Modelling the Paucity of COVID-19 Pandemic Spread Incidence across the India Nation

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Abstract

Background: The highly contagious Coronavirus disease (COVID-19) pandemic affected nearly all nations across the world. It was emerged as most swiftly affected disease across the world and more than 2934 lakhs population suffered in four months of the time period as on date April 26, 2020. Its first epicenter was at Wuhan city of China during the month of December 2019. Currently, the most affected people and new epicenter of Coronavirus is at the United States of America (USA). Various nation's administration including the India government called for the regional and local lockdown. We predicted the confirmed COVID-19 cases for next May-2020 month, map the magnitude of COVID-19 disease for Indian states and model the paucity of COVID-19 disease with statistical confirmatory data analysis model for declining rate for the cases represented for the Indian proportion of population.

Method: The ARIMA model used to predict for next short-term cases, based moving average of past confirmed cases. The restriction of COVID-19 pandemic disease analyzed with predicted cases for month May 2020 data at 95 percent confidence is more than 2.5 lakh cases.

Results: The confirmatory data analysis model for the time estimation for the paucity of cases it takes in between six to eighteen months of time frame. The Confirmatory model which considers recovery rate, social, economic and government policy. To complete recovery from the COVID-19 cases it takes on an average more than next ten months.

Conclusion: The disease impacts also depend upon administrative and local people support for self-quarantine and other measures. The India nation Gross Domestic Product (GDP) based on more than 17% of its agriculture production, due to longer affect of the disease and extended lockdown period it will be severely affected. However, all the economic activities with full of its intensity takes-up after complete paucity of COVID-19 disease spread.

Keywords: SARS-CoV-2; Lockdown; GDP; Nobel-Corona; Confirmatory data model

1. Introduction

The Coronavirus disease (COVID-19) has been identified as a pandemic by the World Health Organization (WHO). After its first detection during December-2019 at Wuhan city in China [1, 2] and after the next four months, all the world nations affected by the disease. The recent new epicenter of the COVID-19 disease is the United States of America (USA) and all across world more than 2934 lakhs of population suffered as on date April 26, 2020. The sudden

spread of the disease caused mortality to reach in some of the largely affected areas to 19% of the infected population with a global average death rate reaching 5%, which is far above its anticipation (COVID-19 Coronavirus Pandemic 2020). The very last pandemic Spanish deadly flu during the year 1918 had claimed more than 50 million lives [3,4] and comes to its paucity after next two years of its.

The COVID-19 is the seventh member of the coronavirus family and other six types of coronaviruses have been reported earlier. The general dimensions of a virus are 500 times smaller than the size dust particle and have caused panic across the world. The genetic and genome structure of COVID-19 was approximately 80% similar to that of the SARS virus detected in bats [5]. Its symptoms are also similar to the seasonal flu, cold, cough, and fever are the initial symptoms identified in the people infected with this virus, followed by clinical pathology and pathogenesis in severely affected patients. Due to swift spread of severe infection symptoms on January 23, 2020, WHO decided declaring the COVID-19 outbreak as a public health emergency of international concern [6,7]. Later during high rise of infected number of the people all across the world nations as on March 11, 2020, declared as world pandemic disease. The WHO provided the guidelines for precaution should be followed strictly by all the nations including the India.

The spread of disease during the China yearly peak travel season and breakout of disease^{8,9}. Migration during the Chinese New Year resulted in spread of the virus to other provinces of China in early and mid-January 2020. ⁷Revealed that positive cases among international travelers had been detected in other countries, particularly major trade partners, i.e. the United States (January 21), including India and many more. We are presenting spatial mapping of magnitude, death and recovery of COVID-19 across all the Indian state.

2. Material and Methodology

2.1 Data used

We here used data from Johns Hopkins Corona Virus Resource Center (<https://coronavirus.jhu.edu/>), which reports very approximate data with cumulative cases for 170+ countries worldwide including state or province wise for some of the special data base cases. Here we have collected each day case data at given stipulated tie from the data of having date 21 January, 2020 to 26 April, 2020. Then after pre-processing the data with latitude and longitude wise we collected and creating some spatial attributes overall available

data sets and processing for spatial analysis and to forecast the trajectory of projection of COVID-19 cases. Also as whole data of worldwide is not available on stipulated times so, we significantly jump on that cases and not creating any epidemic projection of forecasting. Some date wise cases for confirmation of COVID-19 reporting cases along with total cumulative results of recovered cases and death cases are analyzed using statistical analysis cooperating with spatial extinct. We here used BATS and TBATS model in in R-language platform, which is freely available software in coding environment. The new projected data is used up to 8 April, 2020 for creation of trajectory having projected score for the entire three cases reported- case confirmed, recovered and death.

2.2 Statistical Models

We here used some statistical phenomenological model which has been previously used to detect to analysis the disease based trajectory model for prediction purpose. We precisely used four models to analyze the whole data set for time series analysis. This includes BATS and TBATS model, which is a mass model of two different models including AR model (Auto Regression) and MA (Moving Average) model. The use of another statistical analysis is generalized logistic growth model (GLM) which generally depicted as a scaling parameter of integrating additional result oriented value put method. Some epidemic model used in disease epidemic conditions measures oscillates some multiple peak parameter inferred in sub-epidemic and pandemic condition to determine the projected outcomes.

2.3 Forecasting of projected prediction

Here we standardize all the models in a file format to detect the daily case for entire country of available data. But here we will consider the only top 20 country to analyze the forecasting models of different spatial adjacent. Reported data which is collected from entire sources is data that is considering from 22 January 2020 to 26 April 2020, so the projection trajectory will analyze up to 2 July 2020 how these statistical analyze will follow. Here we will fit the BATS and TBATS model with two different other inbuilt statistics for visualization of the projected trajectory with in accordance with regression analysis. The best fit analysis for the overall India countries which we included for analysis of cumulative reported case and its upcoming necessity in future as well as recovery and death cases. The minimal sum square errors between the analyzed model and predicted model from GIS sources is managed to distinguish and prepare the spatial map for the thematic COVID-19 mapping.

2.4 GIS Environment approach

Use of GIS and Remote Sensing for determining this epidemic mapping and how to analyze the upcoming effects is tremendous. GIS software used is Q-GIS which is freely available in open market. This develops the mapping of coherent substitute for continent effort from model based statistical analysis in spatial data.

3. Result and Discussion

Forecasting is extremely vital even to get slightest result for multi variables consideration over public health factors, especially pandemic crisis like COVID-19. In this case, forecast from single models is not enough for reliable result and prediction. Therefore here we are using different models integrated for time series analyses. Hence all the different models will be discussed ahead.

3.1. Scenario of COVID-19 across different states of India

The symptoms of COVID-19 are similar to seasonal flu disease. However, its expression can range from asymptomatic to severe pneumonia and death. As of April 26, 2020 based on the data of 26300 laboratory-confirmed cases in India, it was determined that the typical signs and symptoms of this disease are as follows: conjunctival congestion (0.8%), hemoptysis (0.9%), diarrhea (3.7%), nasal congestion (4.8%), nausea or vomiting (5.0%), chills (11.4%), myalgia or arthralgia (14.8%), headache (13.6%), sore throat (13.9%), shortness of breath (18.6%), sputum production (33.4%), fatigue (38.1%), dry cough (67.7%), and fever (87.9%). The infected people with COVID-19 generally develop signs and symptoms, including fever and mild respiratory symptoms, on an average after 6-7 days (mean incubation period 5-6 days, range 1-14 days) of post infection, so it on an average, take more than one week of time to develop clear symptoms to be identified. However, the infected people are confirmed after two weeks of time. The India nation state wise spatial patterns of the COVID-19 confirmed death and recovery case presented in Fig.1, using latest data updates dated and mapping software ERDAS Imagine and Geomedia. The spatial mapping helps to know the severity to international organizations and the India government. It also allows the medical team to know the regional severity, state-based epicenter and planning at the India region. It also includes asymptomatic cases, and real time data are updated. The increased disease curves for India determined upon symptom onset are presented in Fig. 2, which represents the COVID-19 cases cumulatively confirmed, recovery, and death for Indian region latest update date 26 April 2020.

< **Insert Fig.1:** The India nation state wise spatial pattern for COVID-19 disease (left) confirmed cases, (middle) death cases (right) recovered cases.>

As early as January 30, 2020, a COVID-19 was detected in a patient with pneumonia in relation to a cluster of acute respiratory illness cases in Kerala, India. The patient was a medical student, who had recently returned from Wuhan, China. By the end of February 2020, eleven states, including Maharashtra, Rajasthan, Uttar Pradesh, New Delhi, Punjab, Haryana, Madhya Pradesh, Kerala, Gujarat, Tamil Nadu, Andhra Pradesh, had sustained local transmission of the coronavirus disease. Before a nationwide lockdown of three weeks starting midnight on March 24, 2020, the number of confirmed cases of COVID-19 in India was 415. Even lockdown period extended to May 3, 2020 due to increased number of COVID-19 infected cases. After communal gathering (Tablighi Jamaat) in India event during mid of March, 2020, the COVID-19 identified cases from the community people start get identified by April 2, 2020, At the point of time the main reason for more number of the cases and spread also identified in India (Fig.2). The sharp shoot-up in presents confirmed cases curves from March 22, 2020 to April 26, 2020 as represented in Fig.2.

< **Insert Fig. 2:** Comparisons between cases of COVID-19 India case for (top) cumulatively confirmed cases, (middle) recovery cases, and (bottom) death cases.>

3.2. Confirmatory data model analysis for the paucity of COVID-19 spread in India

This result is based on the statistical confirmatory data analysis model generated for the possible decline of COVID-19 cases and their duration for the paucity of new confirmed Covid-19 cases. The decline rate based on parameters such as government provides recovery rate was 20 percentage, health facilities, economic measures, and government support policies. Here, the results are based partly on the possible recovery rates, which present a daily decrease of 0.5%, 1%, 1.5%, and 2%, and the timeline is set from May 01, 2020. The model predicts decline number of COVID-19 active cases in the India nation. The precedented decline rate I is 0.5%, decline rate II is 1%, decline rate III is 1.5%, and decline rate IV is 2% are assumed, it would take almost 1year and 9months, 10 months, 8 months, and 5 months respective for the complete paucity of the COVID-19 cases. Model represents the number of infected COVID-19 proportional number of cases to the current India population. The decline in the number of the confirmed cases is the steepest and directly

proportional to an increase in the recovery rates. Therefore, this hypothesis is totally based on the above-mentioned parameters and how effectively they are executed in preventing the spread of this pandemic. It indicates the possible range of minimum and maximum duration required by the country to recover from this pandemic (Fig. 3).

< **Insert Fig. 3:** Confirmatory data modelling for the deflation of COVID-19 spread in India.>

3.3 BATS and TBATS model forecast for COVID-19

TBATS (Trigonometric seasonality, Box-Cox transformation, ARMA errors, and Trend and Seasonal components) model has the capability to deal with complex seasonality (e.g., non-integer seasonality, non-nested seasonality and large-period seasonality) with no seasonality constraints, making it possible to create detailed, long-term forecasts. Whereas, BATS is the initial stage for the model, which can improve the prediction performance compared to the simple State Space Model. However, BATS model does not do well when the seasonality is complex and high frequency, then TBATS model comes into play, as added T which denote Trigonometric seasonality, it can, not only dramatically reduced the parameters of model when the frequencies of seasonality are high but also give the model more flexibility to deal with complex seasonality [10].

The model takes its roots in exponential smoothing methods and can be described by the following equations:

$$y_t^{(\lambda)} = l_{t-1} + \phi b_{t-1} + \sum_{i=1}^T s_{t-m_i}^{(i)} + d_t$$

$$l_t = l_{t-1} + \phi b_{t-1} + \alpha d_t$$

$$b_t = \phi b_{t-1} + \beta d_t$$

$$d_t = \sum_{i=1}^p \varphi_i d_{t-i} + \sum_{i=1}^q \theta_i e_{t-i} + e_t$$

Where:

317 $y_t^{(\lambda)}$ = time series at moment t (Box-Cox transformed)
 318 $s_t^{(i)}$ = ith seasonal component
 319 l_t = local level
 320 b_t = trend with damping
 321 d_t = ARMA (p,q) process for residuals
 322

323 3.3.1 L-Jung Box Test

324 This test is used for determining if the database has no correlation or relation between the
 325 variables. Also, if there is relation, it should show with very less residual. Overall, to find the
 326 model fits for the forecast or not. The equation is as follow:

327

$$328 \quad Q = n(n + 2) \sum_{k=1}^h \frac{p_k^2}{n - k}$$

329

330 Where, n is the sample size, p is the sample autocorrelation at lag k, and h is the number of
 331 lags being tested.

332

333 Here is the different result of the Li-Jung Box test for confirmed, death and recovery cases
 334 for India for COVID-19 for better evaluation of the database.

335

336 < **Insert Fig. 4:** Result of the L-Jung Box Test and residual check for Confirm, Recovery
 337 and Death cases.>

338

339 Clearly, we can interprets as the p value, which show residual to be distinguishable from
 340 white noise error, so for confirmed, death and recovery the values are 0.0001, 0.0003375 and
 341 0.0003125, which are below 0.05 [11], therefore they substantially distinguish from white
 342 noise. The second image in Figure 4 which gives the autocorrelation function show very few
 343 lags above the maximum limit, and also the first and second lags are in limit as per
 344 correlation rules, which determine the data are not correlated and are independent for fitting
 345 in forecast model for further studies. Further, from the first image we can see there is
 346 vigorous variation in the end of the data as due to high change in cases, but this residual
 347 graphs shows variation as there is no same data mixed with the database, showing the
 348 minimum possibility of white noise. Similarly, histogram shows less variation and grouped

trend in residual changes. All these parameters clearly, specify the database to be unbiased, non-correlated and fit for further forecast.

3.3.2 Forecast of COVID-19 cases

Forecast has been done for all the cases for India for confirmation, Death and Recovery separately. The Models fits for forecasting for confirm, death and recovery were BATS {1, (2,2), 1, -}, BATS{1,(0,0), 1, -} and BATS{1,(0,0), 1, -} respectively. Here, if we explain the model as for confirm cases that is BATS{1, (2,2), 1, -}, which define as {B, (A), T, S}, that for Box-Cox transformation taken as 1 order and (2,2) stands for (p,q) which determines as Partial auto correlation and Auto correlation so here p and q both taken of differential order of 2, as a whole called as ARMA, Trend is taken as order 1 and finally seasonality variability is not been taken as when the seasonality is constant.

< **Insert Fig. 5:** Forecast for India using TBATS model for confirmed, death and recovery.>

As per the forecast analysis the confirm cases going to rise to approx. 3 lakhs, death cases going to toll to 5000 and recovery going to rise till 50000 till the end of June. The rate is gradually increasing to double in every second week of the pandemic, which is alarming in a sort, but the only relief point from this output is that the recovery will going to rise to rate of 30 to 32 % till the end of June. The death rates are slow and the overall progress is also down as compared to confirm and recovery cases.

4 Conclusions

The paucity of COVID-19 cases with suitable decline rates was modelled using statistical confirmatory data analysis. The complete paucity in India was observed between 1 year and 9 months, 10 months, 8 months, and 5 months from slower to faster declining rates. During the year 1918 Spanish deadly flu pandemic claimed more 50 million lives [12,17,18] and take for its complete paucity during the next two years of its timeline. The paucity of COVID-19 cases depends upon government and local people support to strictly follow the WHO guideline and awareness. Due to non-availability of specific medicine against COVID-19, so suggested precaution and self-awareness useful methods to save spread against the disease. The COVID-19 becomes a server challenge of the century and adversely impacting the India and other world economy [13,14,15]. India is a developing nation and agriculture food production aids more than 20% to Indian GDP [16] however due to outbreak of COVID-19

disease, multiple lockdown period of 35 days and predicted long term of its paucity impacts current Rabi crops harvesting and future cropping pattern. The implementation of the COVID-19 Emergency Response and Health System preparedness package has been planned by the state government in three phases: from January 2020 to June 2020, July 2020 to March 2021, and April 2021 to March 2024. The center has funded a 5-year scheme worth INR 15,000 crores to strengthen the nation and state level systems as the country is combating to control impact of the COVID-19. It is important to track the COVID-19 disease state wise for India nation for proper planning and support to recovery from the COVID-19 pandemic disease. The track of state helps to insure which part of the Indian nation to make follow the strict complete lock down and on other hand to open the normal economic activities.

Ethics approval and consent to participate: Ethical approval for this work was obtained from Public Health and Infection Research Group, Faculty of Health Sciences, Universidad Tecnologica de Pereira, Pereira, Risaralda, Colombia, USA. Informed and written consent was obtained from all participants.

Consent for publication: Consent for publication was given by all co-authors

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Figures

Figure 1

The India nation state wise spatial pattern for COVID-19 disease (left) confirmed cases, (middle) death cases (right) recovered cases.

Figure 2

Comparisons between cases of COVID-19 India case for (top) cumulatively confirmed cases, (middle) recovery cases, and (bottom) death cases.

Figure 3

Confirmatory data modelling for the deflation of COVID-19 spread in India

Figure 4

Result of the L-Jung Box Test and residual check for a. Confirm, b. Death and c. Recovery cases.

Figure 5

Forecast for India using TBATS model for confirmed, death and recovery.