Mathematical Model forAnalysis of COVID-19 Outbreak using VON Bertalanffy Growth Function (VBGF)

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Abstract: The massively increased cases of Covid-19 have caused a major issue to the world and have raised noteworthy health concerns to the society across the glove. Two hundred ten countries and territories including many developing countries are facing limitless burden due to this infectious diseases. Every day we are witnessingincreasing number of reporting cases.So development of an expectation model can help to identify the outbreak sequence. This paper givers a concise idea and outlines a mathematical model using von Bertalanffy growth function (VBGF) to Forecasting of Covid-19 outbreak and analysing of details of parameters which will help other researchers to understand and determine the epidemic trend of the outbreak which can further be used for, country readiness, infection prevention, control and risk communication, and also readiness for clinical management.In this mathematical modelling, we translate those factors into the language of mathematics to make scientific understanding more clearly.

Keywords: Covid-19; Corona virus; Von Bertalanffy growth function (VBGF);Transmission Mechanism of Covid-19;Mathematical Modelling

1. Introduction

As per World Health Organisation, Corona viruses(Covid-19) are a large family of viruses that have been identified since year 1965. This outbreak, emerged in Wuhan city of China in the December 2019 and has claimed more than 3.6 million cases with 0.25 million death as of 5thMay 2020 and it shows an exponential growth in the number affected and death cases around the globe and give rise to a huge threat to global public health. A novel corona virus is a new strain of corona virus that has not been previously identified in human body. Corona viruses (CoV) are a large family of viruses transmitting between animals and people that cause illness ranging from the common cold to more severe diseases such as Middle East respiratory syndrome (MERS-CoV) and severe acute respiratory syndrome (SARS-CoV) [1]. Reports suggest that 2019-nCoV infection can cause mild to severe disease and be fatal in some. Common observed symptoms are fever, cough, shortness of breath and breathing difficulties.[6] In more severe cases, infection can cause pneumonia or severe acute respiratory syndrome, particularly in those with other chronic underlying health conditions, and even death [2-4].

As Covid-19 is a new disease so forecasting of outbreak and analysing of details of parameters is really a difficult challenge. Based on the mathematical modeling, this paper studies rate of positive cases by using The von Bertalanffy growth function (VBGF) , rate of recover cases and the rate of negative cases related to the outbreak of Corona Virus Disease 2019 (Covid-19).[9-10]The von Bertalanffy growth function (VBGF) which is used to find the rate of Positive cases is based on a bioenergetics expression of fish growth. And is a type of growth curve model for a time series and is named after Ludwig von BertalanffyIn India only those underlying Cases that are susceptible to Covid-19 infection have been tested, who have travelled from affected countries or geographical area,come in contact with a confirmed positive cases and shown symptoms after two weeks of quarantine. According to the transmission characteristics of covid-19 at different stages in our model we considered the parameters like the total number of sample tested(T), the total number of non-vulnerable Cases(T_N), the underlying Cases that are susceptible to infection(T_S), vulnerable cases(reported total cumulative count of detected) or clinically confirmed positive cases(T_V), transmission Rate(R_0), the total number of Recovered cases after clinical treatments(T_R), the coefficient of infection(A), the rate of predation of the vulnerable cases(β), rate of recovered cases from the vulnerable cases(γ) etc.[6]

2. Literature Review

According to Cao, J., Jiang, X., & Zhao, B. in Mathematical modelling and epidemic prediction of Covid-19 and its significance to epidemic prevention and control measures outlines the early stage of the Covid-19 propagation, it is difficult to establish a dynamic propagation model with parameters to be estimated and obtain fairly accurate simulation results, but the preliminary estimation of parameters such as average latency and mortality through existing data may be helpful for solving important parameters such as infection rate and rehabilitation rate, which will help us have a more accurate grasp of the transmission trend of COVID-19.[7]On the other hand, statistical modelling of the spread of new coronavirus pneumonia in the population based on time series analysis is a thing that can be done immediately after getting the latest data every day, because the dynamic model of the time series is based on the law of the data itself.[7][8]COVID, C., Chow, N., Fleming in their Research paper Preliminary Estimates of the Prevalence of Selected Underlying Health Conditions Among Patients with Coronavirus Disease 2019 presents a analysed reports from China and Italy suggest that risk factors for severe Covid-19 disease include underlying health conditions and also describing underlying health conditions among U.S. Covid-19 patients.[1]Camacho, A., Kucharski, A., Aki-Sawyerr compiled data from daily situation reports of Ebola from Sierra Leone and fitted an EVD transmission model to these reports to estimate how the reproduction number changed in different parts of the country from August 2014 to January 2015. They also analyse and suggests that the epidemic is peaking in Sierra Leone, particularly in the more heavily populated Western Area, and that the reproduction number is currently close to or below the epidemic control threshold of R=1. [2][9]

3. Ontology

3.1. Test Cases or Total Number of Sample Tested.

It is one of our most important tools/process in the fight with Covid-19 and to slow and reduce the spread and impact of the virus. Tests allow us to identify Non-vulnerable Cases, Susceptible Cases,Positive cases or vulnerable cases after clinical identification [5-6].

3.2. Non-vulnerable Cases

The test negative cases or after clinical treatment the recovered cases from the vulnerable category and having no symptom of COVID-19 infections are called as Non-vulnerable Cases.

3.3. Susceptible Cases

The Susceptible case are the cases that exposed to Covid-19and help in transmission of infection. Some Susceptible Cases which are exposed to Covid-19and affected and carried out transmission is called vulnerable cases and some are exposed but still they cannot help in transmission of infection. Some cases are the Recovered and Discharged after successful clinical treatment as shown in Figure-1[5].

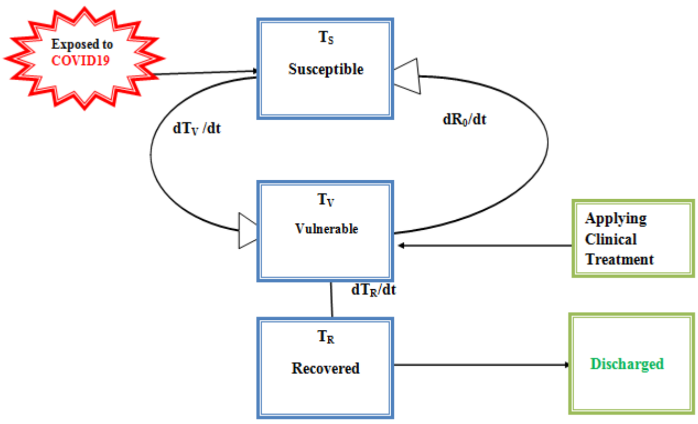

Figure-1: Susceptible-Vulnerable-Recovery cases

3.4. Positive cases orVulnerable cases :

These are the cases that can be exploited by Covid-19 i.e. thereported total cumulative count of detected and laboratory (and sometimes, depending on the country reporting them and the criteria adopted at the time, also clinically) confirmed positive and sometimes - depending on the country reporting standards - also presumptive, suspect, or probable cases of detected infection. So

The total Active Cases = Total cases–Total recovered Cases - Total deathscases[6]

3.5. Transmission Rate:

The attack rate *or* transmissibility (how rapidly the disease spreads) of a virus is indicated by its reproductive number (Ro, pronounced R-nought *or* r-zero), which represents the average number of people to which a single infected person will transmit the virus.

3.6. Recovered cases

These are the Recovered and Discharged case after successful clinical treatment.This statistic is highly important for Covid19 treatment. The total recovered Cases = Total cases - Active Cases - total deaths [6, 7]. The recover cases are the subset ofvulnerable cases. After successful recovery from the Covid-19infection it is recommended to check the symptoms resolve successfully and two negative tests conforms within 24 hours or symptoms resolve and additional 14 days isolations as directed.[6] But after the recovery if again the recover case is exposed to Covid-19then the case can be susceptible case and may help in transmission of infection as shown in Figure-2

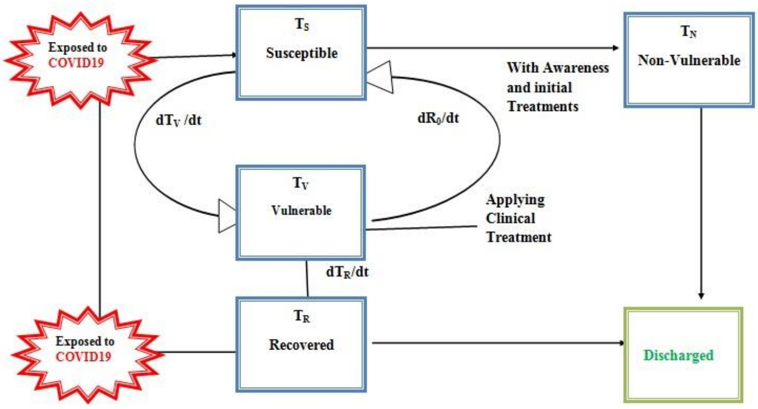

Figure-2: Susceptible-Vulnerable-Recovery-Susceptible cases

3.7. Infection outbreak

An outbreak is when an illness happens in unexpected high numbers. It is the occurrence of cases in excess of normal expectancy. The number of cases varies according to the disease-causing agent, and the size and type of previous and existing exposure to the agent.Infection outbreaks are usually caused by an infection, transmitted through person-to-person contact, animal-to-person contact, or from the environment or other media. Outbreaks may also occur following exposure to chemicals or to radioactive materials.An outbreak can last for days or years.[6][8]

3.8. Rate of positive cases

Rate of positive cases R_0 is the ratio between the total number of affected positive cases or vulnerable cases to the underlying Cases that susceptible to infection that can be made per cases with transmission rate R_0. This is the rate which gives the number of newly infected people from a single case. The average positive rate is the difference of total susceptible case to total negative cases in a day.A number of groups have estimated the positive rate for Covid-19 to be somewhere approximately between 1.5 and 5.5. [6]

3.9. Rate of Negative Cases

The test negative cases rate is the ratio between total number of negative cases to the total number of test conducted. Test negative cases must be approaching to the total number of test conducted.

3.10. Rate of Recover Cases

The total recovered Cases = Total cases - Active Cases - total deaths. So the rate of Recovery is ratio between the total recovery cases in cumulative to total number of affected positive cases.[6]

3.11. Rate of Death Cases

Total Deaths cases is the cumulative number of deaths among detected positive cases.[6]

4. Methodology

4.1. Von Bertalanffy Growth Model

Bertalanffy model is one of the interesting dynamics in the biological world. The von Bertalanffy growth function (VBGF), or von Bertalanffy curve, is a type of growth curve model for a time series and is named after Ludwig von Bertalanffy.[10]It has been used to analyse somatic growth data in a wide range of studies. Although variations in the growth rate influenced by extrinsic environmental fluctuations have been examined in many studies. It is now commonly put into practice to partially re-parameterize the VBGF parameters to avoid their co-variation and to ensure statistical accuracy [10-12].The Von Bertalanffy Growth Function (VBGF) is based on a bioenergetics expression of fish growth. And is a type of growth curve model for a time series and is named after Ludwig von Bertalanffy. It is a special case of the generalised logistic function. The growth curve is used to model mean length from age in animals. The function is commonly applied in ecology to model and study the fish growth.

The model can be written as the following:

$$L(a) = L_{\infty}\left(1 - e^{-K(a-a0)}\right)$$

where a is age, k is the growth coefficient, a0 is a value used to calculate size when age is zero, and L_{∞} is asymptotic size.

Hence this gives the solution of the linear differential equation:

$$\frac{\partial L}{\partial a} = K(L_{\infty} - L)$$

The development of infectious diseases is similar to the growth of individuals and populations. In this paper, the derived equation is in the form of Bertalanffy growth function and it is used to describe the factors that control and affect the spread of Covid-19.[12]

5. Mathematical model for Covid-19Outbreak Analysis

Mathematical modelling and the identification of Transmission Mechanism are very important tools in Covid-19 with identification of at-risk population, and the evaluation of interventions. Infectious disease prediction models mainly include differential equation based on prediction dynamics. There are more specific challenges to such analyses, particularly in real time environment. This model outlines a mathematical formulation based on the collected epidemic data, using von Bertalanffy growth function (VBGF) for Forecasting of Covid-19 outbreak and analysing of details of parameters[12-18]

5.1. ModellingParameters

T	The total number of sample tested for Covid-19
T_N	The total number of non-vulnerable Cases
T_S	The underlying Cases that are susceptible to infection
T_V	The total number of infected positive cases or vulnerable cases(reported total cumulative count of detected) or clinicallyconfirmed positive cases
R_0	Transmission Rate i.e. the number of newly infected people from a single case /The number of infection outbreak by the individual $T_v(T_{v1} + T_{v1} + T_{v1}$ ......)
T_R	The total number of Recovered cases after clinical treatments.
A	The coefficient of infection i.e. $T_V$per R_0
K	The total number of cases that can be made per T_S vulnerable with Transmission Rate R_0 during the period
α	Coefficient of intraspecific competition
β	The rate of predation of the vulnerable cases.
γ	Rate of recovered cases from the vulnerable cases.
dR_0/dt	Growth rate of infection outbreak by the individual T_V
dT_V/dt	Growth rate of positive cases i.e. vulnerable cases

5.2. The Growth model

Let

1. The total number of sample tested(T) for COVID-19 a function of T_N and T_S so
$$T = f(T_N, T_S) \quad (1)$$
2. The total number of affected positive cases or vulnerable test cases is a function of T_S and R_0 so
$$T_V = f(T_S, R_0) \quad (2)$$

The equation-2 can be written as the partial differential equation of the from

$$\frac{\partial T_V}{\partial T_S} = f_1(T_S, R_0) \quad (3)$$

or

$$\frac{\partial T_V}{\partial R_0} = f_2(T_S, R_0) \quad (4)$$

But from the above two equation the equation 3 has more probability of getting the value of T_S, and R_0 ,asR_0 is a part of T_S i.e. the underlying Cases that are susceptible to infection.If Transmission Rate(R_0) i.e. the number of newly infected people from a single case /The number of infection outbreak by the individualcan generate a total R_0K number of affected positive cases or vulnerable cases and $\frac{\partial T_V}{\partial T_S}$diminishes gradually as ∂T_V approaches maximum number and can affected to all the susceptible cases .

Hence

$$\frac{\partial T_V}{\partial T_S} = R_0 A(R_0 K - T_V) \quad (5)$$

Where A is the coefficient of attack i.e. $T_V$per R_0 .If the value of A is larger, then the value of $\frac{\partial A}{\partial R_0}$ will be larger. So it is very difficult to predict the transmissibility rate(how rapidly the disease spreads). But if the value of R_0 i.etransmissibility rate will increase than the value of $\frac{\partial A}{\partial R_0}$ must decrease in a inverse ratio to R_0. The Figure 3 shown below is an example of Transmission Rate i.e. the number of newly infected people from a single case /The number of infection outbreak by the individual T_v (T_{v1} + T_{v1}+ T_{v1} ......) if each infected people can spread to two more and so on.From research it is estimated R_0 for Covid-19 be somewhere between 1.5 and 5.5. Most modelling simulations that project future cases are using R_0s in this range.

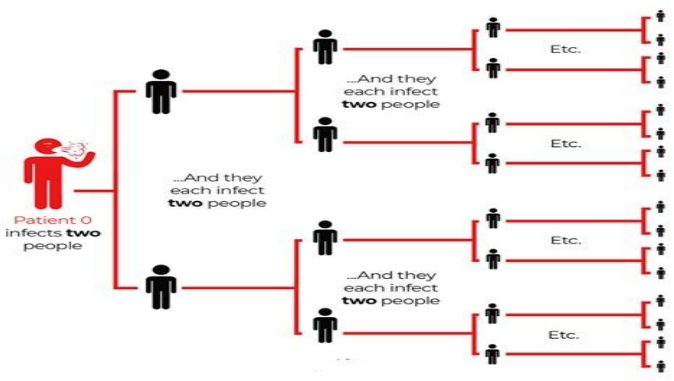

Figure-3:The number of infection outbreak by the individual with spread R_0=2

So the equation can be represented as

$$\frac{\partial A}{\partial R_0} = -b\,\frac{A}{R_0} \quad (6)$$

or

$$A = aR_0{}^{-b} \qquad (7)$$

Where $a$and$b$ are constant value. Substituting the value of A from equation 7 in equation 5, we have

$$\frac{\partial T_V}{\partial T_S} = R_0 a R_0{}^{-b}(R_0 K - T_V) \qquad (8)$$

$$\frac{\partial T_V}{R_0 a R_0{}^{-b}\ (\ R_0 K - T_V)} = \partial T_S$$

Or

$$\frac{\partial T_V}{(\ R_0 K - T_V)} = \partial T_S . R_0 a R_0{}^{-b} (9)$$

Now by integrating both side of equation 9

$$\int \frac{\partial T_V}{(\ R_0 K - T_V)} = \int \partial T_S . R_0 a R_0{}^{-b}$$

Or

$$\int \frac{\partial T_V}{(\ R_0 K - T_V)} = \int \partial T_S . a . R_0{}^{(1-b)}$$

Or

$$\int a . R_0{}^{(1-b)}\, \partial T_S = \int \frac{\partial T_V}{(\ R_0 K - T_V)}$$

and finally we have

$$a . R_0{}^{(1-b)} T_S = \frac{1}{R_0 K} \int \frac{\partial T_V}{(\ 1 - \frac{T_V}{R_0 K})} \qquad (10)$$

Let $(1 - \frac{T_V}{R_0 K}) = x$

Then

$$\frac{\partial x}{\partial T_V} = \frac{1}{R_0 K} \int \frac{-dx . R_0 K}{x} = -\ln x$$

Or

$$a . R_0{}^{(1-b)} T_S = -\ln\,(1 - \frac{N_A}{R_0 K})$$

$$\ln\left(1 - \frac{N_A}{R_0 K}\right) = -a . R_0{}^{(1-b)} T_S$$

Or

$$1 - \frac{T_V}{R_0 K} = e^{-a . P^{(1-b)} T_S}$$

So finally we obtain

$$T_V = R_0 K \left(1 - e^{-a . T_S . R_0{}^{(1-b)}}\right) (11)$$

Finally,we got the equation (11) in the form of Bertalanffy model. This model is one of the interesting dynamics in the biological world often used as a growth model to study the parameters that control and accelerate the growth. It is used to describe the growth characteristics of fish. Other species can also be used to describe the growth of animals, such as pigs, horses, cattle, sheep, etc. and other infectious diseases. The development of infectious diseases is similar to the growth of individuals and populations. In this paper the derived equation is in the form of Bertalanffygrowth function and is used to describe the factors that control and affect the spread of Covid-19.

So the number of affected positive cases or vulnerable casesT_V depends upon the underlying cases that susceptible to infectionT_S,transmission RateR_0 and the total number of infection cases K. In the previous equation (11) by taking *a* and*b* as constant values. Some assumptions can be considered as follows

1. *The value of affected positive cases T_V depends on R_0 and T_S with the changing value of K.*
2. *The value of K can be variable subject to the value of $T_S$and R_0 or remain constant.*
3. *If the value of K remains fixed then depending on the value of a andb then the value of affected positive cases T_V can be predicted with the values ofT_S&R_0.*
4. *The number of affected positive cases $T_V$should not be greater or exceed the susceptible cases T_S. as per Figure-1*

It is estimated R_0 for Covid-19 be somewhere between 1.5 and 5.5. Now to calculate transmission RateR_0, it is important to choose the values *a*, *b*.From the previous equation(11), as we observe for$T_V = \lim_{R0 \to \infty} f(T_V, R_0)$, and the values of *a* and*b* depending on the value of *K*.

If the value of *a* and *b* are

(a) *a = 1* & *b = 1 then* *affected positive cases or vulnerable cases$T_V \to \infty$*

(b) *a =2* & *b = 2 then* *affected positive cases or vulnerable cases$T_V \to 2K\ T_S$,*

Depend on the value of K.

(c) *a> 2* & *b> 2, then* *affected positive cases or vulnerable cases$T_V = 0$*

In the above 3 cases If the value of *a* and*b* are 1 and greater than 2 then it is very difficult to find the value underlying cases that susceptible to infectionT_S, transmission RateR_0. And If the value of *a* and *b* is 2 then

$$T_V = a\ K\ T_s \quad (12)$$

So finally by putting the values for constant a=2 and b=2 , the new value of T_V is

$$T_V = R_0 K\left(1 - e^{\frac{-2T_S}{R_0}}\right) \quad (13)$$

And by solving for Ts from the above equation we get

$$T_S = -\frac{1}{2} R_0 . Ln(R_0 K - T_V) \quad (14)$$

And by putting the new value of susceptible cases T_S, for$T_V$we have

$$T_V = R_0 K(1 - e^{\frac{-2(-\frac{1}{2}R_0 . Ln(R_0 K - T_V))}{R_0}})$$

Or

$$T_V = R_0 K - {R_0}^2 K^2 + R_0 K . T_V$$

Consequently

$${R_0}^2 K^2 - R_0 K . T_V - R_0 K + T_V = 0$$

$${R_0}^2 K^2 - R_0(K(T_V + 1) + T_V = 0 \quad (15)$$

And by solving the above equation the value $\mathbf{R_0}$is

$$\mathbf{R_0} = \left(\frac{(T_V + 1)}{2K}\right) \pm \left(\frac{(T_V - 1)}{2K}\right) \quad (16)$$

Where $\mathbf{R_0}$ has two values$\frac{T_V}{K}$and $\frac{1}{K}$.

Hence the final acceptable value of $\mathbf{R_0}$is $\frac{T_V}{K}$as $\mathbf{T_V} = \boldsymbol{f}(\mathbf{T_S}, \mathbf{R_0})$

So $\mathbf{R_0}$ is the ratio between the total number of affected positive cases or vulnerable cases to the underlying Cases that susceptible to infection that can be made per cases with transmission rate$\mathbf{R_0}$.

$$\mathbf{R_0} = \frac{\textbf{(The total number of affected positive cases or vulnerable cases)}}{\textbf{The total number of infection cases that can be made per } \mathbf{T_V} \textbf{ vulnerablewith Transmission Rate}\mathbf{R_0}\textbf{during the period}}$$

So the Rate of Positive *or* transmissibility (how rapidly the disease spreads) of a virus is indicated by its reproductive number (Ro, pronounced R-nought *or* r-zero),[6] which represents the average number of people to which a single infected person will transmit the virus. So the analysis of different parameters can help in future prediction and forecasting. The values of the parameters are formulated and represented in Table-1 as follows.

Table-1: Formulations of the modelling parameters

Parameters	Explanation	Formulations
T	The total number of sample tested for Covid-19	$T= T_N + T_V$
T_N	The total number of non-vulnerable Cases	$T_N=T- T_V$
T_S	The underlying Cases that are susceptible to infection	$\mathbf{T_S = -\frac{1}{2} R_0 . Ln(R_0 - T_V)}$
T_V	The total number of infected positive cases orvulnerable cases(reported total cumulative count of detected) or clinically confirmed positive cases	$T_V = R_0 K - R_0{}^2 K^2 + R_0 K . T_V$
R_0	Transmission Rate i.e. the number of newly infected people from a single case /The number of infection outbreak by the individual T_v (T_{v1} + T_{v1}+ T_{v1} ......)	$R_0 = \frac{T_V}{K}$
T_r	The total number of Recovered cases after clinical treatments.	Recovered Cases(T_r) = T_V - Active Cases - total deaths.
A	The coefficient of infection i.e. $T_V$per R_0	$A = aR_0{}^{-b}$
α	Coefficient of intraspecific competition	Coefficient of intraspecific competition
β	The rate of predation of the vulnerable cases.	The rate of predation of the vulnerable cases
γ	Rate of recovered cases from the vulnerable cases.	Rate of recovered cases from the vulnerable cases.
dR_0/dt	Growth rate of infection outbreak by the individual T_V	$\frac{dR_0}{dt} = R_0(\alpha - \beta T_S)$
dT_V /dt	Growth rate of positive cases ie vulnerable cases	$\frac{dT_S}{dt}$=-T_S $(\gamma\text{-}\delta R_0)$

6. Simulation

In India only those underlying Cases that are susceptible to Covid-19 infection have been tested, who have travelled from affected countries or come in contact with a confirmed positive cases and shown symptoms after two weeks of quarantine. So the number of affected positive cases or vulnerable cases depends upon the underlying cases that susceptible to infection transmission Rate and the total number of infection cases K. This section outlines and analyse the formulated parameters. Here we have used a detailed Covid-19 dataset of one of the state from India i.e. Odisha. It is a day's wise information related to Date, Total test cases, Total positive cases, Cumulative positive cases, Recovered cases, cases, Rate of Positive, Rate of recovered, Rate of negative, Cumulative death cases etc. from(21st March2020 to 30th April2020).

7. Dataset

Table-2: Properties of Dataset

	Days	Total_Test_Cases	Cumulative_test	Total_Positive_Cases	Cumulative_Positive	Cumulative _Active	Recovered_Cases	Total_Death_cases	Rate_Positive	Rate_recovery	Rate_negative

count	41.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00	41.00
mean	21.00	833.65	8185.95	3.487	49.53	34.75	14.07	0.58	1.06	18.10	98.93
std	11.97	880.45	10004.71	4.94	41.88	27.32	14.66	0.49	0.63	15.47	0.63
min	1.00	23.00	61.00	0.00	2.00	2.00	0.00	0.00	0.40	0.00	96.72
25%	11.00	137.00	610.00	0.00	4.00	4.00	0.00	0.00	0.55	0.00	98.56
50%	21.00	315.00	3549.00	1.00	50.00	38.00	12.00	1.00	0.89	22.22	99.10
75%	31.00	1197.00	11748.00	5.00	79.00	50.00	25.00	1.00	1.43	32.14	99.44
max	41.00	2588.00	34133.00	19.00	143.00	101.00	41.00	1.00	3.27	39.34	99.59

According to the data set the Susceptible underlying Cases (Total Test Casesday wise and Cumulative test cases) are exposed to Covid-19 infection and have been testedclinically.[6] Out of the total test cases some cases that exposed to Covid-19 and help in transmission of infection are considered as Test positive caseswhich are exposed to Covid-19 are affected and carried out transmission.

Some susceptible cases are exposed but still they cannot help in transmission of infection are called as Test negative cases. The test cases are increases in an exponential manner and it's very clear from the graph that if the number of test cases are increasing more than it is easier to identify the total positive cases in due time so that necessary actions can be taken. Figure 4 represents the total susceptible cases and its growth day wise and cumulative.

The test negative cases are the cases which exposed to Covid19 i.e. susceptible but not affected and non transmission category or after clinical treatment the recovered cases from the vulnerable category and having no symptom of Covid-19infections are also called as Non-vulnerable Cases.[6] The growth rate of negative test cases are as shown in Figure-5. Which reflects that the total test negative cases per day are more than 95%.

Table-3: Properties of Dataset

SL No	Date(2020)	Total_Test_Cases	Cumulative_test	Total_Positive_Cases	Cumulative_Positive	Cumulative_Active	Recovered_Cases	Total_Death_cases	Rate_Positive	Rate_recovery	Rate_negative
1	21st March	61	61	2	2	2	0	0	3.27	0	96.72
2	22nd March	24	85	0	2	2	0	0	2.35	0	97.64
3	23rd March	25	110	0	2	2	0	0	1.81	0	98.18
4	24th March	23	133	0	2	2	0	0	1.50	0	98.49
5	25th March	31	164	0	2	2	0	0	1.21	0	98.78
6	26th March	25	189	1	3	3	0	0	1.58	0	98.41
7	27th March	37	226	0	3	3	0	0	1.32	0	98.67
8	28th March	71	297	0	3	3	0	0	1.01	0	98.98
9	29th March	73	370	0	3	3	0	0	0.81	0	99.18
10	30th March	103	437	0	3	3	0	0	0.68	0	99.31
11	31st March	137	610	1	4	4	0	0	0.65	0	99.34
12	1st April	290	900	1	5	5	0	0	0.55	0	99.44
13	2nd April	213	1113	0	5	4	1	0	0.44	20	99.55
14	3rd April	282	1395	15	20	18	2	0	1.43	10	98.56
15	4th April	304	1699	1	21	19	2	0	1.23	9.52	98.76

16	5th April	189	1888	18	39	36	2	0	2.06	5.12	97.93
17	6th April	302	2190	1	40	37	2	0	1.82	5	98.17
18	7th April	251	2441	2	42	39	2	1	1.72	4.76	98.27
19	8th April	400	2841	0	42	39	2	1	1.47	4.76	98.52
20	9th April	453	3249	6	48	45	2	1	1.47	4.16	98.52
21	10th April	300	3549	2	50	37	12	1	1.40	24	98.59
22	11th April	315	3862	4	54	41	12	1	1.39	22.22	98.60
23	12th April	308	4170	0	54	36	18	1	1.29	33.33	98.70
24	13th April	564	4737	2	56	37	18	1	1.18	32.14	98.81
25	14th April	803	5537	4	60	41	18	1	1.08	30	98.91
26	15th April	1197	6734	0	60	41	19	1	0.89	31.66	99.10
27	16th April	843	7577	0	60	41	19	1	0.79	31.66	99.20
28	17th April	1042	8619	0	60	40	21	1	0.69	35	99.30
29	18th April	1071	9690	1	61	38	24	1	0.62	39.34	99.37
30	19th April	954	10644	7	68	43	24	1	0.63	35.29	99.36
31	20th April	1104	11748	11	79	53	25	1	0.67	31.64	99.32
32	21st April	2027	13775	3	82	51	30	1	0.59	36.58	99.40
33	22nd April	2209	15984	1	83	50	32	1	0.51	38.55	99.48
34	23rd April	2474	18458	7	90	56	33	1	0.48	36.66	99.51
35	24th April	2141	20599	4	94	60	33	1	0.45	35.10	99.54
36	25th April	2217	22816	9	103	68	34	1	0.45	33.00	99.54
37	26th April	2287	25103	5	108	72	35	1	0.43	32.40	99.56

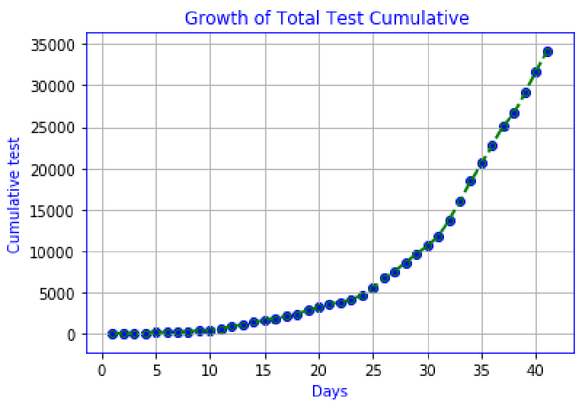

Figure-4 : Growth of Cumulative test conducted(21st March2020 to 30th April2020).

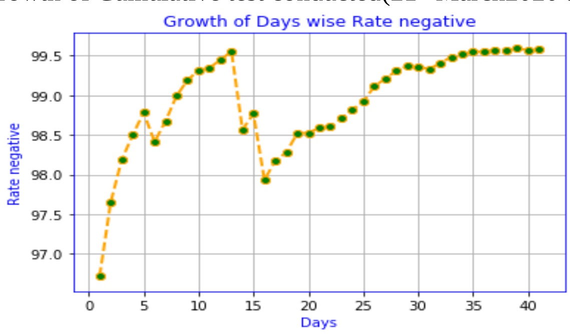

Figure-5: Growth of Days wise Negative Cases(21st March2020 to 30th April2020).

The test Positive cases or vulnerable cases arethe cases that can be exploited by Covid-19 i.e.the reported total cumulative count of detected and laboratory (and sometimes, depending on the country reporting them and the

criteria adopted at the time, also clinically) confirmed positive cases. And sometimes it depending on the country reporting standards and also presumptive, suspect, or probable cases of detected infection.[6][8]
Figure-6 & 7 represents the growth of Cumulative Positive test cases and Positive test cases day wise. As the Covid-19 is a new disease so the positive cases are also increasing in an exponential manner throughout the world as there is no clinically conform treatments available till now.

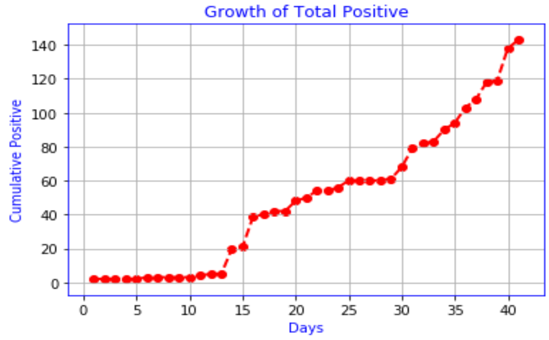

Figure-6: Growth of Cumulative Positive Cases(21st March2020 to 30th April2020).

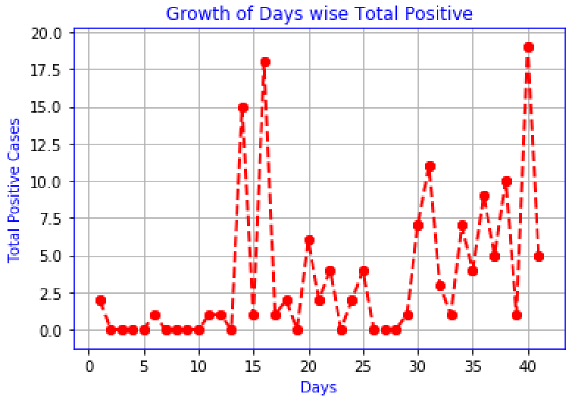

Figure-7: Growth of Day wise Positive Cases(21st March2020 to 30th April2020).

The total Active Cases = Total cases – Totalrecovered Cases - Total deaths cases. And The total recovered Cases = Total cases - Active Cases - total deaths.[6] The recover cases are the subsetofvulnerable cases. After successful recovery from the Covid-19 infection it is recommended to check the symptoms resolve successfully and two negative tests conforms within 24 hours or symptoms resolve and additional 14 days isolations as directed.

But after the recovery if again the recover case is exposed to Covid-19 then the case can be susceptible case and may help in transmission of infection. The cumulative growth of total recover case is as shown in figure-8

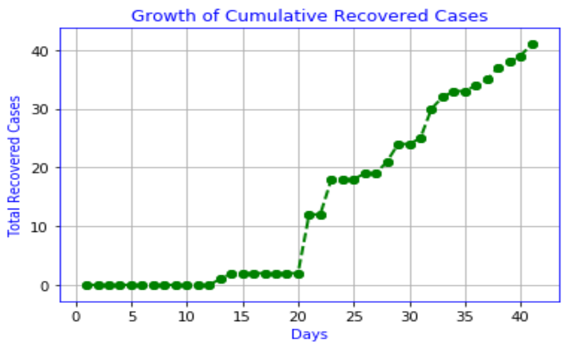

Figure-8: Growth of Cumulative Recover Cases(21st March2020 to 30th April2020).

Rate of positive cases R_0 is the ratio between the total number of affected positive cases or vulnerable cases to the underlying Cases that susceptible to infection that can be made per cases with transmission rate R_0. This is the rate which gives the number of newly infected people from a single case. The average positive rate is the difference of total susceptible case to total negative cases in a day. If the rate of positive cases approaching to zero then it will increase the negative cases and the recover cases. The Figure-9 shows the growth of total positive cases. In the initial the test cases are less and positive cases are corresponding to that and when the number of test cases are more in number and the total positive cases are comparatively less.

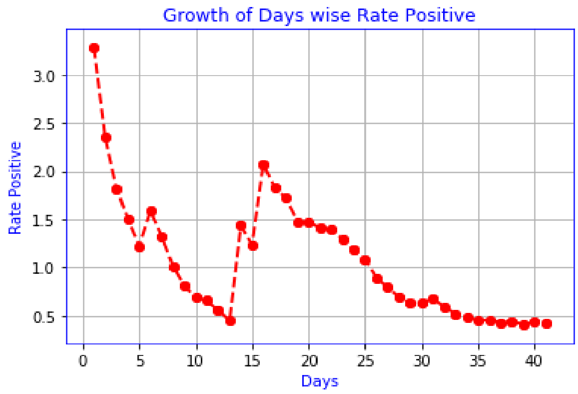

Figure-9: Growth of Rate of positive cases(21st March2020 to 30th April2020).

The rate of recovery depends upon the condition of the patient and clinical treatment. The growth rate of recovery, is shown in Figure-10. And also a comparative representation of rate of Positive, and Recovery cases is shown in Figure-11.

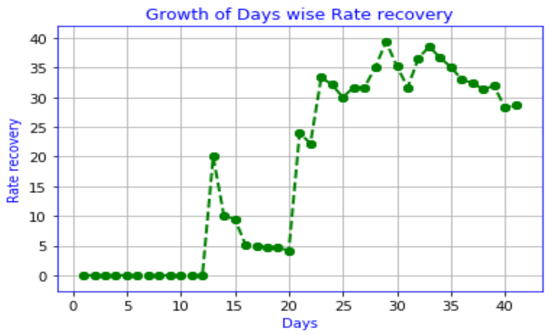

Figure-10: Growth Rate of Total Recover cases (21st March2020 to 30th April2020).

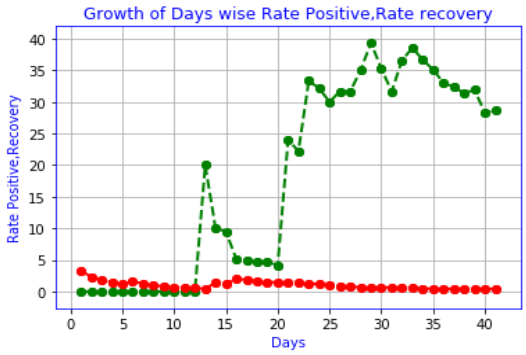

Figure-11: Comparative Growth Rate of Total rate of Positive cases and total Recover cases(21st March2020 to 30th April2020).

8. Conclusion

Mathematical modelling and the identification of Transmission rate is very important tools in Covid-19 management. This paper outlines a mathematical model using von Bertalanffy growth function (VBGF) to Forecasting of Covid-19 outbreak and analysing of details of parameters which will help other researchers to understand and determine the epidemic trend of the outbreak which can further be used for, country readiness, infection prevention, control and risk communication, and also readiness for clinical management. Here we have used a detailed Covid-19 dataset of one of the state from India i.e. Odisha. It is a day's wise information related to Date, Total test cases, Total positive cases,Cumulative positive cases, Recovered cases, cases, Rate of Positive, Rate of recovered, Rate of negative, Cumulative death cases etc. from(21st March2020 to 30th April2020). Assuming that the data used in the data set reliable and that will future continue to predict the rates of propagation of the disease.By simulating the propagation process with date of the conform positive Covid-19 cases, we found that if the total test cases are increases or if more number of tests conducted than it is easier to identify the total positive cases in due time so that necessary actions can be taken. As per the model R_0 is the ratio between the total number of affected positive cases or vulnerable cases to the underlying Cases that susceptible to infection that can be made per cases with transmission rateR_0.and finally if the If the rate of positive cases approaching to zero then it will increase the negative cases and also the recover cases. So the rate of positive cases should be less, than it is easier to identify the transmissions and to take necessary clinical treatments. Test negative cases must be approaching to the total number of test conducted and the total number of recover cases should approach to the total number of conformed positive cases.

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