MATHEMATICAL ANALYSIS ON EFFECT OF COVID-19 IN INDIAN POPULATION

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***Abstract*: The corona virus disease 2019 pandemic is a new destructive disease, which now days rising its transmission in worldwide population among all countries, India is also one of them. The first case of COVID-19 disease in India was detected on 30 January2020, then after day by day the cases increases gradually & now a days India becomes the vulnerable region with for covid-19 infection during the initial phase outbreak. Later this virus was transmitted from one person to another person through contact and tiny droplets. After consideration of the world's largest health organization, i.e., WHO & National Health Commission of China takes an immediate action to reduce COVID-19 rate and fertility rates, but the taken action has failed to stop COVID-19 rates in India as well as all over India so there is no break of positive cases & fertility rates.**

Here we designed a project report on the effect of covid-19 as per exponential growth & compared how the graph resulted in the case of real data by world data organization and in the case of exponential growth.

***Keywords*: Covid-19, Exponential Growth, WHO, Data, Population, Increase Ratio**

MATERIAL AND METHOD:
We collected all covid-19 data fromwww.ourworlddata.org & by using the data, we found how the number of cases increases by the help of exponential growth.
RESULT: The online data are used for observe some notable increase ratio of COVID-19 cases. Finally, it has been concluded that exponential growth does not have any speed.

INTRODUCTION:
The harmful deviation stated to pandemic by World Health organization (WHO) due to as its spreader globally and infected thousands of people day by day. The statistics on COVID–19 virus is taken out from hygiene findings of China, Italy, Korea, USA, and now India. The 1st case in India was reported on 30th January 2020, WHO was a student of Wuhan University, China. Then after day by day that unknown virus was passed from one human being to another through contact. Till now, the number of cases increases exponentially. On 22th March the prime minister of our country shot for unforced Janata curfew which lasted for 14 hours marking the starting of long struggle. as fertility rate and number of cases increases, the World Health organization (WHO) centers for Disease Control & National Health Commission of China takes an instant action to reduce transference and fertility rates , but the action has failed to stop the +ve cases in India as well as other countries.

A very simple way to look out for exponential growth is Robert Thomas Malthusian law. In 1789, he gives the principle on population growth and food production that the population grows exponentially while the food production grows arithmetically. also theorized that the food production will not able to keep up with in human population.

i.e.$\frac{dP}{dt}$=kP

where $\frac{dP}{dt}$ is rate of change of population w.r.t time "t".

Comparing the covid-19 disease with Malthusian law, by considering the number of positive cases grows exponentially while fertility rate grow arithmetically.

In this paper, we will present the number of positive cases as well as graph changes as per real data & as per exponential model from 01-04-2020 to 27-12-2020 by taking 15 days prediction.

MATHEMATICAL MODEL
If we recall the 80th century, Thomas Malthusian was one of the philosophers and economist which states on population and food supply grew in a geometric progression whether the food supply in arithmetic progression.

The basic example of a differential equation is Malthusian law of population growth$\frac{dP}{dt}$=kP

The above differential equation istheoretically expressed as Suppose the number of covid-19 positive cases at a time "t" is "P".Then over a short time interval of duration h from 't' to't+h'.

Approximately the total number of positive cases is bhP , for some constant b or per capita positive rates. Similarly, the number of death rates is approximately μhP .

So the total change in population in short interval of time from 't' to 't+h' is

P(t+h)-P(t) may be approximated by (bh-μh) P(t)

i.e. P(t+h)-P(t) = (bh-μh) P(t)

$\frac{P(t+h)-P(t)}{h}$= (b-μ) P(t) & passage to the limit as h→0

=> $\frac{dp}{dt} =$ (b-μ) P(t)

=>$\frac{dp}{dt} =$ KP(t), for some constants k

Now by integrating on both sides we get

=>$\int \frac{dP}{p(t)} = \int kdt$

=>Ln P = kt +c

=>P(t)= ce^{kt}

GROWTH AS PER REAL DATA

All real data covid-19 comes from the center for system science, engineering (CSSE) at Jhons Hoping university (JHU) & also collected from blavatnik school of government, world bank & united nations.

The number of cases & data set is updated daily wise and also number of +ve cases and deaths is also updated by WHO &others. It is the only cause of long reporting which exists in death and the number of cases in statistics.

Table 1: Impact of COVID-19 on Indian population.

Date	No. of covid-19 cases as per real data	No. of new cases found
01-04-2020	1998	1998
16-04-2020	13430	11432
01-05-2020	37257	23827
16-05-2020	90648	53391
31-05-2020	190609	99961
15-06-2020	343091	152482
30-06-2020	585481	242390
15-07-2020	968877	383376
30-07-2020	1634746	665889
14-08-2020	2525922	891176
29-08-2020	3542733	1016811
13-09-2020	4846427	1303694
28-09-2020	6145291	1298864
13-10-2020	7239389	1094093
28-10-2020	8040203	800818
12-11-2020	8728795	688592
27-11-2020	9351109	622314
12-12-2020	9857029	505920
27-12-2020	10207871	350842

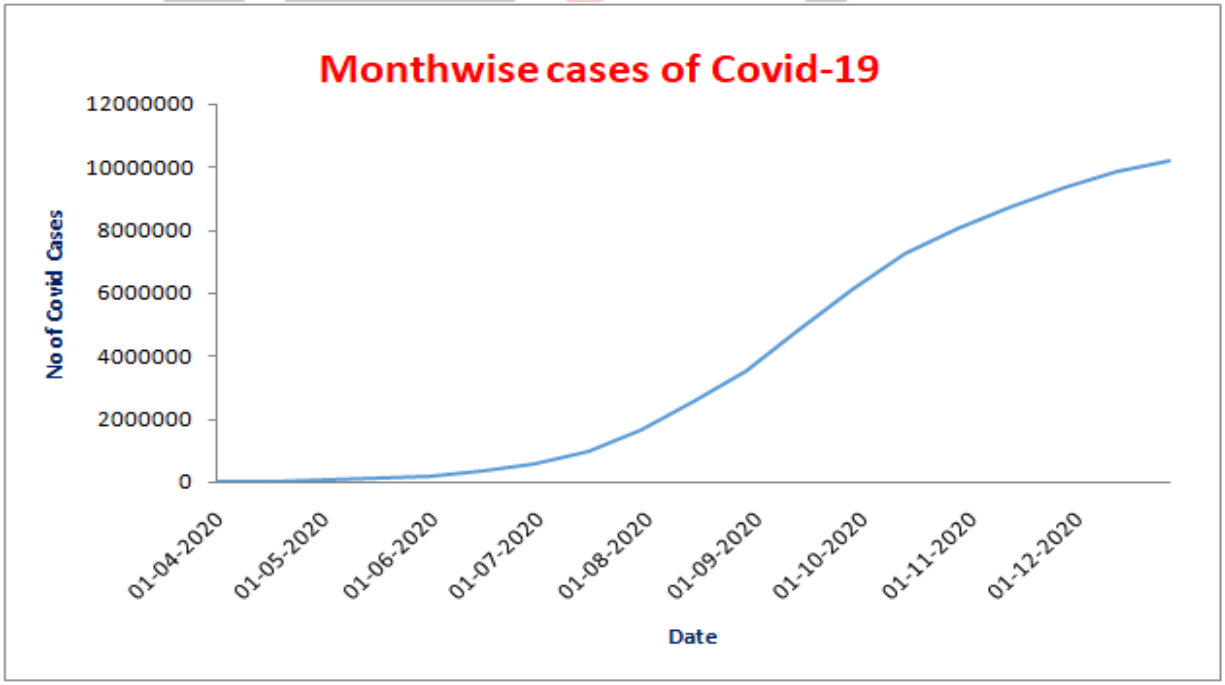

Figure 1: COVID-19 cases as per real data

GROWTH AS PER EXPONENTIAL MODEL

As we know from Malthusian theory of population model is p(t)=ce^{kt}

For finding the number of cases, we take 15 days prediction from 01-04-2020 to 27-12-2020. As per real data, if we take, the initial time is 01-05-2020. Then,

The number of +ve cases before 30 days is 1998

& the number of +ve cases before 15 days is 13430

We know P(t)= ce^{kt}

Before 30 days,P (30) =c e^{-30k}= 1998 ……. (1)

Before 15 days, P (15) =ce^{-15k}= 13430……. (2)

Now dividing equation (2) by equation (1)

=>$\frac{c\, e^{-15k}}{c\, e^{-30k}} = \frac{13430}{1998}$

=>e^{15k}=6.7217

=>15k = log (6.7217)

=>15k = 0.8274

=>K = 0.05516

From equation (2) ce^{-15k}= 34863

=>c $e^{-15(0.05516)}$= 13430

=>c (0.437149) = 13430

=>c = 30721.79

from P(t) = ce^{kt}

=>P(t) = 30721.79× $e^{(0.05516)t}$ ……. (3)

=>Then, the +ve cases after 15 day is,

=>P (15) = 30721.79× $e^{(0.05516)15}$

=>P (15) = 30721.79× 2.287363

=>P (15) = 70270.1050

So, the +ve case after 15 day (or) on 16-05-2020is 70270

Similarly, +ve case on 31-05-2020 is160733

+ve case on 15-06-2020 is 367655

+ve case on 30-06-2020 is 840961

+ve case on 15-07-2020 is 1923586

+ve case on 30-07-2020 is 4399941

+ve case on 14-08-2020 is 10064266

+ve case on 29-08-2020 is 23020639

+ve case on 13-09-2020 is 62656578

+ve case on 28-09-2020 is 120444754

+ve case on 13-10-2020 is 275500978

+ve case on 28-10-2020 is 630170980

+ve case on 12-11-2020 is 1441430325

+ve case on 27-11-2020 is 3297075626

+ve case on 12-12-2020 is 7541611619

+ve case on 27-12-2020 is 17250409837

Table 2: Impact of COVID-19 on Indian population as per exponential growth.

Date	No. of covid-19 cases as per exponential growth	No. of new cases found
01-04-2020	1998	1998
16-04-2020	13430	11432
01-05-2020	30721	17291
16-05-2020	70270	39549
31-05-2020	160733	90463
15-06-2020	367655	206922
30-06-2020	840961	473307
15-07-2020	1923586	1082625
30-07-2020	4399941	2476355
14-08-2020	10064266	5666325
29-08-2020	23020639	12956373
13-09-2020	62656578	29635939
28-09-2020	120444754	67788176
13-10-2020	275500978	155056224
28-10-2020	630170980	354670002
12-11-2020	1441430325	811259345

27-11-2020	3297075626	1855645301
12-12-2020	7541611619	4244535993
27-12-2020	17250409837	9708798218

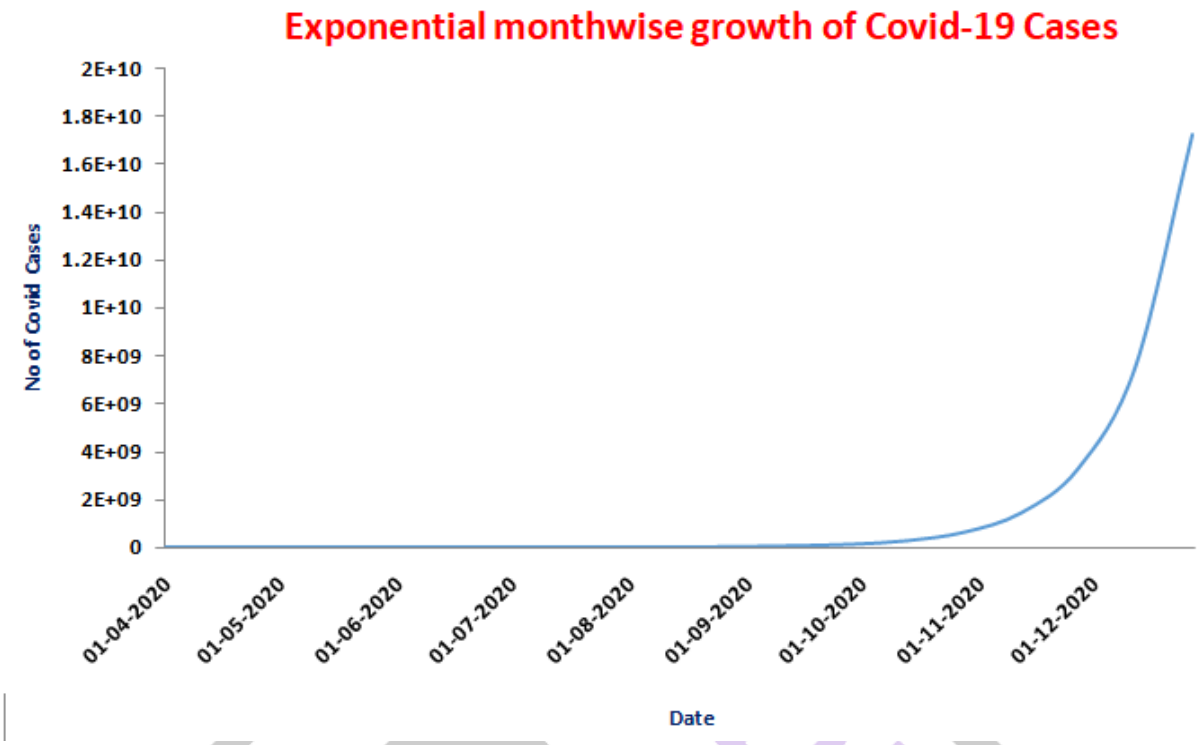

Figure 2: COVID-19 cases as per exponential growth.

COMPARING THE EXPONENTIAL GROWTH WITH REAL DATA

As previously, we have learned about exponential growth, which is taken out the synonyms for fast/speed growth. Now we will see in this project that exponential growth does not have speed. For better understanding exponential growth, let us take an example of predators and pray organism, where the predator is an organism which eats the pray organism & pray is an organism which predator eats. The number of predators increases as it ate pray organism & the number of pray organism decreases. after some interval of time, the predator organism will have less food to eat & start die out, which assigned the prey organism to live in doubling time.

Table 3: comparing real data & exponential growth data

Date	cases as per real data	No. of new cases found	cases as per exponential growth	No. of new cases found
01-04-2020	1998	1998	1998	1998
16-04-2020	13430	11432	13430	11432
01-05-2020	37257	23827	30721	17291
16-05-2020	90648	53391	70270	39549
31-05-2020	190609	99961	160733	90463
15-06-2020	343091	152482	367655	206922
30-06-2020	585481	242390	840961	473306
15-07-2020	968877	383376	1923586	1082625
30-07-2020	1634746	665889	4399941	2476355
13-08-2020	2525922	891176	10064266	5666325
28-08-2020	3542733	1016811	23020639	12956373
13-09-2020	4846427	1303694	62656578	29635939
28-09-2020	6145291	1298864	120444754	67788176
12-10-2020	7239389	1094093	275500978	155056224
27-10-2020	8040203	800814	630170980	354670002
12-11-2020	8728795	688592	1441430325	811259345
27-11-2020	9351109	622314	3297075626	1855645301
12-12-2020	9857029	505920	7541611619	4244535993
27-12-2020	10207871	350842	17250409837	9708798218

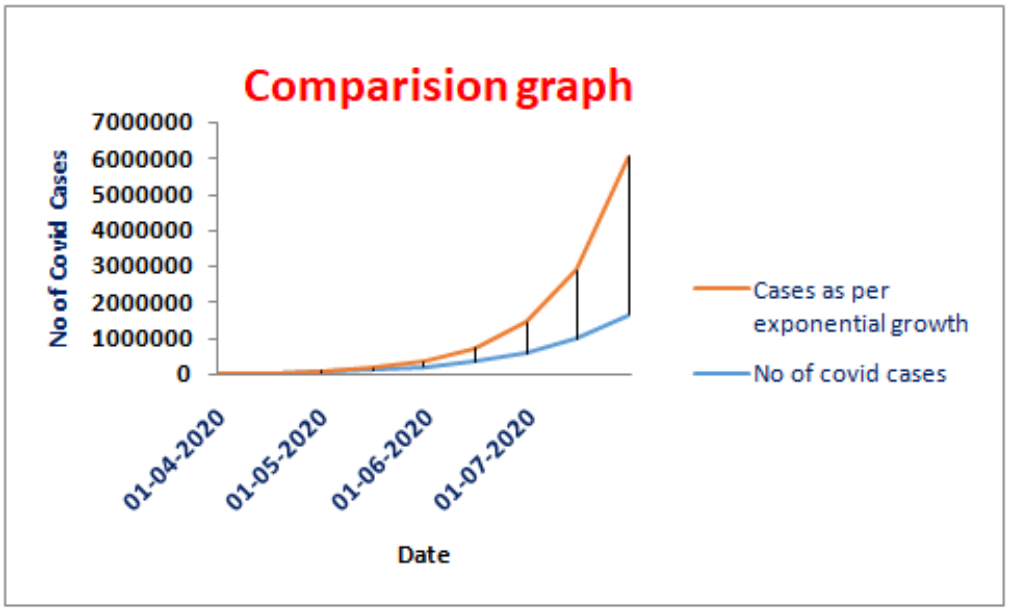

Figure 3: comparing real data & exponential growth data of COVID-19

CONCLUSION

In conclusion, the above studies lays out a technique for studying the behavior of a number of cases with exponential growth. Previously we know the synonym of exponential growth is aggressive or fast, finally, we concluded that exponential growth does not have any speed or fast.

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