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COVID-19: Herd Immunity Projection in Bangladesh

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Abstract*: Herd Immunity is the opposition to the spread of infectious disease like COVID-19 within a population that appears if an adequately high proportion of individuals are immune to the infectious disease. According to infectious disease law, if at least 70 percent of a population becomes resistant to a particular disease or infectious disease, they can no longer spread the disease to the remaining 30 percent of susceptible people. If 70 to 90 percent of total populations in a country are infected by COVID-19, then herd immunity will be obtained and by this way the novel corona virus can be annihilated from that country. According to the World Health Organization, a person infected with corona virus can infect 2.5 people. At least 90 percent of people need to be infected with corona virus to have herd immunity. If there is to be herd immunity in the case of Bangladesh, there are 161.4 million people here, so about 145.5 million people will have to be infected with corona virus. If the infection continues in Bangladesh, there is no way out until herd immunity comes. If Bangladesh makes a decision to go to herd immunity, it is necessary to know the death and infected status in herd immunity stage. In this paper, a model based on Malthusian theory has proposed to make the projection of herd immunity with the status of infected cases, cured cases and death in Bangladesh. The model of exponential growth has implemented to evaluate the time of herd immunity and also to estimate the total death and infected cases. The proposed model has validated using MATLAB and Microsoft excel.

Keywords*: COVID-19, Projection, Exponential growth, Malthusian theory, Herd immunity.

I. INTRODUCTION

In Bangladesh, lockdown has been taken to deal with the corona virus situation. According to the pattern or graph of infection, there is no way out except to wait for herd immunity. When the corona virus epidemic began around the world, there was talk of herd immunity in many countries. However, in the end no country has followed that path but the path of lockdown. Before the invention of the vaccine, the number of people who would be infected to build up herd immunity naturally, the number of people who would die would be huge. The word herd means herd of animals. The origin and prevalence of hard immunity from the concept of immunity in cattle herds or sheep flocks [1]. About 70 percent of sheep are immune to vaccination or infection, while the rest of the flock is safe, including the remaining 20 percent [1]. The term hard immunity originated centuries ago but was not widely used. It has come under more discussion this decade, especially in the COVID-19 crisis. When most people in an area are vaccinated against an infectious disease, there is no risk of the disease spreading to that area. Because there are no more infected people in that area. For example, if measles occurs in someone in a community, and most people are vaccinated. Then the disease can not spread to anyone else. This is herd immunity or community immunity. Because of this, newborns, the elderly and sick people who cannot be vaccinated are free of the disease. Herd immunity will only work when most people in a group are given antidotes. For example, in the case of measles, if only 19 out of 20 people can be vaccinated, then hard immunity will develop in certain communities. No antidote or vaccine for corona virus has yet been discovered. So question arises how will herd immunity work to deal with it. Once infected with the virus, the immune system is strengthened against the virus. In this way, if more people become infected with the virus, then at one time a large number of people develop immunity to the virus. This creates a safety net in a particular community and stops the spread of the disease. Scientists believe that this method should be followed until a vaccine can be developed. Although most countries in the world have opted for the lockdown method, Sweden, New Zealand and the United Kingdom have been seen to adopt hard immunity system against the current [1].

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II. METHODOLOGY

A. Malthusian Theory

Let $M(t)$ be the number of individuals in a population at time t and let u and v be the average per capita birth rate and death rate respectively. In a short time Δt, the number of births in the population is $u\,\Delta t M$, and the number of deaths is $v\Delta t M$. An equation [2] for M at time $t+\Delta t$ is then determined to be

$$M(t+\Delta t) = M(t) + u\,\Delta t\,M(t) - v\,\Delta t\,M(t)$$

This can be rearranged to

$$\frac{M(t+\Delta t)-M(t)}{\Delta t}=(u-v)M(t)$$

And as $\Delta t \to 0$,

Where r, is the population growth rate, sometimes called Malthusian Parameter

$= (u-v)$Positive

$$\frac{d}{dt}M(t)=rM(t)\,(1)$$

Integrating we get

$$\int \frac{dM}{M}=r\int dt$$

$$\ln M = rt + x$$

$$M = e^{rt+x}$$

$$M = e^{x}.e^{rt}$$

$$M = Ce^{rt}$$

With an initial population size of $M(0)=M_0$

The solution for $M(t)$grows exponentially:

$$M(t)=M_0 e^{rt}(2)$$

This is known as the solution of Malthusian growth model [2].

B. Model of exponential growth

Let, P is the number of people in Bangladesh carrying COVID-19 virus. There is some probability of infecting others with each infected person.

Table-I: Infection, cured and death rate in Bangladesh

Infection rate per day	21%
Cured rate per day	40%
Death rate per day	1.3%

If the infection rate is r and change in time measured in days is **Δd,** the infection rate can be found by

$$\frac{\Delta P}{\Delta d}=rP$$

Using the rate of change formula above, the number of infected people and from that the number of next day can be calculated.

$$P_{i+1}=P_i+rP_i\Delta d$$

At each step, I will calculate the number of infected people and from that calculate the number for the next day. Using the rate of change formula above, I get the following infected update expression:

Solving that equation gives the following

$$P(d)=P_0e^{rd}$$

C. COVID-19 Infected status in Bangladesh

After its first origin from China; the first case of COVID-19 in Bangladesh was reported on March 7, 2020 and the first death occurred on March 16, 2020 [4]. Fig.1 shows the overall infected cases of COVID-19 in Bangladesh upto 6 July 2020 [5].

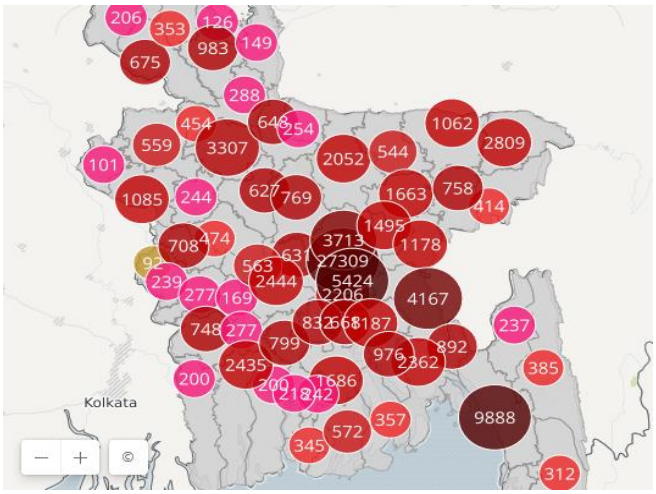

Fig.1. COVID-19 infected status in Bangladesh upto 6 July 2020

From 24 March 2020 to 6 July 2020, the overall picture of COVID-19 status in Bangladesh [5] has recorded shown in Table II. According to the data of the Department of Health as of July 1, the infected rate is 21%, the recovery rate in Bangladesh is 47.6% and the mortality rate is 1.3% shown in Table I [5].

Table-II: COVID-19 data in Bangladesh upto 6 July 2020

Month	Infected cases	Cured	Death
24-Mar-20	39	5	4
31-Mar-20	51	25	5
7-Apr-20	123	33	12
13-Apr-20	803	42	39
20-Apr-20	2948	85	101
27-Apr-20	5913	131	152
4-May-20	10143	1209	182
11-May-20	15691	2902	239
18-May-20	23870	4585	349
25-May-20	35585	7334	501
1-Jun-20	49534	10597	672
8-Jun-20	68504	14560	930
15-Jun-20	90619	14560	1209
22-Jun-20	115786	46719	1502
29-Jun-20	141801	57744	1782
6-Jul-20	165618	76149	2096

As of March 24, the total number of infected in Bangladesh was 39 and gradually the number has increased and now stands 165618 shown in Fig.2.

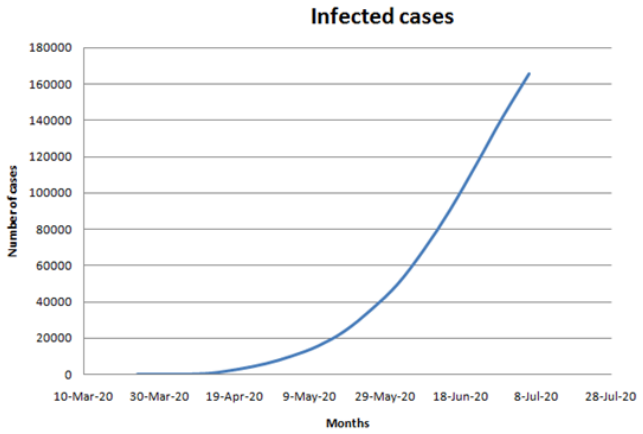

Fig.2. Infected cases in Bangladesh upto 6 July, 2020

Table III shows the infected cases per month from March 2020 to June 2020 derived from Table II.

Table III: Infected cases from March 2020 to June 2020

Month	Infected cases
Mar-20	51
Apr-20	5862
May-20	29723
Jun-20	112078

The infected cases of individual month shown in Fig.3 as a pie chart.

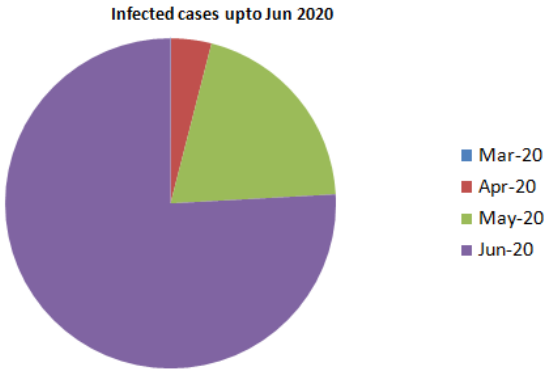

Fig.3. COVID-19 infected status per month upto June 2020

As of March 24, the total number of cured person in Bangladesh was 5 and gradually the number has increased and now stands 76149 shown in Fig.4.

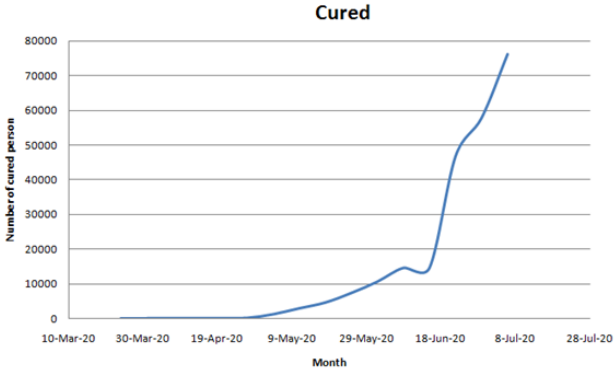

Fig.4. Cured cases in Bangladesh upto 6 July, 2020

Table IV shows the number of cured per month from March 2020 to June 2020 derived from Table II.

Table IV: Number of cured from March 2020 to June 2020

Month	Number of cured
Mar-20	30
Apr-20	101
May-20	7233
Jun-20	50511

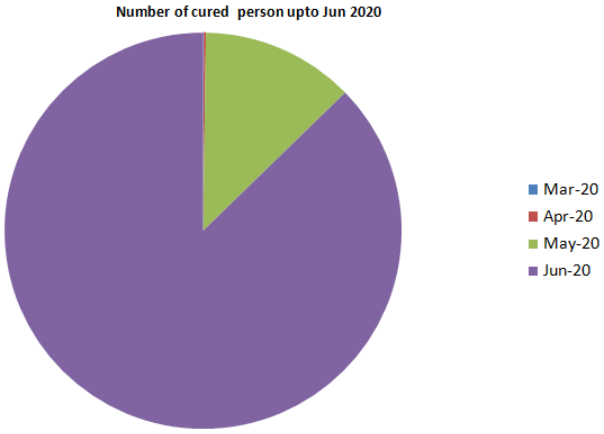

Fig.5. COVID-19 cured status in Bangladesh upto June 2020

As of March 24, the total number of death in Bangladesh was 4 and gradually the number has increased and now stands 2096 shown in Fig.6.

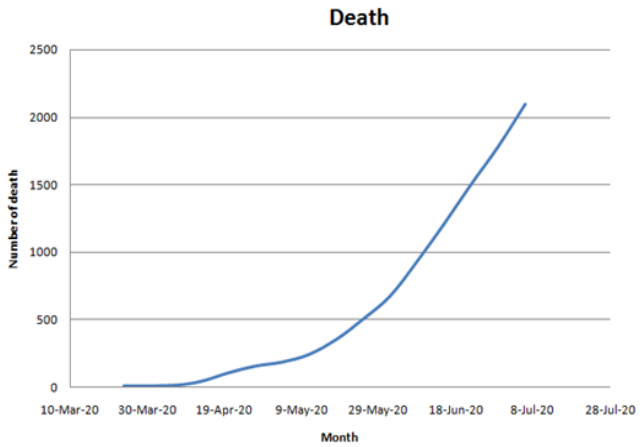

Fig.6. Death cases in Bangladesh upto 6 July, 2020

Table V shows the number of death per month from March 2020 to June 2020 derived from Table II.

Table V: Number of death from March 2020 to June 2020

Month	Number of death
Mar-20	9
Apr-20	143
May-20	358
Jun-20	1424

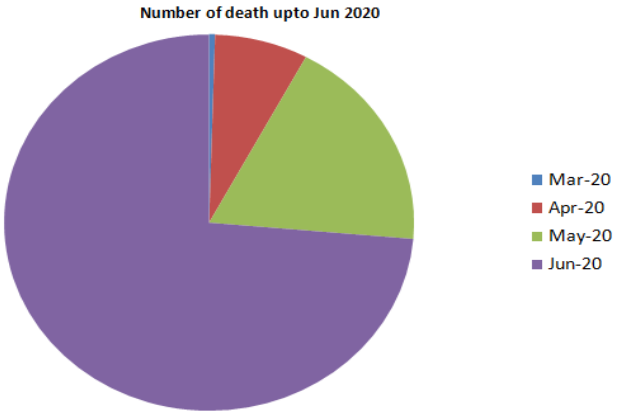

Fig.7. COVID-19 death status in Bangladesh upto June 2020

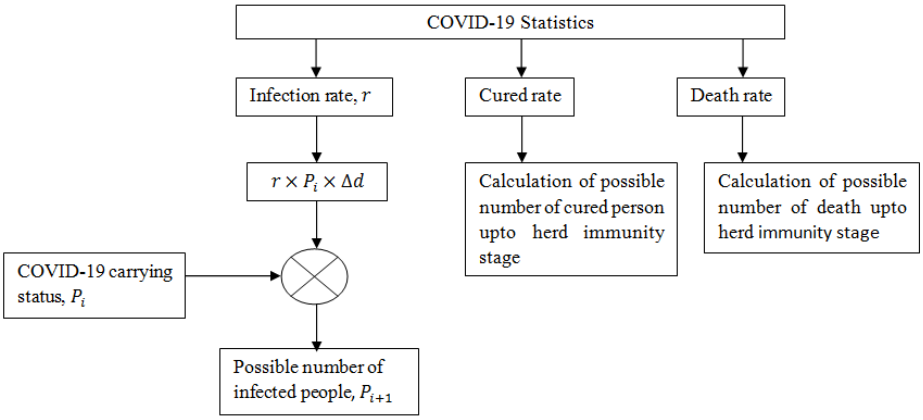

Fig.8. A model to make the projection of COVID-19 in case of herd immunity

III. Result & Discussion

In the case of corona virus, hard immunity is difficult to work with. More than 70 percent of people need to be infected with the virus to develop strong immunity against the corona virus. It is not yet a recognized method of preventing corona virus. But many think it could be a way. If an infected person encounters 10 other people, a virus would infect two of them on average shown in Fig.9 and 10.

Fig.9. 10 people encountered

Fig.10. 2 people becomes infected

If enough people are immune, the virus has fewer pathways to spread shown in Fig.11 and 12.

Fig.11. 5 people are immune

Fig.12. Only 1 person becomes infected

The emphasis on hard immunity as one of the strategies to prevent the corona virus epidemic in Bangladesh has now been called into question by this research. If a sufficient number of people are infected with a single virus, then the infection can be prevented, and then herd immunity will be achieved. Therefore, to protect those who are not infected, 70-90 percent of the people in the area should be infected.
The projection of infected cases in order to achieve herd immunity shown in Fig.13 has revealed that if this method is applied in Bangladesh, the consequences could be dire. About 150 million people in the country will be infected with the virus at the end of April 2021. This could be a very frightening decision considering the current health system in the country.

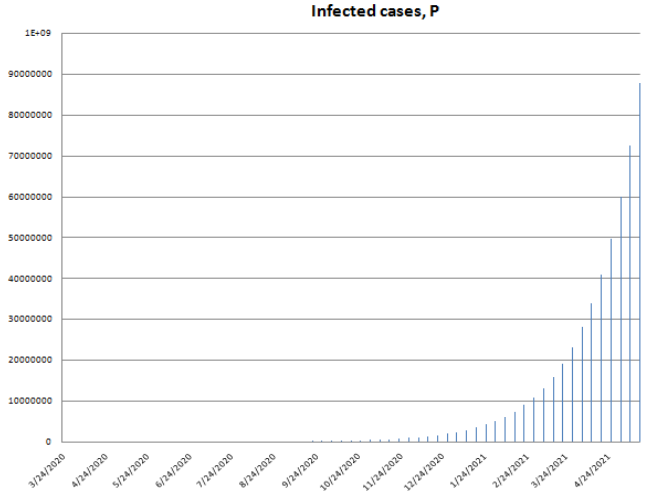

Fig.13. Projection of infected cases in order to achieve herd immunity

Table VI shows the projection of infected cases per month from July 2020 to March 2021 derived from Fig. 13.

Table VI: Projection of infected cases from July 2020 to May 2021

Month	Infected cases (Million)
Jul-20	0.152
Aug-20	0.609
Sep-20	1.02
Oct-20	2.47
Nov-20	6.59
Dec-20	12.8
Jan-21	28.8
Feb-21	60.5
Mar-21	171

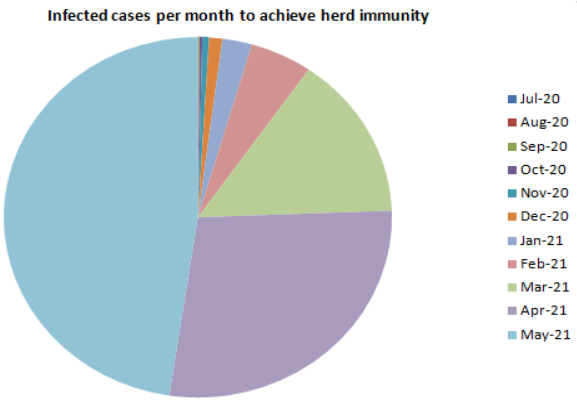

Fig.14. Projection of infected cases in order to achieve herd immunity

Table VII shows the projection of cured per month from July 2020 to May 2021 derived from Fig. 13.

Table VII: Projection of number of cured from July 2020 to May 2021

Month	Number of cured person [Thousand]
Jul-20	13.5
Aug-20	26
Sep-20	31.8
Oct-20	52.8
Nov-20	83.4
Dec-20	116
Jan-21	176
Feb-21	251
Mar-21	437

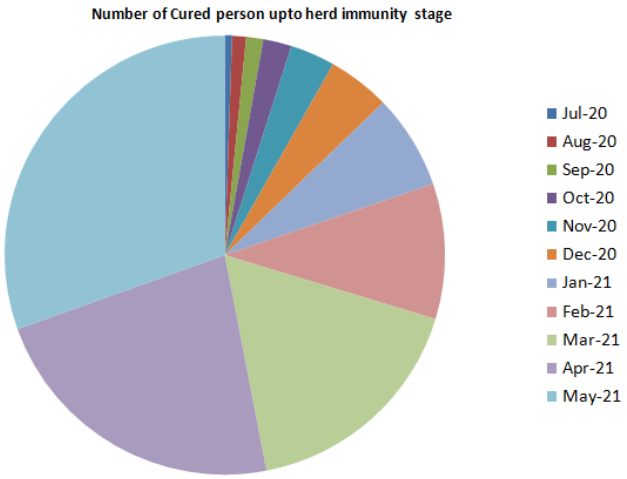

Fig.15. Projection of infected cases in order to achieve herd immunity

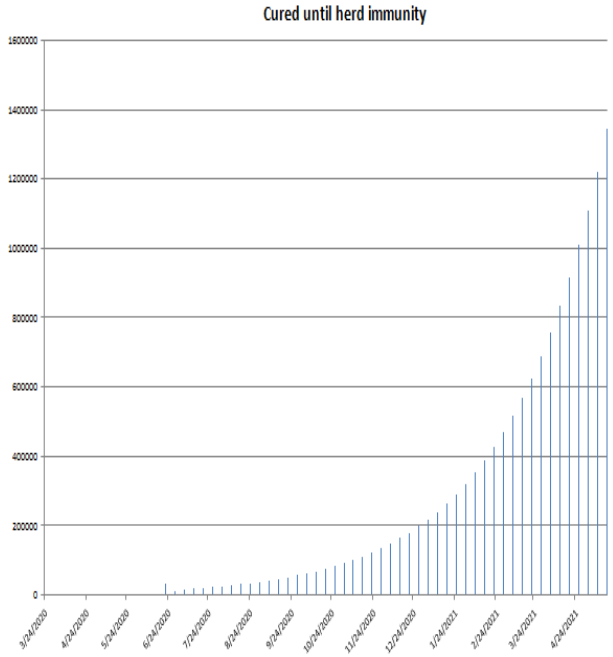

Fig.16. Projection of cured cases with herd immunity

Table VIII shows the projection of the number of death per month from July 2020 to May 2021 derived from Fig. 13.

Table VIII: Projection of number of death from July 2020 to May 2021

Month	Number of death [Thousand]
Jul-20	0.263
Aug-20	1.09
Sep-20	1.71
Oct-20	4.09
Nov-20	10.4
Dec-20	19.6
Jan-21	42.5
Feb-21	86.3
Mar-21	234

COVID-19 is a very dangerous and deadly disease that can lead to death. These thoughts without antidote are so foolish. So far, the mortality rate from COVID-19 disease is about 2%. If 60% of the total population were infected, the total mortality rate of Bangladesh would be about 1.5%, which is undoubtedly a catastrophic catastrophe.

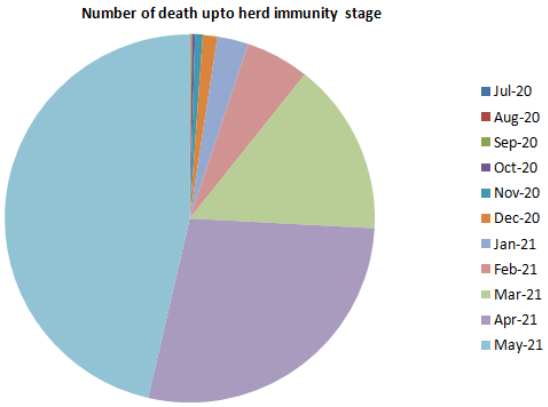

Fig.17. Projection of death cases in order to achieve herd immunity

The population of Bangladesh is approximately 17 crore. If 90% of them are infected with COVID-19 disease, the number of patients will be 14 to 15 crore at the end of March 2021 shown in Fig.13. According to the current mortality rate in Bangladesh, more than 1100000 peoples will die at the end of March 2021 shown in Fig.18.

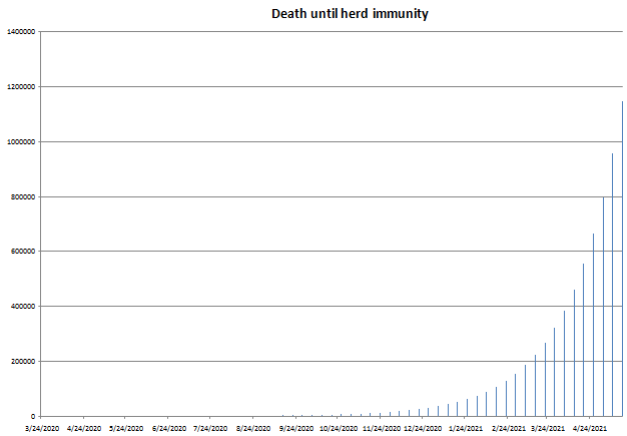

Fig.18. Projection of death cases with herd immunity

And if even 10% of patients have to be hospitalized, the whole health system will collapse. The death toll will also jump by leaps and bounds. So sad but true, Herd Immunity COVID-19 is not the right solution against the global epidemic.

IV. CONCLUSION

To protect people in the future, a certain part of the population should be allowed to be infected with the virus. This will make their bodies collectively immune against infection. This will cause the body to make antibodies against the virus which can be tried to prepare the vaccine from their body. In this paper, a model has proposed based on Malthusian theory to determine the projection of herd immunity with the status of infected cases, cured cases and death in Bangladesh. The model of exponential growth has implemented to evaluate the time of herd immunity and also to estimate the total death and infected cases. To build hard immunity, 70 to 80 percent of the total population needs to recover after being infected. More than 160 million people live in Bangladesh whose density is more than a thousand per square kilometer. It is almost impossible to do so in a populous country like Bangladesh, India etc. Besides, it is not reasonable to follow the developed state exactly. As a result, the government should take groundbreaking decisions with the help of experts according to its own resources and capabilities. For 70-80 percent of infections, Bangladesh now has 165618 infections, it has to rise to 15 crore in March 2021. And the consequences will be terrible. If this is done in the country, about 1100000 people may lose their lives. Besides, the amount of hospital facilities required for walking on the path of hard immunity is not available in Bangladesh as in other countries of the world. The vaccine is the mainstay of infection prevention in the absence of COVID-19 specific or specific drug. The vaccine is real, not an infection for herd immunity. Maintaining social or physical distance until the vaccine is available is the only way to prevent infection. Failure to do so would result in the collapse of the health and medical system and the death of many people in Bangladesh. Social and physical distance and adherence to hygiene rules destroy the chain of transmission in the same way as herd immunity and vaccines, thus reducing the number of infected people in the society and reducing the pressure on the medical system, improving the overall situation.

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