

## EDITORIAL

# Epidemiology of Coronavirus Disease Outbreak: The Italian Trends

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On December 31<sup>st</sup> 2019 a cluster of pneumonia cases of unknown etiology was reported in Wuhan, a city of the Hubei Province in China. On January 9<sup>th</sup> 2020, the Chinese CDC described a novel strain of coronavirus as the causative agent of this outbreak, which is phylogenetically in the SARS-CoV clade [1]. Therefore, the animal origin of the virus was postulated and, reportedly, the epicenter of the outbreak was the local seafood market, where a cross-species jump would have happened through a still unidentified intermediate host [2, 3]. The disease associated with the virus is referred to be a new coronavirus disease 2019 (COVID-19).

On March 11, 2020, World Health Organization stated that the outbreak might be uncontrolled and made the assessment that COVID-19 can be characterized as a pandemic [4]. As of March 28<sup>th</sup>, 2020, 649,604 cases of COVID-19 were reported worldwide in more than 177 countries and regions, with 30,249 total confirmed deaths [5]. On the same date, considering the ratio of individuals tested positive to the COVID-19 over population, Italy is the second world's worst-affected country in the pandemic, with 92,472 cases and 10,023 [6]. However, these data are constantly updated on international data resources.

In Italy, since the identification of COVID-19 travel-related cases, the number of infected people increased quickly. In fact, the country is experiencing the greatest health crisis in recent history. The Northern region of Lombardy presents the highest number of patients infected by COVID-19 and appears to be the epicenter of the Italian outbreak. In order to monitor the epidemiology of the virus, the Department of Italian Civil Protection, provides data related to COVID-19 through its official GitHub Repository, which is updated daily [7]. Such repository contains the following information related to the Italian scenario:

- Number of people hospitalized with symptoms
- Number of people in intensive care
- Hospitalized patients (*i.e.* “Hospitalized total”)
- Number of people in home isolation
- Positive cases (hospitalized + home isolation)
- Number of new positive cases
- Number of healed people (*i.e.* “cured”)
- Number of deaths for COVID-19 (*i.e.* “dead”)
- Total cases (positive cases + cured + dead)
- Swabs: number of coronavirus tests performed

All indexes, except for the new positive cases, are generated by adding the new daily values to the sum of the previous day.

We analyzed the data reported by using the statistical software platform IBM SPSS Statistics. Firstly, a descriptive analysis has been performed on positive COVID-19 patients to evaluate the related trend, considering the period from February 24<sup>th</sup> to March 28<sup>th</sup> (Table 1). We found that the number of new positive subjects recorded its highest growth on March 21<sup>st</sup> with 4821 new cases. During the same time period the minimum has been registered on February 26<sup>th</sup> with 74 new cases. Note that the latter represents the third day in our dataset. Thus its value is affected by the epidemiological evolution of COVID-19, which

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**Table 1. COVID-19 Italian infection trends.**

Date	Hospitalized w/ Symptoms	Intensive Care	Hospitalized (Total)	Home Iso- lation	Positive Cases	New Positive Cases	Cured	Dead	Total Cases	Swabs
24-feb-20	101	26	127	94	221	221	1	7	229	4324
25-feb-20	114	35	150	162	311	90	1	10	322	8623
26-feb-20	128	36	164	221	385	74	3	12	400	9587
27-feb-20	248	56	304	284	588	203	45	17	650	12014
28-feb-20	345	64	409	412	821	233	46	21	888	15695
29-feb-20	401	105	506	543	1049	228	50	29	1128	18661
01-mar-20	639	140	779	798	1577	528	83	34	1694	21127
02-mar-20	742	166	908	927	1835	258	149	52	2036	23345
03-mar-20	1034	229	1263	1000	2263	428	160	79	2502	25856
04-mar-20	1346	295	1641	1065	2706	443	276	107	3089	29837
05-mar-20	1790	351	2141	1155	3296	590	414	148	3858	32362
06-mar-20	2394	462	2856	1060	3916	620	523	197	4636	36359
07-mar-20	2651	567	3218	1843	5061	1145	589	233	5883	42062
08-mar-20	3557	650	4207	2180	6387	1326	622	366	7375	49937
09-mar-20	4316	733	5049	2936	7985	1598	724	463	9172	53826
10-mar-20	5038	877	5915	2599	8514	529	1004	631	10149	60761
11-mar-20	5838	1028	6866	3724	10590	2076	1045	827	12462	73154
12-mar-20	6650	1153	7803	5036	12839	2249	1258	1016	15113	86011
13-mar-20	7426	1328	8754	6201	14955	2116	1439	1266	17660	97488
14-mar-20	8372	1518	9890	7860	17750	2795	1966	1441	21157	109170
15-mar-20	9663	1672	11335	9268	20603	2853	2335	1809	24747	124899
16-mar-20	11025	1851	12876	10197	23073	2470	2749	2158	27980	137962
17-mar-20	12894	2060	14954	11108	26062	2989	2941	2503	31506	148657
18-mar-20	14363	2257	16620	12090	28710	2648	4025	2978	35713	165541
19-mar-20	15757	2498	18255	14935	33190	4480	4440	3405	41035	182777
20-mar-20	16020	2655	18675	19185	37860	4670	5129	4032	47021	206886
21-mar-20	17708	2857	20565	22116	42681	4821	6072	4825	53578	233222
22-mar-20	19846	3009	22855	23783	46638	3957	7024	5476	59138	258402
23-mar-20	20692	3204	23896	26522	50418	3780	7432	6077	63927	275468
24-mar-20	21937	3396	25333	28697	54030	3612	8326	6820	69176	296964
25-mar-20	23112	3489	26601	30920	57521	3491	9362	7503	74386	324445
26-mar-20	24753	3612	28365	33648	62013	4492	10361	8165	80539	361060
27-mar-20	26029	3732	29761	36653	66414	4401	10950	9134	86498	394079
28-mar-20	26676	3856	30532	39533	70065	3651	12384	10023	92472	429526

naturally recorded lower values at the beginning of its spreading. Indeed, the data shows a growing trend in the next days. The average of new cases per day has attested to 2061. Table 2 summarizes the information described above for the period under consideration, February 24<sup>th</sup>, 2020 to March 28<sup>th</sup>, 2020. Fig. (1) shows the new cases per day, while Fig. (2) shows the trend of infected subjects per day, within the same period. In Fig. (2), the value per day is obtained by the sum of all new positive cases registered during the previous period. Latter shows the growth of positive cases seems to have been along an exponential curve for the period concerned.

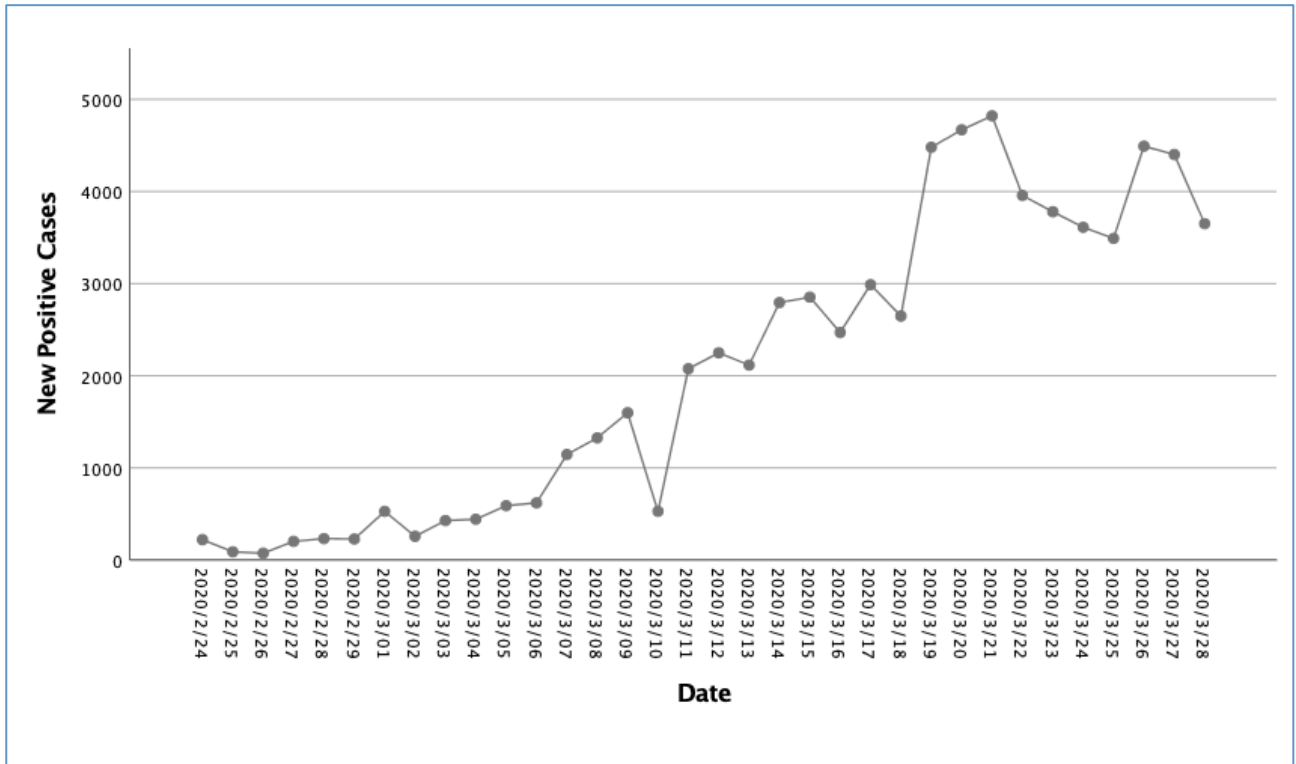


Fig. (1). New cases per day from February 24<sup>th</sup>, 2020 to March 28<sup>th</sup>, 2020.

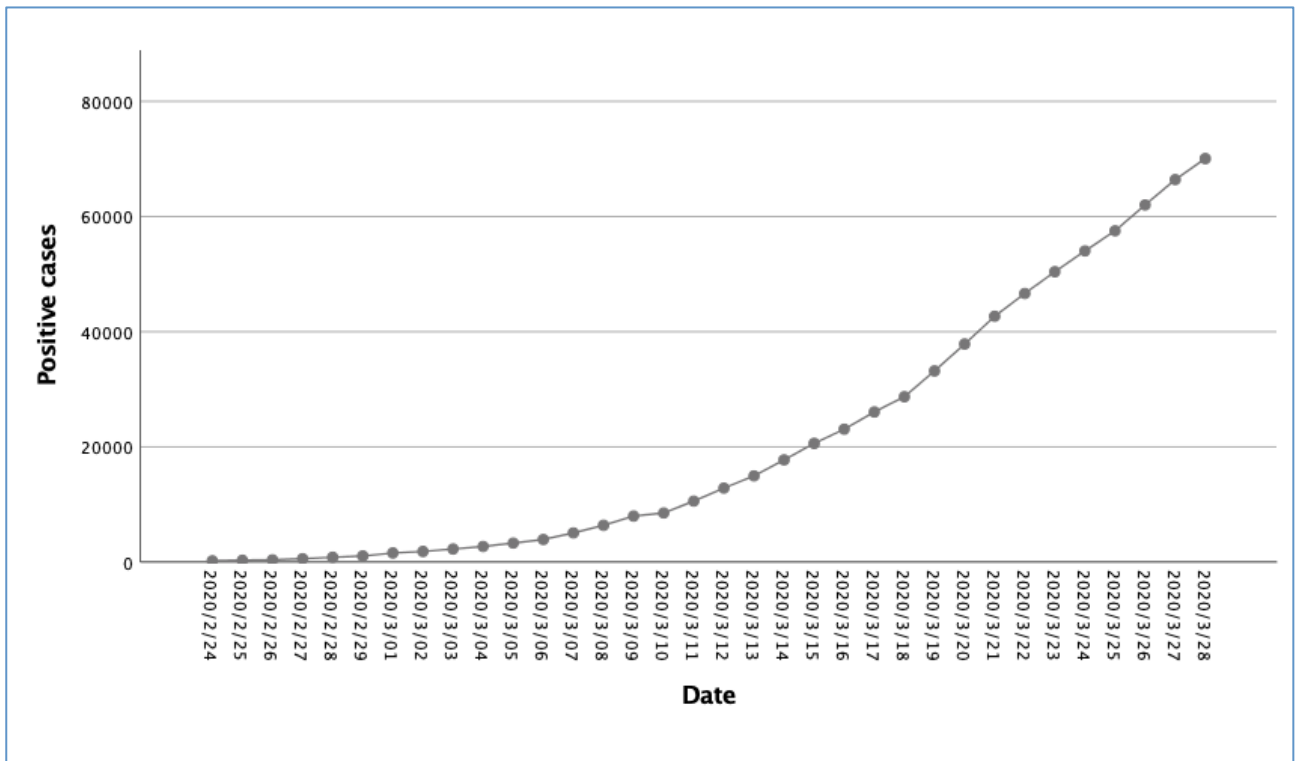
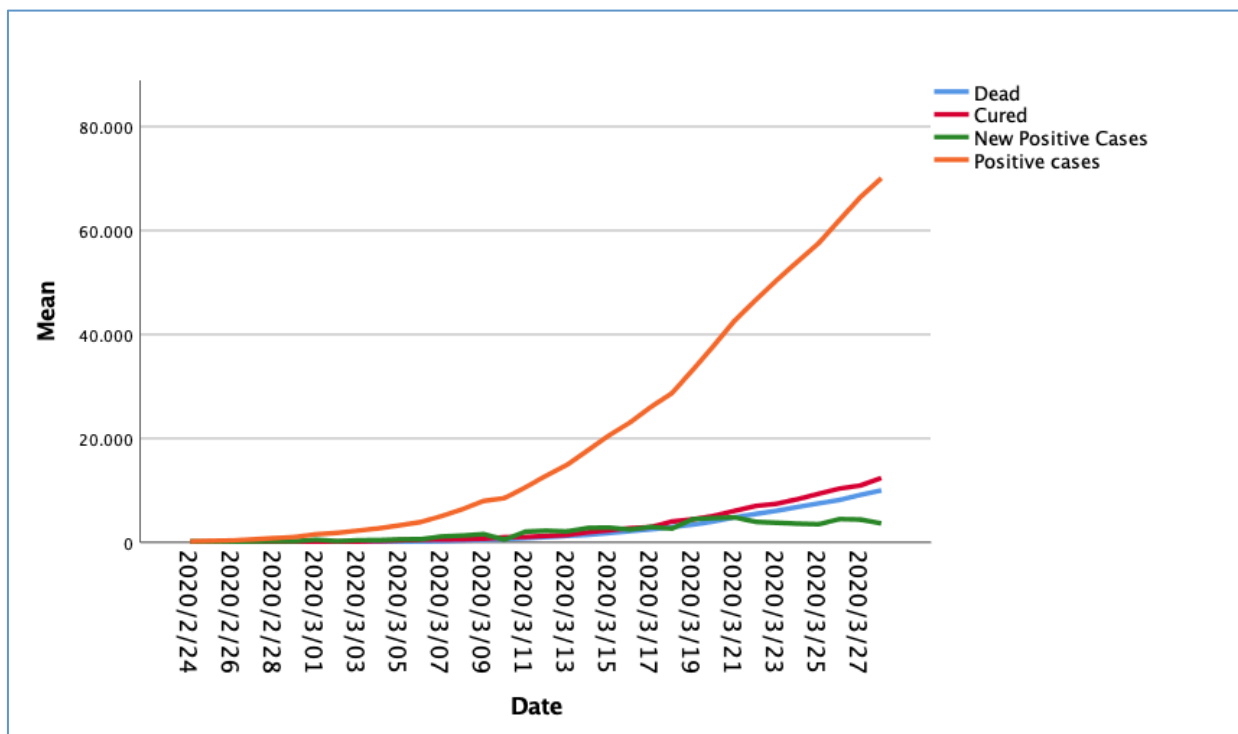


Fig. (2). Trend of infected subjects per day from February 24<sup>th</sup>, 2020 to March 28<sup>th</sup>, 2020.

**Table 2.** Descriptive analysis related to positive COVID-19 cases for the analyzed period.

-	N	Range	Min	Max	Mean	Std. Deviation	Variance
New positive cases	34	4747	74	4821	2061	1634.91	2672914.56
Valid N (listwise)	34				-		

Furthermore, we analyzed the trend of the positive cases in relation to deaths (*i.e.* dead), the healed people (*i.e.* cured), the new positive cases per day, as well as the number of total cases actually positive (*i.e.* positive cases). These ones have been plotted in Fig. (3) through a multi-line chart. We have found that although the number of positive cases is clearly greater than healed people, latter continues to increase in according to a positive trend. The growth rate of the infections is still particularly high but shows a slowdown which we have decided to study by analyzing the percentage of infection.



**Fig. (3).** Trend of the positive cases in relation to deaths (*i.e.* dead), new positive cases per day, and healed people (*i.e.* cured). (A higher resolution / colour version of this figure is available in the electronic copy of the article).

In detail, the percentage of the new positive cases per day is shown in Table 3. The data has been analyzed in order to produce a global view which shows the trend related to the growth rate. The results show an average growth rate of +19.63% with a minimum value of +5.50% on March 28<sup>th</sup>, and a maximum of +52.73% on February 27<sup>th</sup>. The analysis indicates that the rate of positive cases is decreasing. Furthermore, the percentage of deaths is relatively low (7.68%) in relation to the positive cases registered within the dataset.

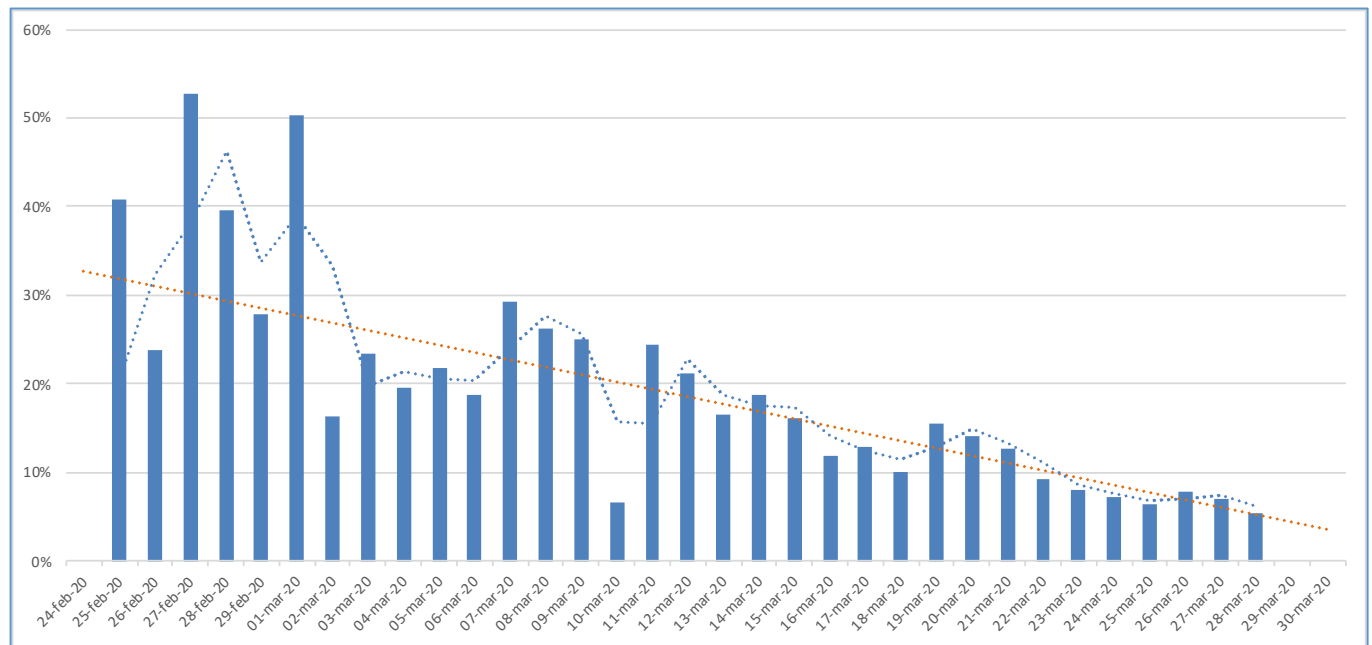
**Table 3.** Growth rate for the new positive cases.

Date	Positive Cases
24-feb-20	Day 1 (0%)
25-feb-20	+ 40.72%
26-feb-20	+ 23.79%
27-feb-20	+ 52.73%
28-feb-20	+ 39.63%

(Table 3) contd...

Date	Positive Cases
29-feb-20	+ 27.77%
01-mar-20	+ 50.33%
02-mar-20	+ 16.36%
03-mar-20	+ 23.32%
04-mar-20	+ 19.58%
05-mar-20	+ 21.80%
06-mar-20	+ 18.81%
07-mar-20	+ 29.24%
08-mar-20	+ 26.20%
09-mar-20	+ 25.02%
10-mar-20	+ 6.62%
11-mar-20	+ 24.38%
12-mar-20	+ 21.24%
13-mar-20	+ 16.48%
14-mar-20	+ 18.69%
15-mar-20	+ 16.07%
16-mar-20	+ 11.99%
17-mar-20	+ 12.95%
18-mar-20	+ 10.16%
19-mar-20	+ 15.60%
20-mar-20	+ 14.07%
21-mar-20	+ 12.73%
22-mar-20	+ 9.27%
23-mar-20	+ 8.10%
24-mar-20	+ 7.16%
25-mar-20	+ 6.46%
26-mar-20	+ 7.81%
27-mar-20	+ 7.10%
28-mar-20	+ 5.50%

By focusing the attention on the trend related to the rate of new positive cases, as well as on the data produced by our analysis and reported in Table 3, we found evident degrowth. The data exposed in Table 3 has been used to analyze the global trend as shown in Fig. (4), which indicates the mobile mean (MM, blue line) and the linear regression (orange line). We analyzed our data as time series by applying a MM in order to smooth out short-term fluctuations and highlight longer-term trend. Furthermore, we performed the linear regression analysis to synthesize the global trend. The results clearly indicated that the rate of new cases has been decreasing as compared to the previous week. We assume that this result has been partly produced by the quarantine program issued by the Italian government [8]. It is not possible to quantify exactly the benefits of this program without knowing what the alternative evolution would have been [9, 10]. However, the present study highlights the importance of the constant monitoring of the epidemiological indexes and the continuous learning process characterizing the managing of a health emergency such as the COVID-19 pandemic. The trend emerging from our data shows a positive outlook for the week following the latest data analyzed. Certainly, the trend will not be constant day by day, but it is possible to estimate a likely upcoming decrease for the new positive cases. Finally, our analysis can provide a valuable tool to assess the current evolution of the COVID-19 outbreak in Italy and to evaluate the impact of the countermeasures adopted in the short and mid-term, leading to an optimization of healthcare policies, economic resources and clinical processes to deal with this crisis.



**Fig. (4).** Growth rate for the new positive cases. (A higher resolution / colour version of this figure is available in the electronic copy of the article).

#### CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise. I.G. acted as a consultant for Abbvie, MSD, Correvio, Angelini, Nordic and Pfizer and received department grants from Gilead Sciences.

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