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COVID-19 Pandemic in Odisha: A model Based Prediction Analysis

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***Abstract*: This is paper of model based prediction analysis predicting the end of covid-19 in the Indian State Odisha based on the real time daily data from 16th March 2020 to 13th June 2020 under certain assumption and limitation. Based on the accuracy of fitting, Cubic model has been selected for prediction and Bailey's principle has been used to get relative removal of the pandemic from Odisha. It has been estimated that corona virus *will end by the middle of August 2020* in Odisha under the assumption and limitation described in this paper.**

***Keywords*: Covid19, Infection, Recovery, Relative Removal Rate, Prediction, Cubic model, Bailey's model, R^2.**

1. Introduction

The novel corona virus COVID-19 was first out broken in Wuhan City of China during the last part of 2019. Now it has been spread all over the world and has affected 213 countries and territories badly by taking the form of pandemic. Its first touch to India was during first month of 2020.The first case of COVID-19 pandemic was confirmed in the Indian state of Odisha on 16th of March 2020.Initially it was confined within the boundary of the state capital and now it has been spread all over the state covering all the 30 districts including rural sector. As on 16th June 2020, the total numbers of confirmed covid cases have crossed 4000 with recovery rate nearly 69 % and the fatality rate is 0.26 %. The economic impact of the pandemic in India is highly disruptive. It has affected badly to the human health and social life. How to control the spread of the pandemic is an urgent issue facing the society at present.

Due to the declaration of lockdown in all over India and the advanced preventive measures taken by Government, the current pandemic situation of Odisha is now better than some other major Indian states. But if the total confirmed infection cases will expand exponentially for a long time it may badly weaken the health and socio-economic backbone of Odisha. What would be the day or week in Odisha, when all confirmed infected cases would be replaced as recovered cases? Mathematical Models can be established to analyze and study the infected and recovery cases under certain assumption so that the future trend of relative removal of the pandemic can be accurately predicted. As in the current situation, the research and analysis on covid-19 prediction models have become a hot research topic. This paper is an attempt to reach to at the green zone of prediction where most of the active cases of Odisha would be replaced as cases of removal by recovery. It can provide the practical insight on identifying the issues relating to control and post affect situation of the pandemic covid-19.

2. Data, Source and Software Used

The real time daily data on cumulative confirmed cases, recovery cases and death cases of COVID 19, *from 16th March 2020 to 13th June 2020* have been used for model fitting and prediction analysis of this study. The data have been extracted from the COVID -19 Dash Board of Ministry of Health and Family Welfare, Govt. of India. SPSS and STATA packages have been used for model fitting and analysis.

3. Tools and Model

Statistical modeling plays an essential role in connecting the gap between the mathematical theory and public health practice.

A. Bailey's Model

Norman Bailey in his book '*The Mathematical Theory of Epidemics'* discussed about the distribution of the total size of a stochastic epidemic, involving both infection and removal, in a given group of homogeneously mixing susceptible. The model employed was based on the 'continuous infection' type, rendering to which, the infected individuals continue as sources of infection until they are removed from population by recovery, death or isolation. It is a chain-binomial type of model which involves short stages of high infectivity and approximately constant incubation periods. The basic assumptions are that, with x susceptible and y infectious persons in circulation, the chance of one new infection taking place in time dt is $\beta xydt$, while the chance of a removal is $\alpha y\, dt$, where, β and α are the infection and removal rates, respectively. When $t\rightarrow\infty$, the epidemic occurring in small groups following the introduction of a single infectious case, the obvious application being to intra-household epidemics. From this ultimate distribution of epidemic size β and α cannot be

estimated separately, though the relative removal rate can be estimated as ρ= α /β.

B. Prediction Model and Section

Among different models like linear model, Logistic Model, Exponential Model, moving average model and polynomial model, the cubic model is selected based on minimum of error and maximum fitting ability. The measure R^2 is used to evaluate the fitting ability of various methods and can be obtained by the following equation.

$$R^2 = 1 - \frac{\sum(yi - \hat{y})^2}{\sum(yi - \bar{y})^2}$$

Where $y_i$is the actual cumulative confirmed COVID-19 cases; $\hat{y}_i$ is the predicted cumulative confirmed COVID-19 cases; $\bar{y}$ the average of the actual cumulative confirmed COVID-19 cases. The closer the fitting coefficient is to 1, the more accurate the prediction. Based on more accuracy the following cubic model has been selected for prediction.

$$y= b_0+b_1x +b_2x^2+b_3x^3$$

4. Assumption

Till date about 5 lakhs people have been migrated to Odisha from different states and country. Most of the confirmed covid cases are identified from the quarantine centres, contentment zones and by contact tracing subject to number of covid tests made as per the availability and facilities of testing laboratory and the defined protocol of Government. For prediction analysis it has been assumed that the restriction, reliability of prevention and control measures will be continued as on the date, and the number of cases will not be increased by some irregular factors and community spread causing serious acute variations. As the number death cases in Odisha is only 11 and the fatality rate is only 0.26%, it is assumed as a negligible factor.

5. Research Finding

A. Model Fitting

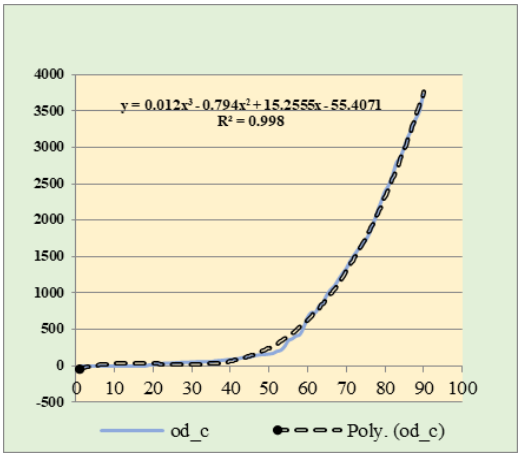

Fig. 1. Model fitting for predicting confirmed cumulative cases of Covid-19

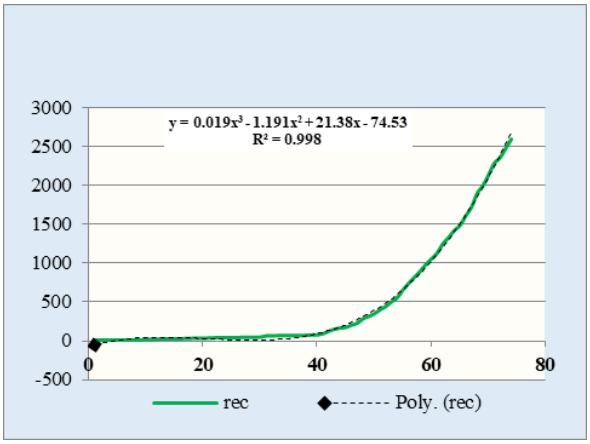

Fig. 2. Model fitting for predicting cumulative cases of recovery

B. Relative Removal Rate

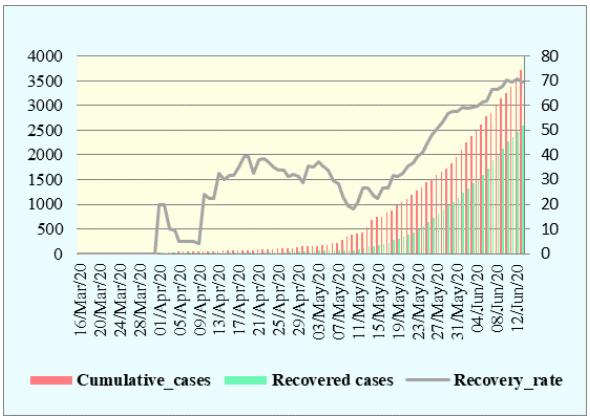

Fig. 3. Recovery rate (%)

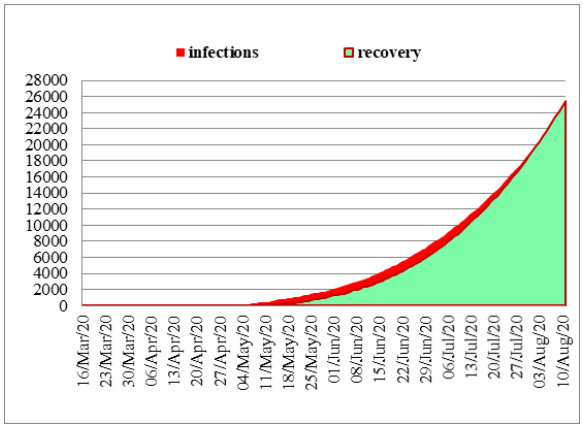

Fig. 4. Infection and recovery chart of Odisha

6. Interpretation and Conclusion

Fig. 1 and Fig. 2 represent the fitting of cubic model for predicting total number of confirmed cases and total number of recovery cases of Covid-19 based on the daily updated real time data from 16th March 2020 to 13th June 2020. The X axis represents the number of days. The first case of covid-19 was confirmed in Odisha on 16th March 2020 and the first case was recovered from covid-19 on 1st April 2020. So for the model fitting in fig. 1, 1st day is 16th March 2020 and for fig. 2 the 1st

day is 1st April 2020.Judging from the value of the measure R^2 of different models the cubic model has been selected for prediction. $R^2 > 0.99$ (very closure to 1) in both cases represents the better accuracy fitting of goodness for cumulative

Table 1
Date wise prediction of cumulative confirmed cases and recovery cases with 95% lower and upper confidence limit

Date	Total Positive Covid Cases			Total Recovery Cases		
	Predicted cases	LCL	UCL	Predicted cases	LCL	UCL
14-Jun-20	3936	3838	4035	2821	2749	2892
15-Jun-20	4112	4013	4212	2983	2910	3057
16-Jun-20	4293	4192	4395	3152	3078	3227
17-Jun-20	4480	4376	4583	3327	3251	3404
18-Jun-20	4671	4566	4776	3509	3430	3587
19-Jun-20	4868	4760	4976	3696	3615	3777
20-Jun-20	5070	4960	5180	3891	3807	3974
21-Jun-20	5278	5165	5391	4091	4005	4178
22-Jun-20	5491	5376	5607	4298	4209	4388
23-Jun-20	5711	5591	5830	4513	4420	4606
24-Jun-20	5935	5812	6058	4734	4637	4830
25-Jun-20	6166	6039	6293	4961	4861	5062
26-Jun-20	6402	6271	6533	5196	5091	5302
27-Jun-20	6645	6509	6780	5439	5329	5549
28-Jun-20	6893	6752	7034	5688	5573	5803
29-Jun-20	7147	7001	7293	5945	5825	6065
30-Jun-20	7408	7257	7559	6210	6084	6336
01-Jul-20	7675	7518	7832	6482	6350	6614
02-Jul-20	7948	7784	8111	6761	6623	6900
03-Jul-20	8227	8057	8398	7049	6904	7194
04-Jul-20	8513	8337	8690	7345	7193	7497
05-Jul-20	8806	8622	8990	7648	7489	7808
06-Jul-20	9105	8913	9297	7960	7793	8127
07-Jul-20	9411	9211	9610	8280	8105	8455
08-Jul-20	9723	9516	9931	8608	8425	8792
09-Jul-20	10043	9826	10259	8945	8753	9137
10-Jul-20	10369	10144	10594	9291	9089	9492
11-Jul-20	10702	10468	10936	9645	9434	9855
12-Jul-20	11042	10798	11286	10008	9787	10228
13-Jul-20	11390	11136	11643	10379	10149	10610
14-Jul-20	11744	11480	12008	10760	10519	11001
15-Jul-20	12106	11831	12381	11150	10898	11402
16-Jul-20	12475	12189	12761	11549	11286	11812
17-Jul-20	12851	12555	13148	11958	11683	12232
18-Jul-20	13235	12927	13544	12375	12089	12662
19-Jul-20	13627	13306	13948	12803	12504	13101
20-Jul-20	14026	13693	14359	13240	12929	13551
21-Jul-20	14433	14087	14779	13687	13362	14011
22-Jul-20	14848	14489	15206	14143	13806	14481
23-Jul-20	15270	14898	15642	14610	14259	14961
24-Jul-20	15700	15314	16086	15087	14721	15452
25-Jul-20	16139	15738	16539	15573	15193	15953
26-Jul-20	16585	16170	17000	16070	15675	16466
27-Jul-20	17040	16610	17470	16578	16168	16988
28-Jul-20	17502	17057	17948	17096	16670	17522
29-Jul-20	17973	17512	18434	17625	17182	18067
30-Jul-20	18453	17975	18930	18164	17705	18623
31-Jul-20	18940	18447	19434	18714	18238	19190
01-Aug-20	19437	18926	19948	19275	18782	19768
02-Aug-20	19942	19414	20470	19847	19336	20358
03-Aug-20	20455	19909	21001	20430	19901	20960
04-Aug-20	20977	20413	21541	21025	20476	21573
05-Aug-20	21508	20926	22091	21630	21063	22198
06-Aug-20	22048	21447	22650	22248	21661	22835
07-Aug-20	22597	21976	23218	22876	22269	23483
08-Aug-20	23155	22514	23796	23517	22889	24144
09-Aug-20	23722	23061	24383	24169	23521	24817
10-Aug-20	24298	23616	24979	24833	24163	25503
11-Aug-20	24883	24180	25586	25509	24817	26201

confirmed cases and of recovery cases.

Based on the fitting models the results for both confirmed cases and recovery cases have been predicted with the lower and upper limit of 95% confidence interval. The detail figures of prediction are given at table 1.

The relative removal rate (%) is presented in fig. 3 using real time daily data up to 13th June 2020. Using the Baliey's principle from table-1 and fig-4 it is seen that *by 10th August 2020, most of the confirmed cases will be recovered and Covid-19 will be inactive in Odisha.*

Now, one can answer to the concerned question '*when will the pandemic COVID-19 end from Odisha?'* Judging from the results and data of this paper, *it will end by the middle of August 2020* in Odisha under the assumption and limitation described in this paper.

References

[1] Bailey NTJ. The total size of a general stochastic epidemic. Biometrika, 1953a;40:177.
[2] Bailey NTJ. Maximum-likelihood estimation of the relative removal rate from the distribution of the total size of an intrahousehold epidemic. J Hyg (Lond). 1954;52(3):400-2.
[3] Organization WH. Coronavirus disease 2019 (COVID-19) Situation Report - 70. 30 March 2020.
[4] Kermack WO, Mc. Kendrick AG. A Contribution to the Mathematical Theory of Epidemics. Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character 1927;115(772):700-21.
[5] Huang P. Research and Implementation of Prediction Model for Class B Infectious Diseases Basedon Machine Learning [D]. University of Electronic Science and Technology, 2019.
[6] Becker NG, Britton T. Statistical studies of infectious disease incidence. J. R. Statist. Soc. B 1999;61(2):287-307.