9,196	54.1	0.85	46.0	39.1
Austria	11,983	137.5	204	2.3	4,954	56.9	0.58	33.2	19.4
Portugal	11,278	108.7	295	2.8	7,734	74.6	1.02	76.1	77.6
Sweden	6,830	69.4	401	4.1	4,024	40.9	1.58	64.7	102.2
Norway	5,640	105.1	58	1.1	2,484	46.3	1.10	50.7	55.5
Ireland	5,111	108.1	158	3.3	3,292	69.7	1.44	100.1	143.7
Czech Republic	4,587	43.2	67	0.6	2,525	23.8	1.17	27.8	32.4
Denmark	4,369	76.5	179	3.1	2,492	43.6	1.68	73.4	123.6
Poland	4,102	10.7	94	0.2	2,881	7.5	1.67	12.6	20.9
Romania	3,864	19.5	148	0.7	2,835	14.3	1.48	21.3	31.5
Luxembourg	2,804	486.8	36	6.3	1,351	234.5	0.95	223.4	212.8
Finland	1,927	35.0	28	0.5	969	17.6	1.62	28.6	46.3
Greece	1,735	15.5	73	0.7	843	7.5	1.07	8.1	8.7
Iceland	1,486	408.0	4	1.1	684	187.8	1.01	189.4	191.1
Croatia	1,182	28.1	15	0.4	687	16.3	0.86	14.1	12.1
Estonia	1,097	83.6	15	1.1	559	42.6	1.84	78.3	144.0
Slovenia	997	48.0	28	1.3	420	20.2	0.88	17.8	15.6
Lithuania	811	27.9	13	0.4	512	17.6	1.32	23.2	30.7
Hungary	744	7.6	38	0.4	444	4.6	1.72	7.8	13.5
Latvia	533	27.0	1	0.1	289	14.7	0.73	10.7	7.8
Bulgaria	531	7.4	20	0.3	267	3.7	1.12	4.2	4.7
Slovakia	485	8.9	0	0.0	259	4.8	1.13	5.4	6.1
Cyprus	446	38.1	14	1.2	300	25.6	1.54	39.4	60.6
Malta	234	54.5	0	0.0	100	23.3	ND	ND	ND
Liechtenstein	78	202.3	1	2.6	22	57.1	ND	ND	ND

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	300.0	300.0
Best	Best	Best	Best	Best	Best	0.0	0.0	0.0

(1) Disclaimer: parameter ρ is very sensitive and experiments daily variations. Mean ρ is averaged per 3 consecutive days, but it can still vary the following days.

(2) EPG stands for Effective Growth Potential. It is obtained by multiplying attack rate per 10^5 inhabitants of last 10 days (i.e. density of cases) by ρ (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG2 is a similar index but attack rate of last 10 days is multiplied by ρ^2.

Highlights for countries with highest number of reported cases

- ✓ According to predictions, next days the countries with highest number of cases will be Spain and UK, both of them on the range 5000-6000. Nevertheless, predictions suggest that Spain will follow a decreasing tendency in this range, while UK will be in a growth tendency.
- ✓ Germany will be at the range of 5000-4000 new cases daily, followed by Italy (4000) and France (3500-2500)
- ✓ Among these countries, UK has the highest ρ (1.7 last 3 days), followed by Germany (1.22). Italy, Spain and France are on the threshold between control and growth (ρ≈1).

Analysis: What is the mortality of COVID-19 in different countries? An assessment on the diagnosis rate and the quality care of UE countries

Some of the population are worried about the differences in mortality presented by COVID-19 in different countries, fearing that their country's health system is not working as it should. It is therefore an important cause for concern. It must be well explained that differences in case fatality rate, for the most part, have nothing to do with the quality of the healthcare system.

First, relevant parameters must be explained. The mortality rate is the ratio of deaths caused by the disease, which we know to be around the order of 1%. This value is deduced from the analysis of the situation in South Korea, where the number of tests was, and continues to be, very high. In South Korea we have a good knowledge of the total number of infected people. **The mortality rate caused by COVID-19 is the ratio between the number of deaths and the number of infected people multiplied by 100.**

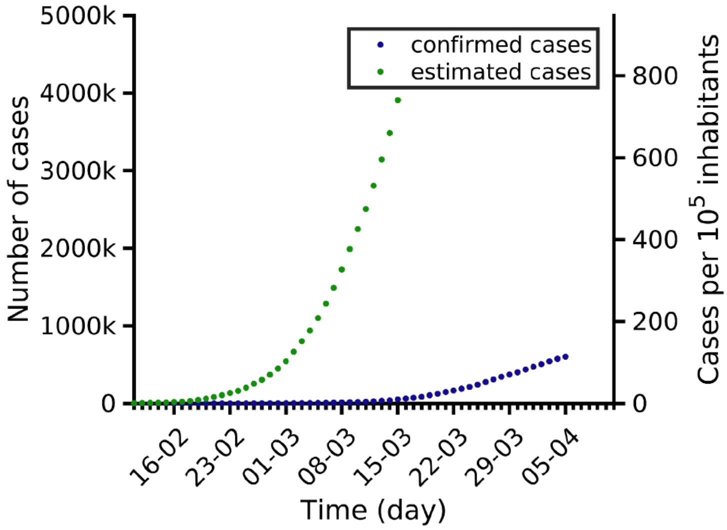
Another relevant parameter is the reported case fatality rate, which is the ratio between the number of deaths caused by COVID-19 and the number of reported infected people, multiplied by 100. This rate, which we calculate for each country in the table, **is severely affected by variations in the two terms, especially by the denominator**. The number of tests performed in many countries has been quite low. Therefore, if we divide the number of deaths by a number of infected people much lower than the real one, the quotient gives us a much greater result, but this does not indicate that the mortality caused for the disease is really higher.

Country	Cumulated COVID19 cases[1]	Cumulated COVID19 deaths[1]	Case fatality rate
Italy	128,948	15,889	12%
France	70,478	8,078	11%
United Kingdom	47,806	4,934	10%
Netherlands	16,627	1,651	10%
Spain	130,759	12,418	9%
Belgium	19,691	1,447	7%
Sweden	6,830	401	6%
Hungary	744	38	5%
Greece	1,735	73	4%
Denmark	4,369	179	4%
Romania	3,864	148	4%
Bulgaria	531	20	4%
Switzerland	21,065	715	3%
Cyprus	446	14	3%
Ireland	5,111	158	3%
Slovenia	997	28	3%
Portugal	11,278	295	3%
Poland	4,102	94	2%
Austria	11,983	204	2%
Lithuania	811	13	2%
Germany	95,391	1,434	2%
Czech Republic	4,587	67	1%
Finland	1,927	28	1%
Estonia	1,097	15	1%
Luxembourg	2,804	36	1%
Liechtenstein	78	1	1%
Croatia	1,182	15	1%
Norway	5,640	58	1%
Iceland	1,486	4	0%
Latvia	533	1	0%
Slovakia	485	0	0%
Malta	234	0	0%

[1] Data from ECDC, 06th April 2020

In our group we take that the mortality caused by the disease is indeed 1% on average (it may vary depending on demography, as it is higher in older people). We use this hypothesis to calculate what the total number of infected probably is. It should be noted that we consider infected people to take about 18.5 days to die[1], which is why the number of deaths per day is useful for estimating the number of actual infected 18.5 days before. This also means that at the beginning of the epidemic the mortality will be lower than in the later days. In the next page we show the figure of **estimated cases for EU+EFTA+UK**, which is shown in detailed report for all countries.

[1] Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3



There are other factors that affect the calculation of reported mortality, in particular the number of deaths evaluated. **In many countries, many deaths, especially the elderly in residences, are not evaluated for virus carriers.** In this way, the number of deaths due to COVID-19 is less than the actual one. However, the changes in the denominator have much more effect on the mathematical ratio. The total number of deaths caused by the disease will be evaluated properly later, by comparing the average mortality rate of the different countries in the months of the epidemic with the actual mortality at the moment (www.euromomo.eu).

Finally, **in certain areas, the saturation of the health care system may have caused, or may cause in a close future, that not all serious patients could be adequately attended to** due to lack of intensive care units or due to lack of respirators, for example. In this case, it is possible that the mortality caused by COVID-19 is more than 1%. In the following days we will try to asses, using hospitalization data, where this extreme case may have occurred or where it may occur. However, right now, it is clearly not a general scenario. Obviously, healthcare systems in different EU countries have different qualities and resources but, in most countries, all are providing quality care. The message for the population should be calm, so far, people with serious conditions are properly attended.

Situation and tendencies in Italian Spanish and Belgian regions

Italy. Data from 06/04/2020

Country	Reported data						Indexes		
	Cumulated cases	Attack rate / 10^5 inh.	Cumulated deaths	Mortality / 10^5 inh.	Active cases (last ten days)	Active cases (last ten days) / 10^5 inh	Mean ρ[(1)]	EPG[(2)]	EPG2[(2)]
Lombardia	51,534	513.2	9,202	91.6	14,236	141.8	1.04	147.3	153.0
Emilia Romagna	17,556	393.7	2,108	47.3	5,968	133.8	0.97	130.0	126.3
Piemonte	12,924	296.7	1,251	28.7	5,832	133.9	1.23	164.7	202.6
Veneto	11,588	236.2	662	13.5	4,091	83.4	0.92	77.1	71.3
Toscana	6,001	160.9	350	9.4	2,551	68.4	0.75	51.0	38.0
Marche	4,614	302.5	612	40.1	1,418	93.0	0.85	78.6	66.5
Liguria	4,549	293.4	595	38.4	1,853	119.5	1.06	126.1	133.0
Lazio	4,031	68.6	229	3.9	1,736	29.5	0.78	22.9	17.8
Campania	3,058	52.7	204	3.5	1,604	27.6	1.00	27.8	27.9
Puglia	2,444	60.7	195	4.8	1,110	27.5	0.71	19.6	13.9
Trento	2,348	219.0	230	21.4	957	89.2	1.08	96.4	104.0
Friuli Venezia Giulia	2,103	173.1	158	13.0	786	64.7	1.44	93.0	133.8
Sicilia	2,046	40.9	123	2.5	796	15.9	0.71	11.3	8.0
Bolzano	1,722	1,602.8	164	152.6	719	669.2	0.66	439.3	288.3
Abruzzo	1,721	131.2	169	12.9	704	53.7	0.82	44.0	36.1
Umbria	1,253	142.1	44	5.0	369	41.8	0.91	38.1	34.8
Sardegna	922	56.2	47	2.9	392	23.9	0.97	23.2	22.5
Calabria	817	42.0	58	3.0	323	16.6	1.00	16.6	16.6
Valle dAosta	805	640.9	96	76.4	353	281.0	1.23	345.7	425.3
Basilicata	287	51.0	13	2.3	136	24.2	0.63	15.3	9.7
Molise	224	73.3	13	4.3	115	37.6	2.03	76.6	155.8

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2	600.0	800.0
Best	Best	Best	Best	Best	Best	0	0.0	0.0

Spain. Data from 05/04/2020

Autonomous regions	Reported data						Indexes		
	Total cumulated cases	Attack rate /10^5 inh.	Cumulated deaths	Mortality rate /10^5 inh.	Active cases (last 10 days)	Active cases (last 10 days) /10^5 inh.	Mean ρ[(1)]	EPG[(1)]	EPG[(2)]
Madrid	38,723	583.1	5,136	77.3	19,480	293.3	0.95	279.8	267.0
Catalunya	26,824	354.6	2,760	36.5	13,884	183.5	1.03	189.0	194.6
Castilla-La Mancha	10,602	520.9	1,132	55.6	6,668	327.6	1.19	389.4	463.0
Castilla y Leon	9,116	378.6	919	38.2	4,984	207.0	0.91	188.9	172.3
Euskadi	8,810	404.5	548	25.2	4,209	193.2	0.98	188.7	184.2
Andalucia	8,581	101.8	491	5.8	4,788	56.8	0.83	47.1	39.0
Comunitat Valenciana	7,334	147.4	637	12.8	3,802	76.4	0.61	46.8	28.7
Galicia	6,151	227.8	190	7.0	3,829	141.8	0.81	115.4	94.0
Aragon	3,347	253.4	284	21.5	2,009	152.1	0.77	116.6	89.3
Navarra	3,231	497.1	187	28.8	1,590	244.6	0.86	210.0	180.2
La Rioja	2,719	867.1	141	45.0	1,483	472.9	1.25	591.4	739.7
Extremadura	2,068	194.1	228	21.4	837	78.6	0.86	67.9	58.7
Canarias	1,649	74.7	85	3.9	771	34.9	0.65	22.6	14.6
Asturias	1,646	161.0	86	8.4	746	73.0	0.88	64.2	56.4
Cantabria	1,483	254.9	77	13.2	673	115.7	0.73	84.1	61.2
Baleares	1,320	111.1	81	6.8	565	47.6	0.46	21.7	9.9
Murcia	1,259	84.6	68	4.6	545	36.6	0.74	26.9	19.8
Melilla	86	101.5	2	2.4	44	51.9	ND	ND	ND
Ceuta	83	97.8	3	3.5	66	77.8	ND	ND	ND

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	600.0	800.0
Best	Best	Best	Best	Best	Best	0.0	0.0	0.0

Belgium. Data from 05/04/2020.

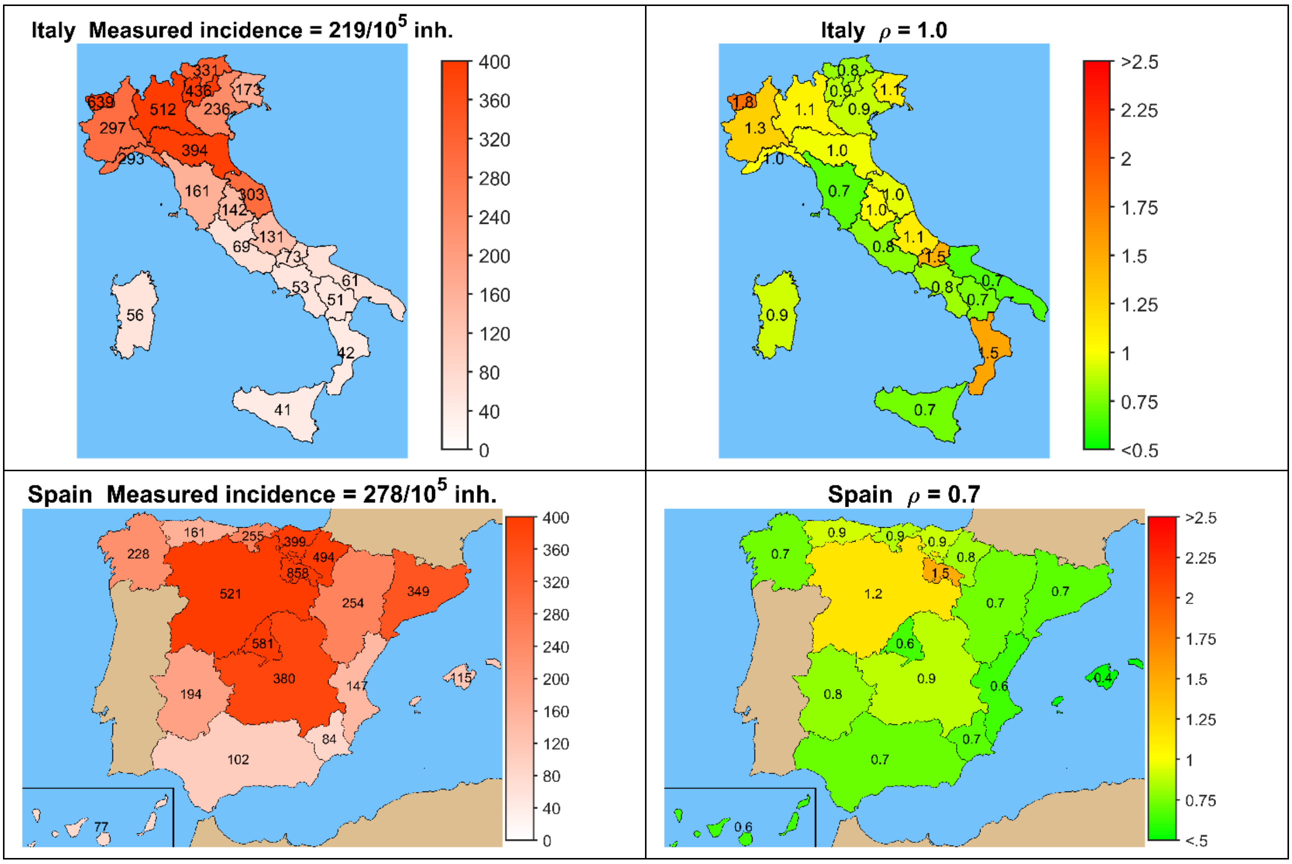
Country	Reported data						Indexes		
	Cumulated cases	Attack rate / 10^5 inh.	Cumulated deaths	Mortality / 10^5 inh.	Active cases (last ten days)	Active cases (last ten days) / 10^5 inh	Mean ρ[(1)]	EPG[(2)]	EPG2[(2)]
Flanders	12,269	186.2	633	9.6	6,276	95.2	0.91	86.9	79.3
Wallonia	5,785	159.2	688	18.9	2,606	71.7	0.76	54.2	40.9
Brussels	2,341	193.7	311	25.7	1,220	100.9	0.79	79.7	63.0

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	300.0	300.0
Best	Best	Best	Best	Best	Best	0.0	0.0	0.0

[(1)] Disclaimer: parameter ρ is very sensitive and experiments daily variations. Mean ρ is averaged per 3 consecutive days, but it can still vary the following days. [(2)] EPG stands for Effective Growth Potential. It is obtained by multiplying attack rate per 10^5 inhabitants of last 10 days (i.e. density of cases) by ρ (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG2 is a similar index but attack rate of last 10 days is multiplied by ρ^2.

Maps of Italian and Spanish regions (06/04/2020)

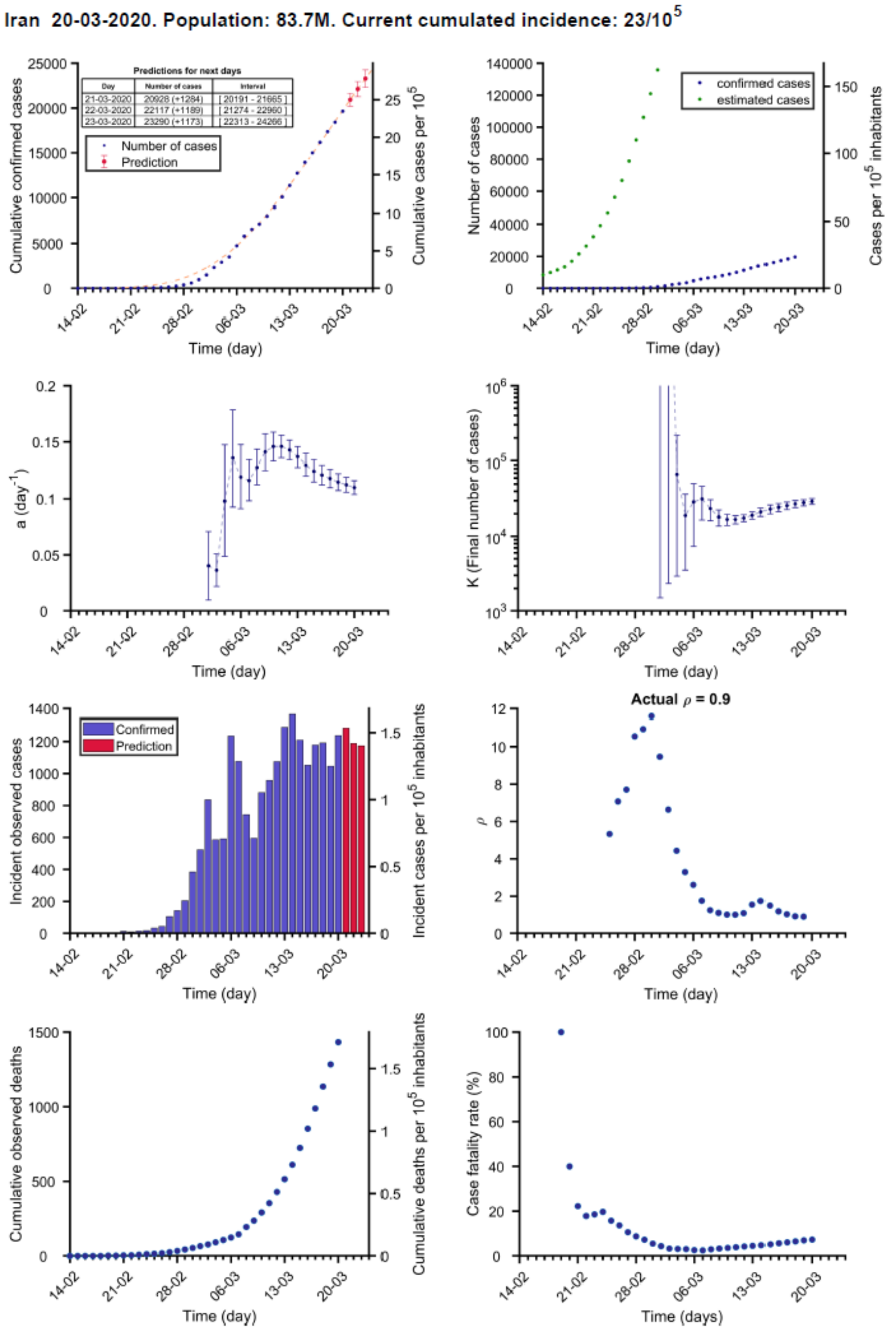
Cumulated incidence and spreading rate (ρ) in Europe, Italian regions and Spanish autonomous communities.



Legend: Countries' reports details

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

Estimated cases using death rate (see Methods)



Fitted a value using points prior to each date

Fitted K value using points prior to each date

Reported and predicted new cases

Evolution of ρ, a parameter related with Reproduction number (see Methods)

Reported deaths

Deaths / cumulated reported cases

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

Data obtained from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale (Italy)

(2) Analysis and prediction of COVID-19 for other countries

Data obtained from https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases

(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

Data obtained from https://github.com/datadista/datasets/tree/master/COVID%2019 and https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm

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.
- ✓ 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.

[2] https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports
[3] https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases
[4] https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm
https://github.com/datadista/datasets/tree/master/COVID%2019

(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:

$$N(t) = K\, e^{-ln\left(\frac{K}{N_0}\right)\cdot\, e^{-\,a\cdot(t-t_0)}}$$

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 $a>0.2\ day^{-1}$, 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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[5] 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[6];
- 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.

[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.

[7] Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3