Modelling of COVID – 19 Infection Propagation Data in Indian Population

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Abstract

Ever since the first COVID – 19 infection reported in India, the government is trying to take appropriate measures to safeguard Indian population from this deadly virus. In order to make correct policy, the evolution behaviour of the virus among Indian population should be understood accurately. We present in this manuscript the mathematical modelling of COVID – 19 infection data. Our modelling is based on open source data available on the website www.covid19india.org, which gives real time number of population infected, recovered and deceased due to COVID – 19. We further, show that, we can predict outcome with a reasonable accuracy.

1.0 Introduction:

The risk factors associated with corona viruses vary significantly. Some can kill more than 30% of those infected (such as MERS-CoV), and some are relatively harmless, such as the common cold. The major symptoms of corona virus infections are fever, and sore throat from swollen adenoids, occurring primarily in the winter and early spring seasons. Corona viruses can also cause pneumonia (either direct viral pneumonia or a secondary bacterial pneumonia) and bronchitis (either direct viral bronchitis or a secondary bacterial bronchitis). The much publicized human coronavirus discovered in 2003, SARS-CoV, which causes severe acute respiratory syndrome (SARS), has a unique pathogenesis because it causes both upper and lower respiratory tract infections. In December 2019, a pneumonia outbreak was reported in Wuhan, China. On 31 December 2019, the outbreak was traced to a novel strain of coronavirus, which was given the interim name 2019-nCoV by the World Health Organization (WHO), later renamed SARS-CoV-2 by the International Committee on Taxonomy of Viruses. Some researchers have suggested the Huanan Seafood Wholesale Market may not be the original source of viral transmission to humans even though it is still debated. As of 4 April 2020, there have been at least 58,937 confirmed deaths and more than 1,118,921 confirmed cases in the coronavirus pneumonia pandemic. The numbers are evolving daily. The Wuhan strain has been identified as a new strain of Betacoronavirus from group 2B with approximately 70% genetic similarity to the SARS-CoV. The virus has a 96% similarity to a bat corona virus, so it is widely suspected to originate from bats as well. The pandemic has resulted in travel restrictions and nationwide lockdowns in several countries. Most of this information have been obtained by open source internet pages.

We present in this article, the attempt to mathematically model the evolution of corona virus among Indian population. The data was obtained from the open source site www.covid19india.org. The site gives update on the number of infected, recovered and deceased population of India. We collected the data from the site and attempt was made to find the mathematical relations describing the viral evolution.

2.0 Results and Discussions

The evolution of corona virus depends upon number of initial populations infected. Since the rate of increase depends upon the initial value of infected population, the evolution can be described by the exponential curve. We try to fit the data with exponential curve using MATLAB.

Figure 1. Plot showing number of infected populations at different dates starting from 6th March 2020. The best fit plot of exponential curve is also shown in the figure along with lockdown period.

Figure 1 shows the number of populations infected with the COVID – 19 viruses. The data is plotted starting from 6th March 2020 up to 3rd April 2020. The lockdown imposed by the Indian government on 23 March 2020 is also shown in the plot. It is interesting to see that the data is very accurately fitted by the single exponential curve. The best fitted exponential curve parameters are given below;

Date: 6th March 2020 to 3rd April 2020

$$f(x) = a \cdot \exp(b \cdot x)$$

Coefficients (with 95% confidence bounds)

$$a = 16.1 \text{ (12.86, 19.35)}$$

$$b = 0.1804 \text{ (0.1729, 0.1879)}$$

Goodness of fit

$$\text{SSE: } 8.205 \times 10^4$$

$$\text{R-Square: } 0.9955$$

$$\text{Adjusted R-Square: } 0.9954$$

$$\text{RMSE: } 55.13$$

Figure 2. Plot showing number of recovered populations at different dates starting from 6th March 2020. The best fit plot of exponential curve is also shown in the figure along with lockdown period.

Figure 2 shows the number of populations recovered with the COVID – 19 viruses. The data is plotted starting from 6th March 2020 up to 3rd April 2020. The lockdown imposed by the Indian government on 23 March 2020 is also shown in the plot. It is interesting to see that the data is very accurately fitted by the single exponential curve. The best fitted exponential curve parameters are given below;

Date: 6th March 2020 to 3rd April 2020

$$f(x) = a \cdot \exp(b \cdot x)$$

Coefficients (with 95% confidence bounds)

$$a = 1.699 \text{ (1.272, 2.126)}$$

$$b = 0.1699 \text{ (0.1605, 0.1793)}$$

Goodness of fit

SSE: 925.9

R-Square: 0.992

Adjusted R-Square: 0.9917

RMSE: 5.856

Figure 3. Plot showing number of deceased populations at different dates starting from 6th March 2020. The best fit plot of exponential curve is also shown in the figure along with lockdown period.

Figure 3 shows the number of deceased populations with the COVID – 19 viruses. The data is plotted starting from 6th March 2020 up to 3rd April 2020. The lockdown imposed by the Indian government on 23 March 2020 is also shown in the plot. It is interesting to see that the data is very accurately fitted by the single exponential curve. The best fitted exponential curve parameters are given below;

Date: 6th March 2020 to 3rd April 2020

$$f(x) = a \cdot \exp(b \cdot x)$$

Coefficients (with 95% confidence bounds)

$$a = 0.1844 (0.1377, 0.2311)$$

$$b = 0.2126 (0.2033, 0.2219)$$

Goodness of fit:

SSE: 67.21

R-Square: 0.9956

Adjusted R-Square: 0.9954

RMSE: 1.578

3.0 Conclusions

The evolution data is best fitted with single exponential curve. Based on the fitted parameters, we can predict the number of infected, recovered and deceased populations at the end of lockdown period (14th April 2020) as following;

Number of infected populations = 21913

Number of recovered populations = 1519

Number of deceased populations = 910

Above numbers are approximate and can vary greatly depending upon other external factors.

4.0 Additional Supporting Data

The complete data used in the study is given below

DATE	Total no. of cases	Recovered	Deceased
06-Mar	31	3	0
07-Mar	34	3	0
08-Mar	39	3	0
09-Mar	49	3	0
10-Mar	63	4	0
11-Mar	70	4	0
12-Mar	82	4	1
13-Mar	91	10	1
14-Mar	107	10	2
15-Mar	113	13	2
16-Mar	127	14	2
17-Mar	146	15	3
18-Mar	171	15	3
19-Mar	199	20	4
20-Mar	158	23	4
21-Mar	334	23	4
22-Mar	403	23	7
23-Mar	505	25	9
24-Mar	571	40	10
25-Mar	657	43	11
26-Mar	735	50	16
27-Mar	886	75	18
28-Mar	1029	85	24
29-Mar	1139	102	27
30-Mar	1347	137	43
31-Mar	1635	150	49
01-Apr	2059	169	56
02-Apr	2545	191	72
03-Apr	3108	229	86