Stochastic Modelling and Simulation of SIR Model for COVID-2019 Epidemic Outbreak in India

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ABSTRACT

Coronavirus disease 2019 (COVID-19) emerged in Wuhan city, China, at the end of December 2019. As of July 26, 2020, 16258353 COVID-19 cases were confirmed worldwide, including 649848 deaths. The spread of COVID-19 is currently very high. Under the classical SIR (Susceptible-Infected-Recovered) model, epidemiological data for India up to 26th July 2020 were used to forecast the COVID-19 outbreak. For controlling the spreading of the virus, we have to prepare for precaution and futuristic calculation for infection spreading. We used the data from the COVID-2019 Outbreak of India on July 26th, 2020 in this report. In these results, for the initial level of experimental intent, we used 16291331 susceptible cases, 481248 infectious cases, and 910298 rewards / removed cases. Through the aid of the SIR model, data on a wide range of infectious diseases have been analyzed. SIR model is one of the most effective models which can predict the spreading rate of the virus. We have validated the model with the current spreading rate with this SIR model. The findings of the SIR model can be used to forecast transmission and avoid the outbreak of COVID-2019 in India. The results of the study will shed light on understanding the outbreak patterns and indicate those regions’ epidemiological points. Finally, from this study, we have found that the outbreak of the COVID-2019 epidemic in India will be at its peak on 09 August 2020 and after that, it will work slowly and on the verge of ending in the second or third week of November 2020.

Keywords: COVID-19, Coronavirus, Pandemics, Prediction, SIR model
1. Introduction

COVID-19 (Coronavirus disease 2019) is a disease caused by a novel virus called SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) which has spread to more than 200 countries worldwide (as of May 12, 2020) infecting more than 40 lakh people[1]. World Health Organization (WHO) confirmed the outbreak of this disease after one month from the first case recording on Dec. 31, 2019, in Wuhan, China, and later as a pandemic on March 11, 2020[2]. Virtually the entire world’s population is using lockdowns, social distancing, and masks to combat this outbreak.

The disease has a very complex structure and is easy to spread. Sadly, 649848 deaths and roughly 16258353 cases were confirmed worldwide as of July 26, 2020. The number of confirmed cases varies from country to country because of variations in epidemiological monitoring and detection capacities. This can however be said that as of today the disease has spread across the world. Since there is no method of treatment for this form of the virus yet known, it requires careful preparation of the health system and facilities where the risk of spread of disease can be managed. Of this purpose, it is important to predict the total reported cases and potential new cases in the future to handle and guide demand to the health system. To cope with the outbreak, mathematical and statistical modeling methods that can be used to make short and long term case predictions are required to schedule the number of additional materials and resources. Estimating the projected burden of disease is important for public health authorities to coordinate medical services and other resources that are required to resolve the epidemic efficiently and in time. These estimates can also guide the strength and form of interventions needed to ease the outbreak[3]. For this analysis, we presumed from the time of spread to India the impact of social distancing interventions, lockdown, and face cover.

So COVID-2019 needs to be reviewed with more data now. In this proposed report, we presented an epidemic model based on COVID-19 spreading to India by the SIR method. There are three differential equations to the proposed SIR model. This type of differential equation is difficult to solve and time-consuming. Most epidemics have an initial exponential curve and then flatten out slowly. The objectives of these studies are given below:

1. Finding the rate of disease transmission using the SIR model.

2. SIR architecture model for exposed outbreak COVID-2019 at a peak in India.
3. Nation outbreak forecast COVID-2019, India with the next days, months, even a year for better management for doctors and different governmental organizations.

4. To find out whether the COVID-2019 outbreak in India is ending

2. SIR Model

We have considered an epidemic model in this proposed study which was developed in 1927 by Kermack and McKendrick[10]. This epidemic model is also known as the epidemic model SIR (Susceptible, Infective, and Recover / Removed). Many infectious outbreaks such as avian influenza, cholera, SARS, Aids, Plague, Yellow Fever, Meningitis, MERS, influenza, Zika, Rift Valley Fever, Lassa Fever, Leptospirosis [11, 12, 13, 14, 15] have also been widely used in this model. The SIR model is very useful for future prediction, ending, and the peak of infectious disease and other outbreak-related activity[12]

This research aims to quantify the prevalence of COVID-19 in India, where the virus spreads more quickly and causes disastrous outcomes. Here, on July 26, 2020, we selected all of India's population checked by COVID-2019.

We have complete COVID-2020 population evaluated in this proposed study is divided into three parts:

1. S(t): number of vulnerable population t at the time t, i.e. number of total population checked by COVID2019 till July 26, 2020.

2. I(t): the number of people infected at the time t, i.e. the number of people infected with COVID2019 in India until 26 July 2020.

3R(t): Number of population recovered at the time t, i.e. number of people rescued or died or spontaneously resistant to the disease COVID-2019 Indian population until July 26, 2020.

For this proposed study we took R(t) is equivalent to the recovered population plus died population from India's COVID-2019 outbreak on July 26, 2020, for the sake of this study's simplicity[16]. Figure 1 gives an overview of the theoretical SIR model for not understanding the evolution of viruses.

Unlike most diseases, this model does not recognize COVID-2019 growth. In comparison, however, my proposed SIR model seen in Figure 2 takes into account the nature of India's COVID-2019 outbreak. This model also predicts high growth in India from the COVID-2019 outbreak. This model also predicts maximum growth in India from the COVID-2019
outbreak. Figure 2 highlights the definition of the SIR model for recovered re-tuning as susceptible since India's COVID-2019 outbreak has developed into one that can re-infect.

![Figure 1: Description of the SIR model not considering COVID-2019 outbreak virus evolution](image1)

![Figure 2: Description of SIR model considering COVID-2019 outbreak virus evolution](image2)

2. Methodology of SIR Model

Let's find the following three differential equations being used for Indian COVID-2019 experimental studies and experimental debate. The definition is given below for these three differential equations:

\[ S'(t) = -rSI \]  \hspace{1cm} (1)  
\[ I'(t) = rSI - aI \]  \hspace{1cm} (2)  
\[ R'(t) = aI \]  \hspace{1cm} (3)

The parameters r and a of the above differential equations are known as Indian countries' infection rate and COVID-2019 recovery/removal rate. For this proposed study India 's average outbreak time for COVID-2019 is around 14 days. This numerical r and a values are very useful in the initial stage for resolving India 's three differential COVID-2019 outbreak equations.
The three differential equations (1), (2), and (3) of the proposed epidemic SIR model for India's COVID-2020 outbreak can also be written as [12]:

\[
\frac{dS}{dt} = -rSI \quad (4)
\]

\[
\frac{dI}{dt} = rSI - aI \quad (5)
\]

\[
\frac{dR}{dt} = aI \quad (6)
\]

Such three differential SIR function equations are known as the Kermack-McKendrick model[12]. Currently, this model is very useful for COVID-2019 data analysis in India. Again by adding the equation (4), (5), and (6), we can get another expression for the data analysis COVID-2019. Below is this expression:

\[
\frac{dS}{dt} + \frac{dI}{dt} + \frac{dR}{dt} = -rSI + rSI - aI + aI = 0
\]

\[
dS + dI + dR = 0 \quad (7)
\]

Using the integration of equation number (7), we can get the following relationship for estimating the total COVID-2019 population:

\[
S' + I' + R' = N, \text{ regarded as the convergence constant comparing the overall population size for COVID-2019 at the original level and after the COVID-2019 epidemic in India. It is a constant population at all COVID-2019 outbreak rates. The expression above can also be denoted in the following form:}
\]

\[
S(t) + I(t) + R(t) = N \quad (8)
\]

We will take the following initial values of the proposed SIR model, i.e., for the experimental reason of data analysis of the COVID-2019 outbreak of India:

\[
S(0) = S_0, \ I(0) = I_0, \text{ and } R(0) = R_0
\]

Here the size of the Indian population is constant. We can quantify India's recovered COVID-2019 outbreak population, which is given by the following formulation:

\[
R(t) = N - (S(t) + I(t)) \quad (9)
\]
The three differential equations (4), (5), and (5) above the proposed SIR model can be translated into the number of differential equations (9). Such two differential equations are very difficult to solve and time-intensive. But of these two differential equations, the solution is very important for data analysis of India's COVID-19 epidemic. We have used a quantitative approach in this proposed study to solve these two differential equations of the model SIR. Now, here we will conclude that if $S'$ for all $t$ is less than zero then $I$ is greater than zero as long as the original population (say the number of susceptible cases in India on 26 July 2020) is greater than the $\frac{a}{r}$ ratio.

In other words, if the original population $S_0$ is greater than the ratio $\frac{a}{r}$, we can assume that we should initially increase to a limit, but gradually it will decrease and reach zero as $S_0$ is decreasing. We have incorporated some cases for India's COVID-2019 outbreak in this proposed study which is given below:

Case-1: If $S_0$ is less than the ratio $\frac{a}{r}$, then India's COVID-2020 epidemic infection $I$ should decrease or be zero after a few days.

Case-2: If $S_0$ is greater than the percentage then India's COVID-2020 outbreak $I$ infection will be the COVID-2019 epidemic. These are the SIR model's conclusions on India's COVID-2019 outbreak. Hence we can conclude from the above two premises that the conduct of India's COVID-2019 outbreak depends on the values of the following expression:

$$R_n = \frac{S_0 r}{a}$$  \hspace{1cm} (10)

The quantity is known as the number threshold. In this present analysis, we have defined another quantity called the reproductive number that is denoted by $R_n$ and defined by the expression (10). That is the number of secondary COVID-2019 outbreak infections in susceptible populations created by one primary infective. Here are two cases from India's COVID-2019 concerning reproductive number:

Case-1: If $R_n$ is less than one, the outbreak of COVID-2019 from India will occur.

Case-2: If $R_n$ is more than one, then the COVID-2019 outbreak in India is still in epidemic mode.

2.1. Step planning and experimental findings for COVID-2019 Indian outbreak
The differential equation of the proposed SIR model for the study of the Indian COVID-2019 outbreak is completely important to be solved. Find a COVID-2019 epidemic-prone population, with a limited number of infected species. Is the of COVID-2019 infectives populations increase substantially in India? The answer to this question will get after solving differential equations of (4), (5), and (6). The differential equations (4), (5) and (6) is the system of the differential equation and these equations have three unknown. Such differential equation schemes are very hard to solve. While we get the single differential equation with an unknown one for the proposed SIR model after combining the equation (4) and (5) then. The method will be as follows:

According to mathematics for chain rule:

\[
\frac{dI}{dS} = \frac{dI/dt}{dS/dt} = \frac{rSI - al}{-rSI} = \frac{rSI}{rSI} - \left(\frac{aI}{rSI}\right) = \frac{a}{rS} - 1
\]

\[
\frac{dI}{dS} = \frac{a}{rS} - 1
\]

\[
dI = \left(\frac{a}{rS} - 1\right) dS
\]

\[
I = \frac{a}{r} \ln(S) - S + C
\]  

(11)

Where, C is the arbitrary constant.

And \( R = N - I - S \)  

(12)

The initial conditions are given for this Karmack-Mchendrick SIR model. We consider the initial conditions as set out below:

\( S(0) = S_0 \) and \( I(0) = I_0 \) then the equation (11) becomes:

\[
I_0 = \frac{a}{r} \ln(S_0) - S_0 + C
\]  

(13)

\[
C = I_0 + S_0 - \frac{a}{r} \ln(S_0)
\]  

(14)

Consider the Indian population size of vulnerable COVID-2019 outbreak is \( K \). This is approximately equivalent to India’s initial population. Here, we must add a limited number of people with infections.
Accordingly, $S_0 = K$, $I_0 = 0$ and $R_n = \frac{rK}{a}$.

If $I(t) = 0$ as $t \to \infty$ and $S_0 < \frac{a}{r}$ then $V(S_0, I_0) = V(S_0)$ gives the following expression:

$$K - \frac{a}{r} \ln(S_0) = S_\infty - \frac{a}{r} \ln(S_\infty)$$

Where $S_\infty$ is India's vulnerable population if the case for infectious diseases is negative. After the above expression has been condensed we can get the following expression:

$$K - S_\infty = -\frac{a}{r} \ln(S_\infty) + \frac{a}{r} \ln(S_0)$$

$$K - S_\infty = \frac{a}{r} \ln(S_0) - \frac{a}{r} \ln(S_\infty)$$

$$K - S_\infty = \frac{a}{r} \left[ \ln(S_0) - \ln(S_\infty) \right]$$

$$K - S_\infty = \frac{a}{r} \ln \left[ \frac{S_0}{S_\infty} \right]$$

$$r = \frac{\ln \left[ \frac{S_0}{S_\infty} \right]}{K - S_\infty}$$

(15)

Here $0 < S_\infty < K$ that is past of the population of India escapes the COVID-2019 infective. In this proposed study, it is very difficult to estimate the parameters of $r$ and because these depend on the disease being studied and on social and behavioral factors of that country. The population $S_0$ and $S_\infty$ can be estimated by serological studies before and after of the COVID-2019 outbreak and using this data, the basic reproduction number is given by the following formula:

$$R_n = \frac{rK}{a}$$

(16)

This expression can be calculated using expression (15). The maximum number of COVID-2019 outbreak infectives at any time in India can be obtained by substantially using the following calculation: Putting $S = \frac{r}{a}$ and $I = I_{max}$ in equation (11), We have the highest number of COVID-2019 infectious cases in India at any given time.

$$I = \frac{a}{r} \ln(S) - S + C$$

Where,
\[ C = I_0 + S_0 - \frac{a}{r} \ln(S_0) \]

Therefore the maximum number of infectious cases \( I = I_{\text{max}} \) COVID-19 outbreak of India can calculate with the help of the following expression:

\[ I_{\text{max}} = I_0 + S - \frac{a}{r} + \frac{a}{r} \ln(S_0) + \frac{a}{r} \ln(\frac{a}{r}) \quad (17) \]

For this proposed thesis we solve the differential equation using the values of the above initial conditions \( S_0, I_0, R_0 \), a and r. Table 1 displays the experimental effects of model SIR.

We used COVID-19 data collection from India as of July 26, 2020 in this proposed report. Here, we took the total number of COVID-19 population confirmed as the total number of infected population and the total number of recovered/removed cases as at the initial stage to examine India's COVID-19 outbreak on 26 July 2020. These three initial populations \( S_0, I_0, R_0 \), a and r are represented as:

\[
S_0 = 162.91331 \quad I_0 = 4.81248 \quad R_0 = 9.10298
\]

The recovery rate/elimination rate and infection rate of India's COVID-19 outbreak can be determined using the following expression:

\[
r = \frac{\text{Infected Population}}{\text{Susceptible Population}} = \frac{481248}{16291331}
\]

\[ r = 0.02954 \]

\[ \frac{1}{a} = 14 \quad (\text{Because the incubation time of COVID-19 outbreak of India is 14 day}) \]

\[ a = \frac{1}{14} \approx 0.07142 \]

Putting the values of \( r, a, S_0, I_0, \text{ and } R_0 \) in equation (4), (5) and (6) to get the next cohort values Susceptible population \( S_1, I_1, \text{ and } R_1 \),

Likewise, we will calculate another repeat. Table displaying empirical effects of the SIR model 1.
### Table 1: SIR Methods Simulation

| S.No | Date       | Day/Time | Susceptible | Infected | Recovered |
|------|------------|----------|-------------|----------|-----------|
| 1    | 26-07-2020 | 0        | 162.91331   | 4.81248  | 9.10298   |
| 2    | 27-07-2020 | 2        | 160.71806   | 6.23773  | 9.87298   |
| 3    | 28-07-2020 | 4        | 157.91102   | 8.04674  | 10.87101  |
| 4    | 29-07-2020 | 6        | 154.35314   | 10.31713 | 12.15849  |
| 5    | 30-07-2020 | 8        | 149.89420   | 13.12534 | 13.80923  |
| 6    | 31-07-2020 | 10       | 144.38544   | 16.53404 | 15.90929  |
| 7    | 01-08-2020 | 12       | 137.70107   | 20.57296 | 18.55473  |
| 8    | 02-08-2020 | 14       | 129.76890   | 25.21346 | 21.84641  |
| 9    | 03-08-2020 | 16       | 120.60751   | 30.34070 | 25.88056  |
| 10   | 04-08-2020 | 18       | 110.36143   | 35.73227 | 30.73507  |
| 11   | 05-08-2020 | 20       | 99.31973    | 41.05680 | 36.45224  |
| 12   | 06-08-2020 | 22       | 87.90203    | 45.90542 | 43.02133  |
| 13   | 07-08-2020 | 24       | 76.60352    | 49.85905 | 50.36619  |
| 14   | 08-08-2020 | 26       | 65.90926    | 52.57587 | 58.34364  |
| 15   | 09-08-2020 | 28       | 56.20660    | 53.86639 | 66.75578  |
| 16   | 10-08-2020 | 30       | 47.72919    | 53.72518 | 75.37440  |
| 17   | 11-08-2020 | 32       | 40.54926    | 52.30908 | 83.97043  |
| 18   | 12-08-2020 | 34       | 34.61020    | 49.87869 | 92.33988  |
| 19   | 13-08-2020 | 36       | 29.77653    | 46.73177 | 100.32047 |
| 20   | 14-08-2020 | 38       | 25.88030    | 43.15091 | 107.79756 |
| 21   | 15-08-2020 | 40       | 22.75338    | 39.37369 | 114.70170 |
| 22   | 16-08-2020 | 42       | 20.24490    | 35.58238 | 121.00149 |
| 23   | 17-08-2020 | 44       | 18.22789    | 31.90621 | 126.69467 |
| 24   | 18-08-2020 | 46       | 16.59946    | 28.42965 | 131.79967 |
| 25   | 19-08-2020 | 48       | 15.27809    | 25.20227 | 136.34841 |
| 26   | 20-08-2020 | 50       | 14.19997    | 22.24803 | 140.38077 |
| 27   | 21-08-2020 | 52       | 13.31539    | 19.57292 | 143.94046 |
| 28   | 22-08-2020 | 54       | 12.58565    | 17.17099 | 147.07213 |
| 29   | 23-08-2020 | 56       | 11.98055    | 15.02874 | 149.81948 |
| 30   | 24-08-2020 | 58       | 11.47640    | 13.12829 | 152.22408 |
|    |    |    |    |    |
|----|----|----|----|----|
| 31 | 25-08-2020 | 60 | 11.05454 | 11.44962 | 154.32461 |
| 32 | 26-08-2020 | 62 | 10.70014 | 9.97208 | 156.15655 |
| 33 | 27-08-2020 | 64 | 10.40137 | 8.67532 | 157.75208 |
| 34 | 28-08-2020 | 66 | 10.14871 | 7.53992 | 159.14013 |
| 35 | 29-08-2020 | 68 | 9.93446 | 6.54779 | 160.34652 |
| 36 | 30-08-2020 | 70 | 9.75232 | 5.68228 | 161.39417 |
| 37 | 31-08-2020 | 72 | 9.59716 | 4.92828 | 162.30333 |
| 38 | 01-09-2020 | 74 | 9.46472 | 4.27219 | 163.09186 |
| 39 | 02-09-2020 | 76 | 9.35151 | 3.70186 | 163.77541 |
| 40 | 03-09-2020 | 78 | 9.25458 | 3.20649 | 164.36770 |
| 41 | 04-09-2020 | 80 | 9.17149 | 2.77654 | 164.88074 |
| 42 | 05-09-2020 | 82 | 9.10018 | 2.40360 | 165.32499 |
| 43 | 06-09-2020 | 84 | 9.03894 | 2.08027 | 165.70956 |
| 44 | 07-09-2020 | 86 | 8.98629 | 1.80007 | 166.04241 |
| 45 | 08-09-2020 | 88 | 8.94100 | 1.55735 | 166.33042 |
| 46 | 09-09-2020 | 90 | 8.90201 | 1.34717 | 166.57960 |
| 47 | 10-09-2020 | 92 | 8.86843 | 1.16520 | 166.79514 |
| 48 | 11-09-2020 | 94 | 8.83950 | 1.00770 | 166.98157 |
| 49 | 12-09-2020 | 96 | 8.81456 | 0.87141 | 167.14281 |
| 50 | 13-09-2020 | 98 | 8.79305 | 0.75349 | 167.28223 |
| 51 | 14-09-2020 | 100 | 8.77450 | 0.65148 | 167.40279 |
| 52 | 15-09-2020 | 102 | 8.75849 | 0.56325 | 167.50703 |
| 53 | 16-09-2020 | 104 | 8.74468 | 0.48694 | 167.59715 |
| 54 | 17-09-2020 | 106 | 8.73276 | 0.42096 | 167.67506 |
| 55 | 18-09-2020 | 108 | 8.72246 | 0.36390 | 167.74241 |
| 56 | 19-09-2020 | 110 | 8.71357 | 0.31456 | 167.80063 |
| 57 | 20-09-2020 | 112 | 8.70590 | 0.27191 | 167.85096 |
| 58 | 21-09-2020 | 114 | 8.69927 | 0.23503 | 167.89447 |
| 59 | 22-09-2020 | 116 | 8.69355 | 0.20315 | 167.93207 |
| 60 | 23-09-2020 | 118 | 8.68860 | 0.17559 | 167.96458 |
| 61 | 24-09-2020 | 120 | 8.68433 | 0.15177 | 167.99267 |
| 62 | 25-09-2020 | 122 | 8.68064 | 0.13118 | 168.01695 |
| Date       | Count  | Susceptible | Infected | Recovered |
|------------|--------|-------------|----------|-----------|
| 26-09-2020 | 124    | 8.67745     | 0.11338  | 168.03794 |
| 27-09-2020 | 126    | 8.67470     | 0.09799  | 168.05608 |
| 28-09-2020 | 128    | 8.67232     | 0.08469  | 168.07176 |
| 29-09-2020 | 130    | 8.67026     | 0.07320  | 168.08531 |
| 30-09-2020 | 132    | 8.66848     | 0.06326  | 168.09702 |
| 01-10-2020 | 134    | 8.66695     | 0.05468  | 168.10715 |
| 02-10-2020 | 136    | 8.66562     | 0.04726  | 168.11589 |
| 03-10-2020 | 138    | 8.66447     | 0.04084  | 168.12345 |
| 04-10-2020 | 140    | 8.66348     | 0.03530  | 168.12999 |
| 05-10-2020 | 142    | 8.66263     | 0.03051  | 168.13564 |
| 06-10-2020 | 144    | 8.66189     | 0.02636  | 168.14052 |
| 07-10-2020 | 146    | 8.66125     | 0.02279  | 168.14474 |
| 08-10-2020 | 148    | 8.66070     | 0.01969  | 168.14838 |
| 09-10-2020 | 150    | 8.66022     | 0.01702  | 168.15153 |
| 10-10-2020 | 152    | 8.65981     | 0.01471  | 168.15426 |
| 11-10-2020 | 154    | 8.65945     | 0.01271  | 168.15661 |
| 12-10-2020 | 156    | 8.65914     | 0.01099  | 168.15864 |
| 13-10-2020 | 158    | 8.65887     | 0.00950  | 168.16040 |
| 14-10-2020 | 160    | 8.65864     | 0.00821  | 168.16192 |
| 15-10-2020 | 162    | 8.65844     | 0.00709  | 168.16323 |
| 16-10-2020 | 164    | 8.65827     | 0.00613  | 168.16437 |
| 17-10-2020 | 166    | 8.65812     | 0.00530  | 168.16535 |
| 18-10-2020 | 168    | 8.65800     | 0.00458  | 168.16620 |
| 19-10-2020 | 170    | 8.65788     | 0.00396  | 168.16693 |
| 20-10-2020 | 172    | 8.65779     | 0.00342  | 168.16756 |
| 21-10-2020 | 174    | 8.65771     | 0.00296  | 168.16811 |
| 22-10-2020 | 176    | 8.65763     | 0.00255  | 168.16858 |
| 23-10-2020 | 178    | 8.65757     | 0.00221  | 168.16899 |
| 24-10-2020 | 180    | 8.65752     | 0.00191  | 168.16934 |
| 25-10-2020 | 182    | 8.65747     | 0.00165  | 168.16965 |
| 26-10-2020 | 184    | 8.65743     | 0.00142  | 168.16991 |
| 27-10-2020 | 186    | 8.65740     | 0.00123  | 168.17014 |
Figure 3 displays the revised SIR model for India’s disease condition COVID-2019 as of July 26, 2020. This figure also reveals that the date of COVID-2019’s highest number of cases of infection in India is 15 August 2020 (see table 1 from the bold column). Figure 4 indicates
the highest number of COVID-19 epidemic contaminated cases in India. Beyond this, Figure 5 indicates restored cases of the Indian COVID-19 outbreak.

![SIR Model Simulation for COVID-19](image)

**Figure 3: SIR Model Simulation for COVID-19 epidemic state of India from July 26, 2020.**

The maximum number of infective cases (I\text{max}) of COVID-19 outbreak of India can be intended consuming equation (17) is as follows:

\[ a = 0.07142 \quad S_0 = 162.91331 \quad I_0 = 4.81248 \quad S_\infty = 8.65720 \]

Then the ratio \( \frac{r}{a} \) can be calculated using equation (15) i.e. \( \frac{r}{a} = 0.008038 \)

Therefore \( r = 0.008038 \times 0.07142 = 0.000574 \)

Hence I\text{max} = 53.86639, Here, we have multiplied by 100000 in I\text{max} to get the maximum number of infectives cases of COVID-19 outbreak of India because 100000 is the stabilization factor of this suggested study. Therefore I\text{max} = 5386639. From this table, we have seen that the maximum number of infectives cases of CODID-2019 is 5228520. This value is nearby the I\text{max}. Therefore, we have seen that there will be a maximum outbreak of COVID-19 in India on July 26, 2020, then it will decrease unceasingly till the Second week of November 2020.
It is also possible to measure the reproductive number of COVID-2019 outbreak on the original, select, end of COVID-2019 outbreak, and sometime during India's COVID-2019 outbreak. Here some estimates of the reproductive number are given below:

1. The initial level of COVID-2019: \( R_n = \frac{S_0 \cdot r}{a} = \frac{162.91331 \times 0.00571}{0.07142} = 1.302165 \)

2. Pick level (maximum of COVID-2019): \( R_n = 162.91331 \times 0.007993 = 1.302165 \)

3. End level of COVID-2019: \( R_n = 8.65720 \times 0.00799 = 0.069197 \)

From the latter equation, we found that if the reproductive number is greater than one, then the COVID-2019 continuously rises at the pick / maximum point (Case-1 and Case-2) and if the reproductive number is less than one, the COVID-2019 will die off (case-3). However, epidemiological scientists all over the world have estimated the replication number of COVID-2019.

![Maximum Number of Infective cases of COVID-19 outbreak of India](image)

**Figure 4: Maximum Number of Infective cases of COVI-2019 outbreak of India**
We get the following finding in the described study:

1. COVID-2019 outbreak is expected to peak in India on 09 August 2020, following which the spread of this disease will begin to function gradually.

2. COVID-2019 outbreak in India will last until the second or third week of November 2020, after which the epidemic ceases.

3. In the initial COVID-2019 point, India’s reproductive number for this outbreak is 1.3.

3. Conclusion

Based on the data provided in the study as of July 26, 2020, the SIR model suggests that the outbreak of COVID-2019 will hit its height in India by August 09, 2020, or by the end of August. Based on this report, we can assume that the outbreak of this epidemic will continue to function gradually by the end of August 2020 and that the outbreak of this epidemic will be near the peak by the second week of November 2020. Based on the data this model obtains, This will be misleading to say that the COVID-2019 epidemic will occur in India because people here today do not obey social distancing or add their face masks. Therefore
this disease danger in India is very strong. This research also reveals that in India, when locking, social distancing and masks, etc. are used correctly, In the second or third week of November 2020, the outbreak of the COVID-2019 epidemic may then almost be removed. This proposed research is highly useful for COVID-2019 future outbreak prediction. The new SIR model would accurately predict the number of weekly, bimonthly, monthly, and even year events. Therefore, we might assume that for next week or in the future, the Indian government and doctors should hold a watch on hospital services, the requisite medicines for new patients, medical aid, and isolation.

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