

Susceptible-Infectious-Recovered (SIR) model-based forecasting of COVID-19 outbreak in Bangladesh

The 2019-20 coronavirus (COVID-19) pandemic was affirmed to have spread to Bangladesh on March 2020. The initial three known cases were accounted for by the nation's Institute of Epidemiology, Disease Control and Research (IEDCR) on 7 March 2020.¹ As of 9th April 2020, the Government of Bangladesh has reported that there is a total of 330 confirmed cases, 33 recoveries and 21 deaths in the whole country.² In this research, I try to forecast the COVID-19 outbreak in Bangladesh using a well-known epidemiological model, Susceptible-Infectious-Recovered (SIR) model.

The SIR model consists of three compartments: S stands for susceptible, I stands for infectious and R stands for recovered or deceased (or immune) or removed individuals. This model has two parameters β and γ which represents the infectious contact rate and the recovery rate, respectively. Another key component, the basic reproductive ratio (R_0) can be predicted with the help of β and γ . For details about SIR model, see Ref.3.

To estimate the parameters I considered the everyday cases of the COVID-19 over the period of March 7, 2020 to April 14, 2020 from worldometers records.⁴ The parameter estimates are displayed in Table 1. From this Table, it is observed that the COVID-19

can be transmitted through exposure in Bangladesh with a rate of $\beta = 0.0014$. The value of γ is found to be 0.2366 represents that the disease can be recovered in a specific period at a rate of 0.2366. Moreover, the average number of people infected from one other person is more than 7 ($R_0 = 7.14$).

Now, I try to draw the SIR model curve by checking the model assumption as well as utilising the estimated values of β and γ with some additional information of susceptible, infectious as well as recovered individuals at initial stage. As of April 14, 2020 the IEDCR informed that among 1905 tested samples there are 209 confirmed cases with no recovered individuals.² Note that, I want to forecast

TABLE 1 Maximum likelihood estimation of the parameters of SIR model

Description	Symbol	Estimated value	P-value
Infectious contact rate	β	0.0014	<.001
Recovery rate	γ	0.2366	<.1
Basic reproductive ratio	R_0	7.15	

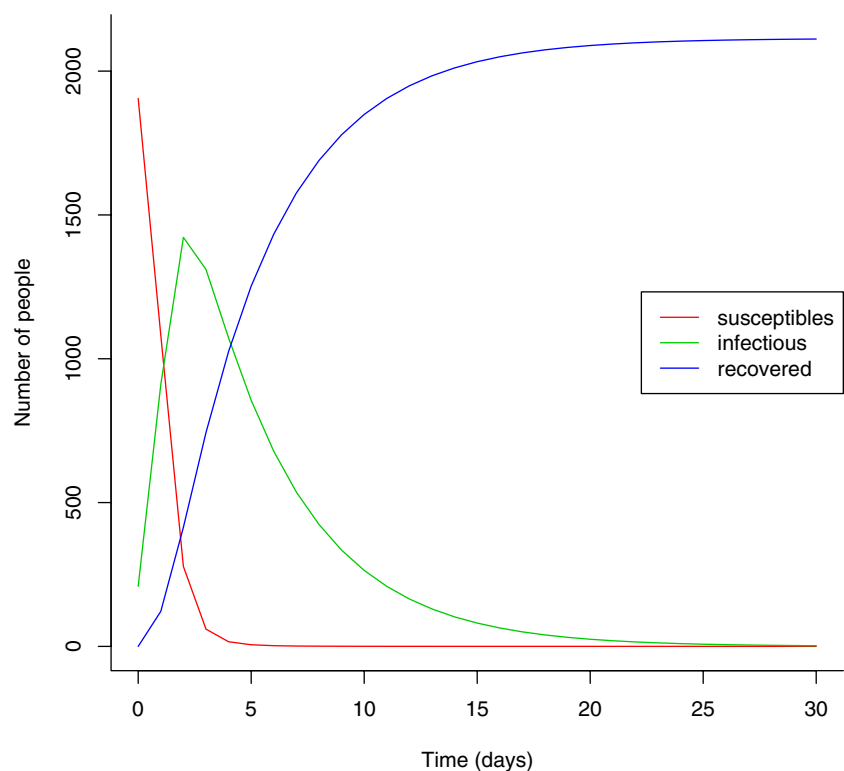


FIGURE 1 SIR Model for COVID – 19 outbreak in Bangladesh

the outbreak from April 15, 2020 to the next 30 days. Therefore, at initial stage (April 14, 2020), the number of susceptible, infectious and recovered individuals were 1905, 209 and 0, respectively. By utilising all these information, the SIR curve had been drawn. The curve is shown in Figure 1. Basically, the figure illustrate how the number of each component (S, I and R) can be changed over time, according to the SIR model.

In Figure 1 the X-axis represents the time periods, specifically the number of days since the beginning of the outbreak. The Y-axis represents the number of people in each of three categories in each day. Note that, in X-axis the 0 value represents the April 14, 2020 since I want to forecast the outbreak from April 15, 2020. The red, green and blue colour represents the susceptible, infectious and recovered individuals, respectively.

The quick decline of the red line (the number of people who have not been yet been infected) indicates that the disease is very contagious, with almost every susceptible individuals being infected by the 5th day from starting point (ie, April 20, 2020). The green line (the daily number of infected cases) changes rapidly up to maximum by the 3rd day and then, falls more slowly until about 25th day when nearly everyone has recovered. Finally, the blue line (the number of recovered cases) increases steadily and reaches the highest point at the 21st day, indicating almost everyone will be recovered from disease. Note that, in the whole course of action, death may be occurred and SIR model consider these death into recovered cases.

Finally, it should be bear in mind that this is a model-based forecasting of the outbreak and the estimates are calculated from available information. If several protective measures will not be taken,

then this rate may exist. However, the government of Bangladesh has already taken various protective measures such as lockdown several areas, facilitate quarantine etc to reduce the rate of COVID-19 outbreak. Hopefully, our country will be successful to reduce the rate of this outbreak.

DISCLOSURE

The author has no conflict of interest to disclosure.

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