Daily report 09-04-2020

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

Situation report 24

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With the financial support of

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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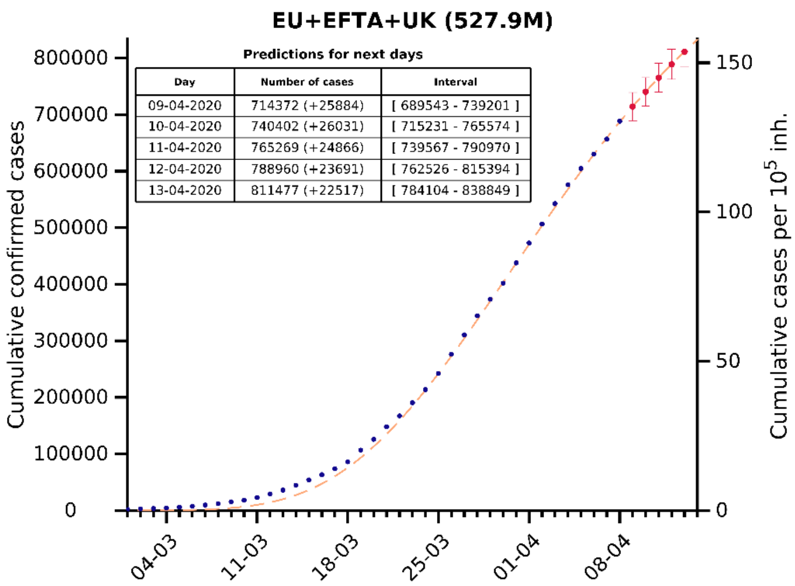
(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs



Day	Number of cases	Interval
09-04-2020	714372 (+25884)	[689543 - 739201]
10-04-2020	740402 (+26031)	[715231 - 765574]
11-04-2020	765269 (+24866)	[739567 - 790970]
12-04-2020	788960 (+23691)	[762526 - 815394]
13-04-2020	811477 (+22517)	[784104 - 838849]

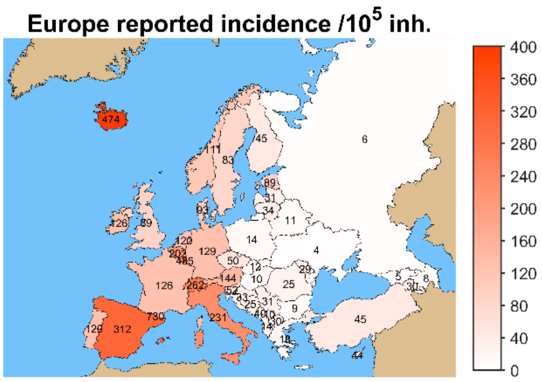
EU+EFTA+UK countries could **overtake the threshold of 700,000 cases tomorrow or the day after**, as expected. Today's reported new cases show a **sudden increase**, which is caused by a similar increase in four of the five countries with highest number of cases (Spain, Italy, Germany and UK). This should be analysed with caution, since there are two possible causes behind this behaviour: first, that these data effectively correspond to new cases diagnosed on Tuesday, and the weekend effect can modulate them; second, that some countries could have started doing more tests, as part of the control strategy. If this trend is maintained the next days, the second option should be explored to discern if the increase is caused by a real increase in incidence or by an increase in the **diagnosis percentage**. By now, this has situated the prediction for the next days at the upper bound, at around 25,000.

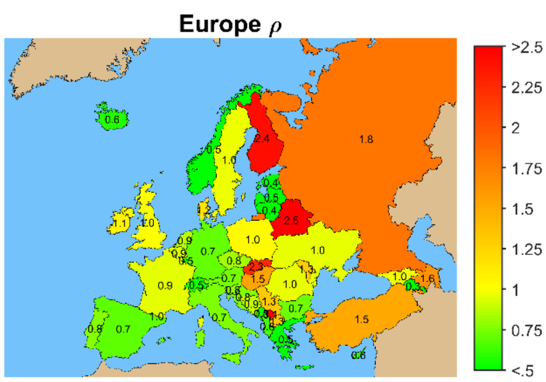
Spreading rate is under 1 for third consecutive day. This is a good symptom, but we still must wait for a few days to confirm that EU-EFTA-UK have globally entered the control phase of the epidemic.

The need for **more and precise data** is still on the table. In addition to the positive cases and deaths daily reported by each country, we would like to remind the high interest of time series on hospitalizations, ICUs, discharges, recovered, positive and negative tests and cases diagnosed by symptoms following similar criteria in all countries. In addition, real-time tracking of total mortality in countries could be an adequate way to estimate the real effect of Covid-19.

Trends for specific countries

As above mentioned, **Spain** (146,690), **Italy** (139,422), **Germany** (108,202) and **UK** (60,733) show a sudden increase in new cases, but this should be put in quarantine since can be hopefully anecdotic. **France** (82,048) seems to have entered a decreasing trend beyond observed fluctuations. Gradually, the ρ of **Spain**, **Italy** and **France** is tending to consolidate its value under 1. **Germany** has a ρ<1 for second consecutive day, and **UK** reaches the threshold ρ=1 for the first time. Highest ρ is still found for **Finland** (2.32), followed by **Slovakia** (1.60), **Poland** (1.30) and **Hungary** (1.26). Risk indexes EPG and EPG2 are improving for **Italy**, **Spain** and **France**. These indexes also slightly improve in **Belgium**, **UK**, **Denmark** and **Ireland**, but in these countries EPG2>EPG; therefore, they must be closely watched out yet.





Situation and trends per country

Table of current situation in EU countries, according to data published by ECDC on April 9th. 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.

	Reported data						Indexes		
Country	**Cumulated cases**	**Attack rate / 10^5 inh.**	**Cumulated deaths**	**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	146,690	316.5	14,555	31.4	67,893	146.5	0.69	100.4	68.8
Italy	139,422	234.6	17,669	29.7	41,733	70.2	0.85	59.6	50.5
Germany	108,202	132.1	2,107	2.6	50,904	62.1	0.72	45.0	32.6
France	82,048	126.8	10,869	16.8	41,874	64.7	0.73	47.5	34.9
United Kingdom	60,733	91.4	7,097	10.7	41,211	62.0	1.17	72.3	84.2
Belgium	23,403	206.0	2,240	19.7	12,567	110.6	1.10	122.2	134.9
Switzerland	22,710	265.0	705	8.2	8,436	98.4	0.70	68.5	47.6
Netherlands	20,549	121.0	2,248	13.2	9,683	57.0	1.00	56.7	56.4
Portugal	13,141	126.7	380	3.7	7,179	69.2	0.77	53.0	40.6
Austria	12,969	148.9	273	3.1	4,156	47.7	0.57	27.3	15.7
Sweden	8,419	85.6	687	7.0	4,719	48.0	0.91	43.8	40.0
Ireland	6,224	131.7	235	5.0	3,609	76.4	1.19	90.6	107.6
Norway	6,010	112.0	80	1.5	1,908	35.5	0.65	23.2	15.1
Denmark	5,402	94.6	218	3.8	3,007	52.6	1.23	64.5	79.1
Czech Republic	5,312	50.1	99	0.9	2,483	23.4	0.76	17.9	13.6
Poland	5,205	13.6	159	0.4	3,343	8.7	1.30	11.3	14.7
Romania	4,761	24.1	209	1.1	3,001	15.2	1.08	16.3	17.6
Luxembourg	3,034	526.7	46	8.0	1,084	188.2	0.55	102.8	56.2
Finland	2,487	45.2	40	0.7	1,269	23.1	2.32	53.5	124.2
Greece	1,884	16.8	83	0.7	728	6.5	0.56	3.6	2.0
Iceland	1,616	443.6	6	1.6	596	163.6	0.76	124.5	94.8
Croatia	1,343	31.9	19	0.5	630	15.0	0.68	10.2	6.9
Estonia	1,185	90.3	24	1.8	506	38.6	0.93	35.9	33.4
Slovenia	1,091	52.5	40	1.9	361	17.4	0.72	12.4	8.9
Hungary	980	10.0	66	0.7	533	5.5	1.26	6.9	8.7
Lithuania	912	31.4	15	0.5	428	14.7	0.61	9.0	5.5
Slovakia	682	12.5	2	0.0	346	6.4	1.60	10.2	16.3
Bulgaria	593	8.3	24	0.3	247	3.5	0.77	2.7	2.1
Latvia	577	29.3	2	0.1	201	10.2	0.55	5.6	3.0
Cyprus	526	45.0	14	1.2	312	26.7	0.60	15.9	9.5
Malta	299	69.7	1	0.2	148	34.5	ND	ND	ND
Liechtenstein	79	204.9	1	2.6	17	44.1	ND	ND	ND

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	200.0	200.0
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

- ✓ Among 5 countries with more cases, Spain and UK are at the level of 4000-5000 new cases in predictions, the former in a decreasing trend and the later in an increasing one. Germany and France are in a similar forecasted range, over 3,000 daily new cases with a decreasing trend, while Italy is moving under 3,000.
- ✓ Average ρ is still higher than 1 for UK, but it is remaining in the control zone for Spain, Italy, Germany and France.

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). Data from 9th April (source: ECDC).

Countries	Days since the first 50 cases	Time interval between 1 and 10 cases / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
Italy	47	11	16
France	41	10	20
Germany	41	12	17
Spain	40	7	12
United Kingdom	37	11	[]
Norway	36	9	24
Switzerland	36	9	12
Netherlands	35	11	20
Sweden	35	10	[]
Austria	34	10	14
Belgium	34	11	14
Greece	33	18	ND
Iceland	33	5	15
Denmark	31	4	ND
Czech Republic	30	11	ND
Finland	29	12	ND
Portugal	29	9	15
Slovenia	29	6	ND
Ireland	28	8	18
Romania	28	15	ND
Estonia	27	5	ND
Poland	27	17	ND
Bulgaria	25	ND	ND
Luxembourg	25	6	7
Slovakia	25	24	ND
Croatia	24	12	ND
Latvia	23	12	ND
Cyprus	22	12	ND
Hungary	22	20	ND
Malta	21	8	ND
Lithuania	20	9	ND
Liechtenstein	15	9	11

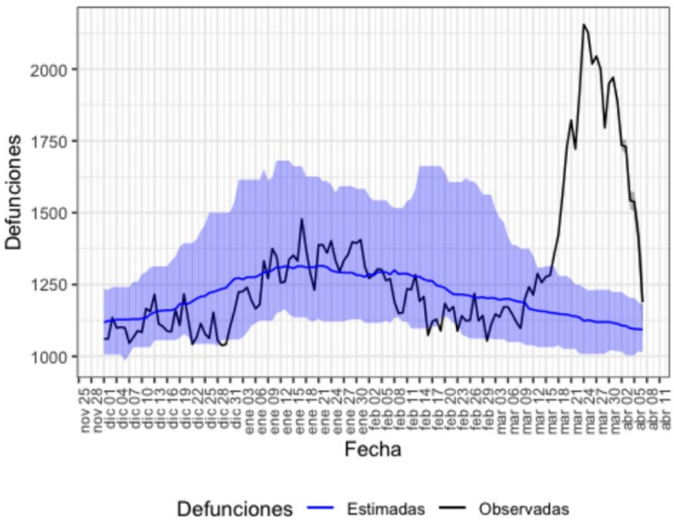
Analysis: Reliability of reported deaths for COVID-19. How many people die as a consequence of the disease?

This question is right now a hot topic given the findings that, in some towns in the North of Italy, **the mortality rate was far above the normal average in March by a number larger than those counted and attributed to COVID-19**. A lot of people are reasonably worried that the number of deaths we should attribute to COVID-19 is much higher than what is being reported. The availability of current data does not allow to answer the question with certainty, but we have given it a first look and draw two important conclusions.

The Spanish National Epidemiology Centre (*Instituto de Salud Carlos III*, ICSiii) recently published the results of the Daily Mortality Monitoring System (MoMo) for April 7th, 2020[1]. They evaluate which periods have mortality well above the average of previous years by regions and for the whole country.

When evaluating the period from March 17th to April 7th for the whole of Spain, they see that, as expected, mortality is much higher than in previous years. An increase of 56.5% is observed. This increase is clearly due to COVID-19. However, it is interesting to compare this with the data reported for COVID-19 deaths. The number is indeed very similar: those reported by COVID-19 are between 13,500 and 14,300 deaths, depending on how you attribute deaths to a particular day in the calendar. On the other hand, the reported excess of deaths by the MoMo surveillance system is 14,000. According to this result, the difference can be anywhere between -3 or +3 %. That is, taking these numbers at face value, **we would be evaluating the number of deaths from COVID-19 quite reasonably**. In this scenario, underestimation is not important even in a country with a high incidence of COVID-19 as Spain.

It is interesting to answer that mortality is higher in men than in women. In men, the increase in mortality is 62.1%, while in women it is 47.0%. There is also an increase in mortality with age (under 65 years, 16.0%; between 65 and 74 years: 53.3%; over 74 years: 64.7%), which is in accord with similar data from other countries.



Indeed, **the evaluation system has significant sources of error**; taking the average over several years makes the daily margin of error on the order of hundreds of deaths, as we can see in the figure extracted from the above mentioned report[1].

On the other hand, **confinement has affected other causes of mortality**. As a result of decrease in mobility and social interactions, there has been a sharp drop in cases diagnosed with influenza, far higher than expected. We have also had a sharp fall in deaths caused from car accidents and probably many other causes of death. For this reason, it is reasonable to think that deaths due to COVID-19 are indeed higher than reported, but it is difficult to estimate with these data.

The same study evaluates over mortality by autonomous community. At the level of each community, a local period where mortality is higher than the previous years is computed. It is a job similar to the one done

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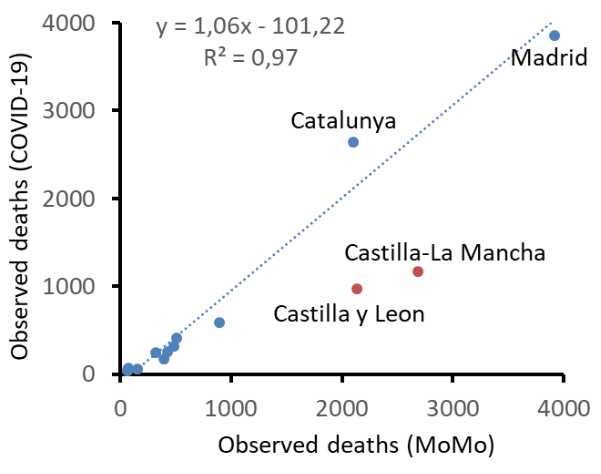
1 https://www.isciii.es/QueHacemos/Servicios/VigilanciaSaludPublicaRENAVE/EnfermedadesTransmisibles/MoMo/Documents/informesMoMo2020/MoMo_Situacion%20a%207%20de%20abril_CNE.pdf

globally but **community to community**. **The results are radically different now**. If we compare COVID-19 deaths with MoMo-reported mortality and look only at the time window when there is an increase in the mortality in each region (i.e., this time window is different from region to region), we find something very interesting. The total amount of excess deaths is again 14,000, whereas the number of deaths associated with COVID-19 in these regional time-windows is only 11,000-12,000 deaths. **This would indicate that the number of COVID-19 deaths should be around 20% higher than reported**. The key difference between aggregating per country and per autonomous community is that one can observe that, at the regional level, the number of deaths was, in key areas, below the historical average just before and after the peak of COVID-19 deaths. We think that the assessment of around 20% underreporting is closer to reality, given that it is a more granular and accurate procedure.



Studying the causes of differentiated behaviour in some communities is also a challenge. Is it because of people in other communities who have moved to second homes? Is it because of higher average age in these communities? Is it because one could track better below-average mortality rates, and measure more properly the period where the excess in mortality appears, in some regions than others?

Mortality data will need to be studied carefully to reach solid conclusions. A methodology must be developed to make the evaluations as objective as possible. By analysing the information from the Spanish National Statistics Center, we arrive at too large an interval, with an underestimation of COVID-19 deaths between 0 and 20% depending on the methodology. **We recommend a systematic procedure to be able to compare COVID-19 mortality data with the average mortality rate for other years in all European states and regions**. It is very important in this procedure to consider data **at the regional scale**. It will be the only way to make a real assessment of the mortality caused by this disease.

Situation and tendencies in Italian and Spanish regions

Italy. Data from 09/04/2020

	Reported data						Indexes		
Country	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	54,802	545.7	10,022	99.8	12,641	125.9	0.75	94.8	71.4
Emilia Romagna	18,677	418.8	2,316	51.9	5,146	115.4	0.66	75.7	49.7
Piemonte	14,522	333.3	1,454	33.4	5,810	133.4	0.93	123.8	114.9
Veneto	12,933	263.6	756	15.4	4,209	85.8	0.94	80.6	75.8
Toscana	6,552	175.7	408	10.9	2,140	57.4	0.62	35.7	22.2
Liguria	5,020	323.7	682	44.0	1,803	116.3	0.89	103.9	92.8
Marche	4,955	324.9	669	43.9	1,271	83.3	0.92	76.8	70.9
Lazio	4,429	75.3	253	4.3	1,515	25.8	0.78	20.0	15.5
Campania	3,344	57.6	227	3.9	1,392	24.0	0.55	13.1	7.2
Puglia	2,716	67.4	225	5.6	1,004	24.9	0.84	20.9	17.5
Trento	2,708	252.5	268	25.0	1,026	95.7	0.90	86.1	77.5
Friuli Venezia Giulia	2,299	189.2	171	14.1	798	65.7	0.60	39.5	23.8
Sicilia	2,232	44.6	138	2.8	677	13.5	0.78	10.6	8.3
Abruzzo	1,931	147.2	194	14.8	586	44.7	1.06	47.4	50.3
Bolzano	1,903	1,771.3	187	174.1	578	538.0	1.16	623.8	723.2
Umbria	1,298	147.2	51	5.8	247	28.0	0.52	14.7	7.7
Sardegna	1,026	62.6	64	3.9	344	21.0	0.67	14.1	9.4
Calabria	874	44.9	61	3.1	227	11.7	1.25	14.6	18.2
Valle dAosta	868	691.0	105	83.6	284	226.1	0.77	175.0	135.4
Basilicata	303	53.8	15	2.7	89	15.8	0.66	10.4	6.9
Molise	234	76.6	13	4.3	100	32.7	0.29	9.4	2.7

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2	700.0	900.0
Best	Best	Best	Best	Best	Best	0	0.0	0.0

Spain. Data from 09/04/2020

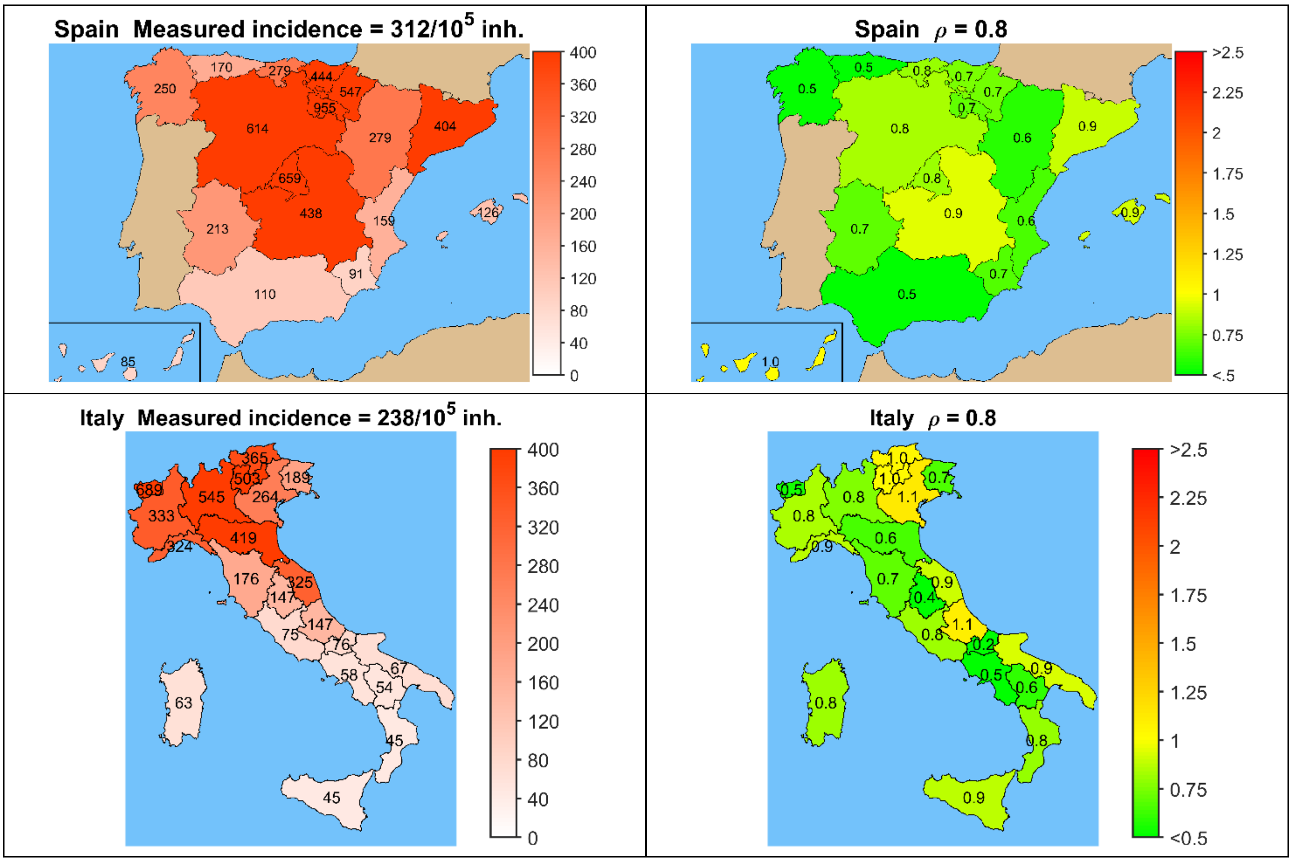
	Reported data						Indexes		
Autonomous regions	Total cumulated cases	Attack rate /10^5 inh.	Cumulated deaths	Mortality rate /10^5 inh.	Active cases (last 10 days)	Active cases (last 10 days) /10^5 inh.	Mean ρ[1]	EPG[2]	EPG[2]
Madrid	43,877	660.7	5,800	87.3	19,787	298.0	0.69	204.2	139.9
Catalunya	31,043	410.3	3,148	41.6	14,886	196.8	0.77	150.6	115.3
Castilla-La Mancha	12,489	613.6	1,322	64.9	6,631	325.8	0.88	285.2	249.8
Castilla y Leon	10,518	436.8	1,082	44.9	4,717	195.9	0.84	165.5	139.8
Euskadi	9,806	450.2	689	31.6	3,749	172.1	0.65	111.7	72.5
Andalucia	9,261	109.9	652	7.7	3,856	45.8	0.49	22.6	11.1
Comunitat Valenciana	7,964	160.1	767	15.4	2,854	57.4	0.51	29.0	14.7
Galicia	6,758	250.3	231	8.6	3,035	112.4	0.55	61.6	33.7
Aragon	3,685	279.0	385	29.1	1,607	121.7	0.6	68.4	38.4
Navarra	3,575	550.0	214	32.9	1,429	219.9	0.73	159.8	116.2
La Rioja	3,026	965.0	182	58.0	1,293	412.3	0.94	387.2	363.6
Extremadura	2,273	213.4	283	26.6	713	66.9	0.56	37.8	21.4
Canarias	1,834	83.1	92	4.2	630	28.5	0.76	21.8	16.6
Asturias	1,737	169.9	110	10.8	579	56.6	0.55	31.3	17.3
Cantabria	1,619	278.3	98	16.8	519	89.2	0.8	70.3	55.5
Baleares	1,448	121.9	89	7.5	448	37.7	0.68	25.5	17.2
Murcia	1,356	91.1	88	5.9	417	28.0	0.62	17.3	10.6
Melilla	93	109.8	2	2.4	42	49.6	ND	ND	ND
Ceuta	84	99.0	4	4.7	59	69.5	ND	ND	ND

Scale								
Worst	Worst	Worst	Worst	Worst	Worst	2.0	700.0	900.0
Best	Best	Best	Best	Best	Best	0.0	0.0	0.0

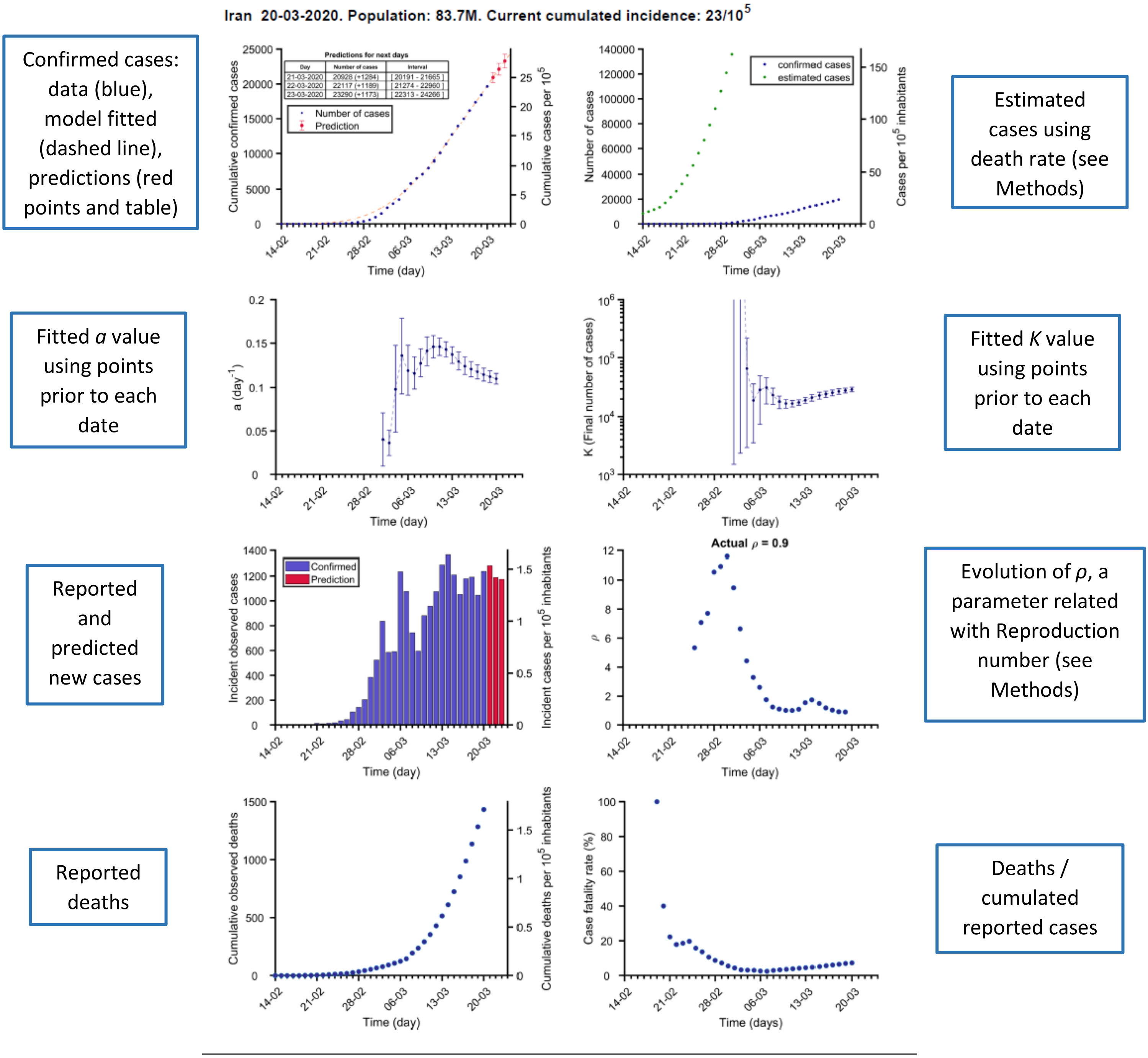
[1] Disclaimer: parameter ρ is very sensitive and experiments daily variations. Mean ρ is averaged per 3 consecutive days, but it can still vary the following days. [2] EPG stands for Effective Growth Potential. It is obtained by multiplying attack rate per 10^5 inhabitants of last 10 days (i.e. density 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

Cumulated incidence and spreading rate (ρ) in Europe, Italian regions and Spanish autonomous communities. Data from 09/04/2020.



Legend: Countries' reports details



(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:

[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