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A SIMPLE AND PREDICTIVE MODEL FOR COVID-19 EVOLUTION IN LARGE SCALE INFECTED COUNTRIES

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ABSTRACT

This paper analyzes the reported COVID-19 cases in some largely affected countries around the world and accurately predicts the future values of new, death, recovery, and active COVID-19 cases for effective decision making. The objective is to provide scientific insights for decision makers in these countries to avoid higher levels of severity and large waves of infections. The data for this study were obtained from COVID-19 stylized facts, extracted from the well-known worlddometer website and verified against the WHO's COVID-19 Dashboard, Johns Hopkins University's COVID-19 Dashboard, and CDC from mid of February 2020 – Early April 2020. The data covered the highest five affected countries, namely, Brazil, India, Russia, South Africa, and the USA. The data were analyzed using time series forecasting model and presented pictorially in graphs bar charts and pie charts. Based on the outcome of the analyzed data, it was concluded that the predicted COVID-19 cases will reach the peak at the end of September 2020 and if the outbreak is not controlled, the studied countries may face inflated numbers and severe shortage of medical facilities that may worsen the outbreak. The paper concludes by few important recommendations about comprehensive and necessary actions that the government and other policymakers of these countries should take in order to control spread of the virus.

Keywords: *Covid-19, Machine Learning, Data Science, Forecasting, Computational Intelligence*

1. INTRODUCTION

Available literature and information storage have maintained applicable proposals on pestilence from ancient times to the HIV pandemic, and currently, the Corona Virus epidemic has become the focus of controversy worldwide because it is causing persistent damage to the entire human race 11. At different levels, efforts to save humanity from the COVID-19 mayhem are synergizing. The 2019 novel Corona Virus was described in China at the end of 2019 as a new strain of Corona Virus not commonly seen in humans. In December 2019, Wuhan City Health Committee briefing on COVID-19 reported that some institutions found that many of the pneumonia cases obtained were linked to the South China city of seafood. From that report, the Municipal Health [2] Commission rapidly initiated a search into South China seafood city in which twenty-seven (27) cases were identified; seven (7) were in severe condition while the remaining cases were found to be stable and controllable (Wuhan City Health Committee, 2019; Nuhu, 2020). From Wuhan Town, tourists, passengers, inter-country sports events, holiday guests became vectors that dispersed the virus across continents, and today, the world is finding diplomatic strategies to prevent the further spread of the virus while work is underway to discover a vaccine and improve treatment [3]. While the world is waiting for the vaccine and cure to come, mortality rates due to the outbreak are on the increase in several nations thereby affecting the world population ratio. Population refers to a category of people, objects, incidents, hospital visits, or acts. Therefore, it may be assumed that a population is a collective sample of subjects linked by a shared feature. In this study, the population is

explained as the overall number of live orgasms in a sovereign nation.

The study by Effiong, Nseobot [4] concluded that the spread of the contagious COVID-19 has undeniably made the world unaware, and thus unprepared, leaving the affected countries to endure the catastrophic dead crises as countries around the world reported new cases, worse cases, and deaths daily. The continuous rise of mortality cases is taking a toll on the population index of some countries which if not contended will continue to collapse economies, shut down factories, increase the unemployment rate, and ultimately lead to inflation if not the annihilation of human in a particular location [5].

Predictive analytics has been already put to use to deal with one or other aspects of COVID-19. A multitude number of research efforts have been made in trying and implementing data science to deal with COVID-19 [6]. A query of the form Covid-19 AND (Machine AND Learning) returned 301 articles, the interests of the efforts are diverse ranging from drug design, disease prediction, and mask and social distance prediction systems. Most of the efforts are focusing on using computer vision techniques for disease detection. One more aspect that has been interested in much of the attention of the research community is predicting the number of expected cases [7]. This information would go a long way in enabling the health care professionals to be ready for any eventuality and let them have proper planning for the allocation of the resources both human and equipment. In Table 1 given below,

Table1: Summary of Related work

Research work	Technique	Objective	Forecasting
Sivaramakrishnan [8]	CNN	DETECTION	NO
HO [9]	CNN	DETECTION	NO
MA ELAZIZ [10]	CNN	DETECION	NO
R Shujath [11]	Conventional Machine Learning	FORECASTING	YES (just for India)
Furqan Rustam [12]	Machine Learning	Forecasting	YES (Consolidated Data)
V Chenthamarakshan [13]	Machine Learning	Drug Design	NO

we provide a theoretical comparison of a few of the works that have already been published ins SCOPUS. As can be inferred from the data, Machine learning has been tested in almost all the aspects related to Covid-19 but forecasting has been left heavily unattended, that is where this research work is focused on.

2. THE AIMS OF STUDY

This study aims to analyze the relationship between reported cases of COVID-19 and death in the population ratios of some affected countries.

2.1. COVID-19 Overview: Origin, Symptoms, and Transmission

The COVID-19's pandemic origin is believed to be from animals, spreading via human to human transmission. The main symptoms of COVID-19 include but are not limited to fever, cough, breathing difficulties, muscle pain, and tiredness[14] .Nuhu, severe cases involve pneumonia, acute respiratory distress, sepsis, and septic shock which may lead to the death of the patient. People with established health problems appear to be more vulnerable to serious illness such as this. The vaccines require time and intense researches to develop. Various biotech companies are consulting on the vaccine candidates. These will take months and likely up to a year before vaccination can be commonly used as it requires extensive testing to determine its safety and efficacy [15].

Based on the fact that the virus is transmitted among humans, medical experts are advising that one wears a mask for daily movements, especially beyond home boundaries where there will inevitably be some forms of human interaction. It is advisable to avoid close contact with people with cough symptoms because the infection is easily transmitted from a sick person to another person. Also, since the evidence shows that the infection originated from animals, it is best advised to stop visiting places where animals are kept and further prevent physical contact with any type of animal, its excretions, or droppings. It is equally safe for all to follow and obey the general rules on hand and food hygiene; that means washing ha thoroughly with soap and water, using alcohol-based disinfectants and sanitizers, before and after using the toilet as well as after some contact with humans and animals.

3. METHODOLOGY

The present study was undertaken to analyze the relationship between reported COVID-19 cases and the death population ratio of some affected countries around the world. Simple Mathematical Model was used to determine the correlates and predict the outcome of future cases in a situation where the virus is not controlled. The study assumed to consider variables Covid-19 confirmed cases, active cases, and death

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cases. World meter data obtained was subjected to predictive mathematical modeling.

3.1. SPECIFICATION MODEL

By using the forecasting technique, the researchers forecast the number of cases, the total number of deaths, and total active cases in the USA, Italy, and Spain. That is the technique of time series by which we can predict the future values of a particular variable based on the values of that variable previously observed. The analysis of the time series can be a simple and effective way of forecasting when the causal relationships are less clear. We usually conduct the simulation policy in the forecasting approach, and at the same time.

The proposed time series forecasting model estimates by using the following mathematical model which calculates the future values of a variable along with a constant term based on the linear combination of past observations and a random error.

$$y_t = c + \sum_{i=1}^{n} \varphi_i y_{t-i} + \varepsilon_i = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \ldots + \phi_n y_{t-n} + \varepsilon_t$$

Where c is constant, $\phi_i (i = 1,2,3,\ldots,n)$ are the n model parameters having past n observations $y_{t-i} (i = 1,2,3\ldots n)$ and $y_t \; and \; \varepsilon_t$ is respectively the actual value and random error at a time t.

4. RESULTS and ANALYSIS

Table 1: Trend Analysis of COVID-19 Cases of Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020.

Country	Total Cases	Total Deaths	Recovered	Active Cases
Brazil	2118646	80120	1,514,300	524226
India	1194085	28770	724578	402529
Russia	777486	12427	552644	212415
South Africa	373628	5173	194865	173590
USA	3830010	140906	1,160,087	2529017

Source: Researcher's Extract from Stylized Fact (2020)

The above figures show the analysis of the trend of COVID-19 total cases, total death, total recovery, and active cases of USA, Brazil, India, Russia, and South Africa from 15th February to 31st April 2020

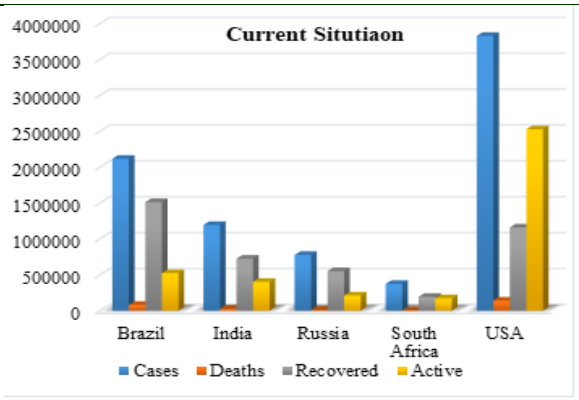
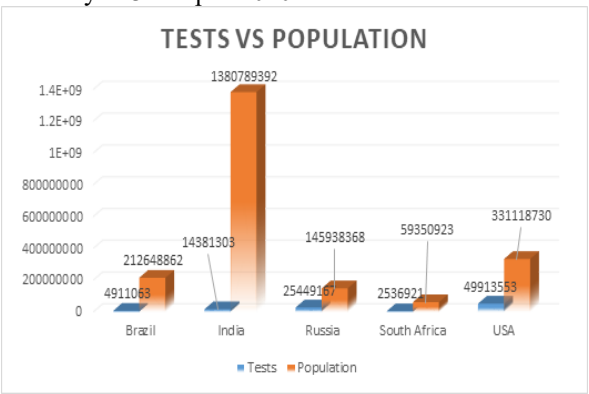


Figure 2: *Trend Analysis of COVID-19 Cases of Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020*

Source: Researchers Extract from Worldometer Fact (2020)

From the graph above, it can be observed that the USA recorded the highest ratio of confirmed cases in the period under study. This was followed by Brazil, India, Russia, and South Africa. With regards to the analysis of total death, the result of the data analysis shows that the USA recorded the highest death rates followed by the USA, Brazil, India, Russia, and South Africa. Also, Brazil recorded the highest recovery of COVID-19 while the USA, India, Russia, and South Africa followed suit in the recovery index, and the graph further shows the countries with actives cases, with USA and Brazil taking the lead. Variation in the above data in total death, active cases, and recovery index could be a result of early awareness and detection of the virus, poor dissemination of information about viruses, better case management.

Fig. 2: Analysis of Covid-19 Test ratio on Population of Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020



Source: Researcher's Extract from Stylized Fact (2020)

Table 2: Analysis of COVID-19 Test ratio on Population of Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020

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Country	Test	Population	Percentage (%)
Brazil	4,911,063	212,648,862	2.30
India	14,381,303	1,380,789,392	1.04
Russia	25,449,167	145,938,368	17.43
South Africa	2,536,921	59,350,923	0.76
USA	49,913,553	331,118,730	15.07

Source: Researchers Extract from Worlddometer Fact (2020)

The table above shows that only 2.30% of the population were tested for COVID-19 in Brazil, 1.04% of the population in India, 17.43% of the population in Russia, 0.76% of the population in South Africa while 15.07% of the population were tested in the USA. This distinction in ratio with regards to population testing for the virus could be as a result of testing techniques adopted in the countries during the months under review. These could include clinical facilities available for tests, technical know-how of lab scientists, and the number of laboratories certified to conduct the COVID-19 test.

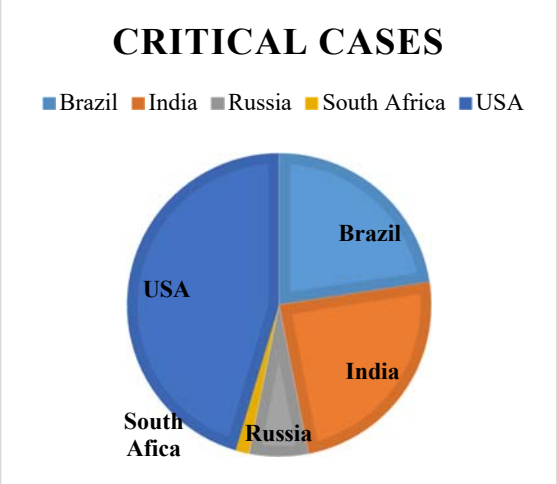

Fig. 3: Analysis of COVID-19 critical Cases in Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020

Analysis of the above pie chat shows that the USA had the highest number of critical cases, followed by Brazil and India while South Africa and Russia had a low index of critical cases in the period under review.

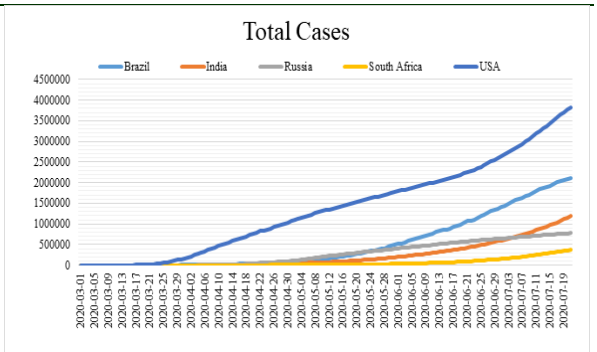

Fig. 4: Trend Analysis of COVID-19 Total Cases in Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020

Source: Researcher's Extract from Stylized Fact (2020)

The above figure shows the analysis of the trend of COVID-19 active Cases of the USA, India, Russia, South Africa from 15th February to 31st April 2020. From the graph above, it can be observed that the USA had the highest ratio of total cases in the period under study. This was followed by Brazil, India, Russia, and South Africa. These variations in the active cases were as a result of new cases of infected persons with the deadly virus.

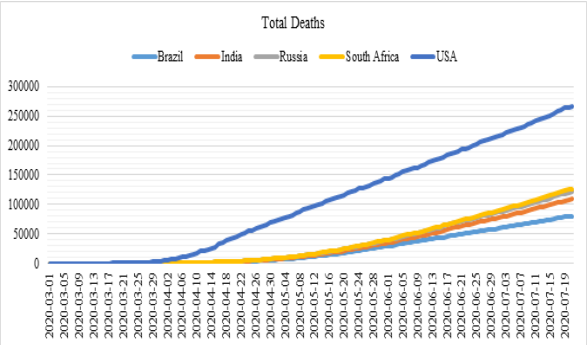

Fig. 5: Analysis of COVID-19 Total Death in Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020

The above figure shows the analysis of the trend of COVID-19 death of the USA, India, Russia, South Africa from 15th February to 31st April 2020. From the graph above, it can be observed that the USA had the highest ratio of total death as a result of COVID-19 in the period under study. While South Africa, Russia, India, and Brazil were relatively experiencing the same death ratios. These variations in the total death were as a result of new cases of infected persons with the deadly virus.

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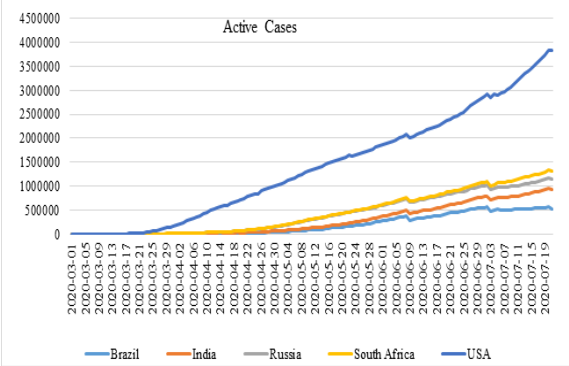

Fig. 6: Analysis of COVID-19 Active Cases in Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020

The above figure shows the analysis of the trend of COVID-19 active cases of the USA, Russia, South Africa, India, and Brazil from 15th February to 31st April 2020. From the graph above, it can be observed that the USA had the highest ratio of active cases in the period under study. This was followed by South Africa, Russia, India, and Brazil. These variations in the active cases were as a result of new cases of infected persons with deadly virus and accumulations of responsive COVID-19 patients.

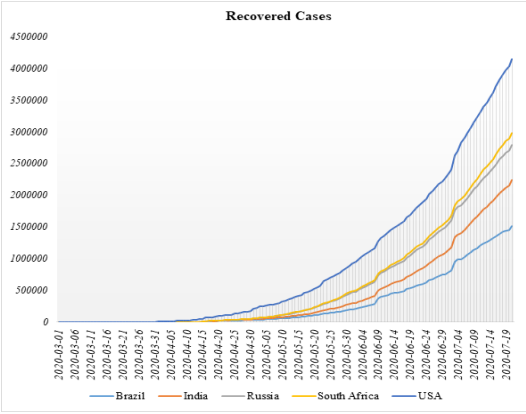

Fig. *7: Trend Analysis of COVID-19 Recovered Cases in Brazil, India, Russia, South Africa & USA from 15th February to 31st April 2020*
Source: Researcher's Extract from Stylized Fact (2020)

Figure 7 shows the analysis of the trend of COVID-19 recovered indexed of Brazil, India, Russia, and South Africa USA from 15th February to 31st April 2020. From the graph above, it can be observed that the USA had the highest ratio of recovered index cases in the period under study. This was followed by South Africa, Russia, India, and Brazil. These variations in the recovered cases are a result of the methodology of clinical trials applied in the countries under study, age, and immune system of the recovered persons with the deadly virus.

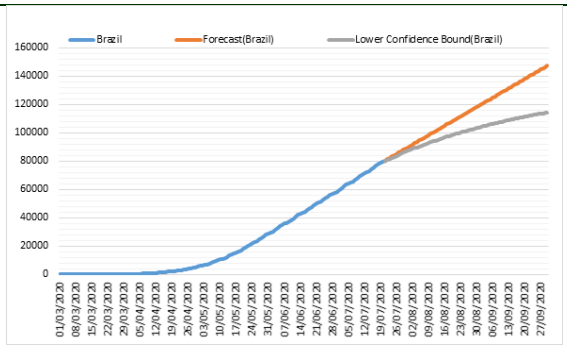

Fig. 8: Trend Analysis of COVID-19 Prediction of Death in Brazil in September 2020

The above figure shows the prediction of the number of death cases in Brazil at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in Italy which may be attributed to the accumulation of newly infected cases.

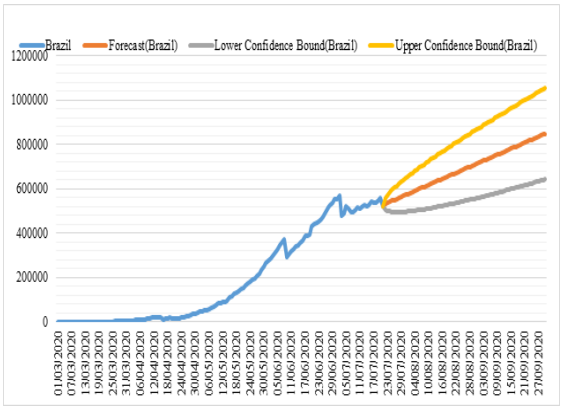

Fig. 9: Prediction Analysis of Active Cases of Covid-19 in Brazil at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of active cases in Brazil at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in Brazil, attributed to accumulated new infected cases.

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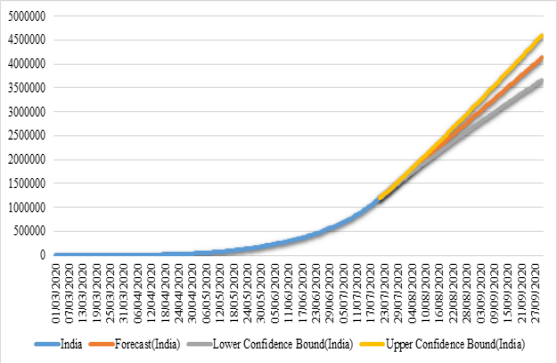

Fig. 10: Prediction Analysis of infected cases in India at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of newly infected cases in India at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of newly infected death cases in India, this may be attributed noncompliance of stay-home policy by W.H.O or social distancing, etc. leads to newly infected cases

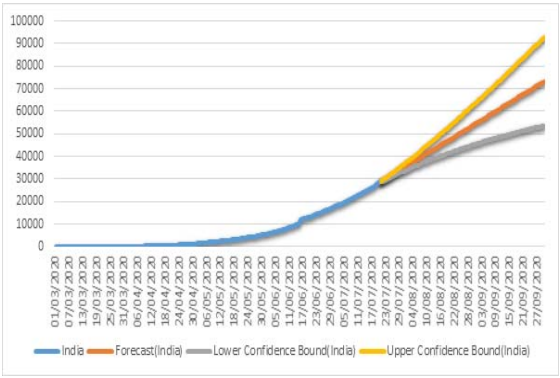

Fig. 11: Prediction Analysis of Death Cases in India at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of the number of death cases in India at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in India, attributed to newly infected cases and accumulated active cases as well as continuous clinical trials to find better options to contend the virus.

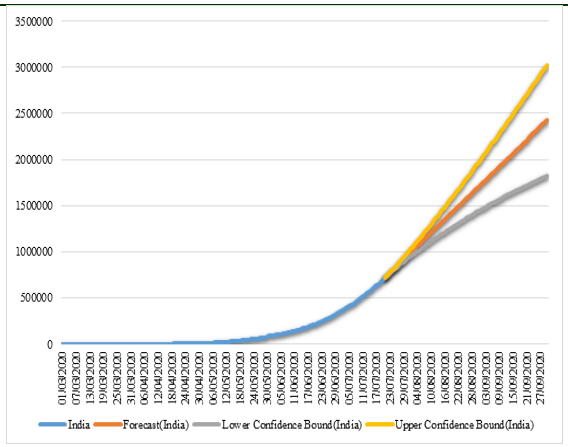

Fig. 12: Prediction Analysis of Prediction of Recovered Cases in India at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of recovered cases in India at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of recovery cases in India. This may be attributed to the trial of clinical methods and better management cases of COVID-19 patients.

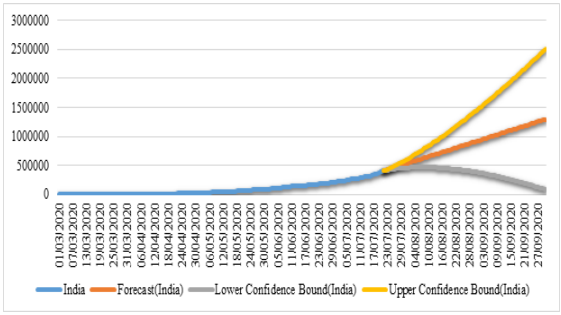

Fig. 13: Prediction Analysis of prediction of Active Cases in India at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of active cases in India at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in India, attributed to newly infected cases and accumulated of unresponsive COVID-19 patients.

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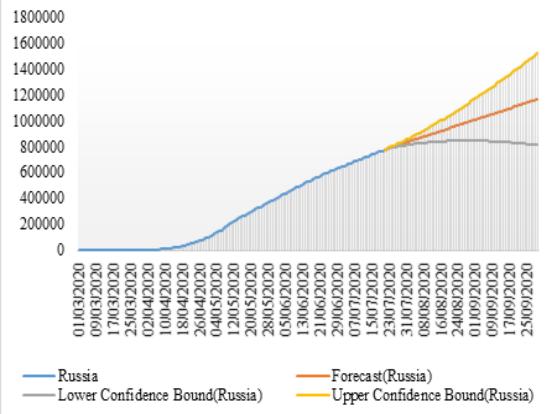

Fig. 14: Analysis of Prediction of infected cases in Russia at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of infected cases in Russia at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of newly infected death cases in Russia. This might be attributed to non-compliance of stay-at-home policy by W.H.O or social distancing etc. leading to new cases of infection.

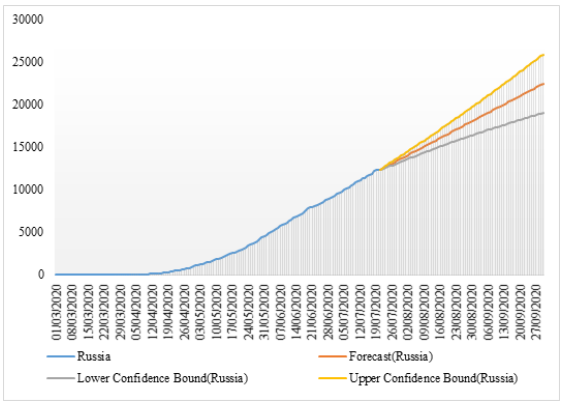

Fig. 15: Prediction Analysis of Deaths in Russia at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of the number of death cases in Russia at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in India, attributed to new infection cases and accumulated active cases as well as continuous clinical trials to find better options to contend the virus.

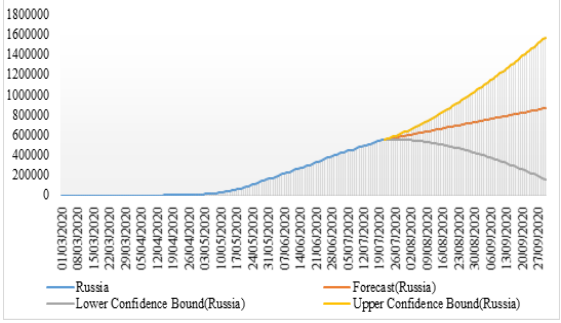

Fig. 16: Analysis of Prediction of Covid-19 Recovered Cases in Russia at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of recovered cases in Russia at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of recovery cases in Russia. This may be attributed to a better trial of clinical methods and better management cases of COVID-19 patients.

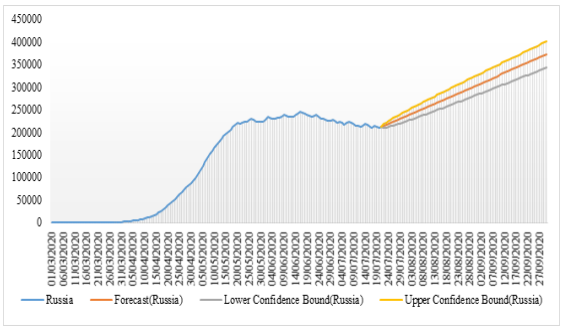

Fig. 17: Analysis of Prediction of Active Cases in Russia at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of active cases in Russia at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in Russia. This may be attributed to new cases and the accumulation of unresponsive COVID-19 patients.

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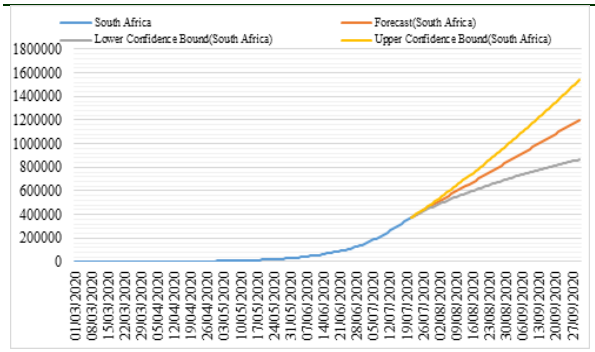

Fig. 3: Analysis of Prediction of COVID-19 infected cases in South Africa at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of active cases in South Africa at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of infected cases in South Africa, possibly attributed to non-compliance with WHO safety rules.

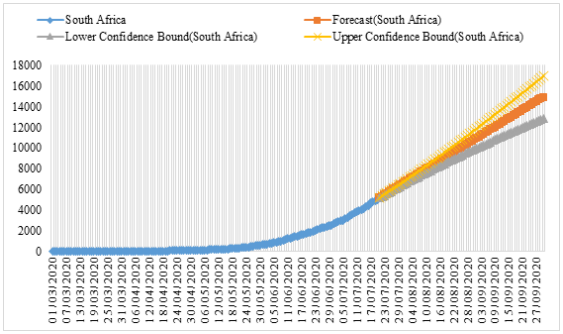

Fig. 19: Prediction of Deaths in South Africa at the end of Sep. 2020

The above figure shows the analysis of the trend of COVID-19 prediction of the number of death cases in South Africa at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in South Africa due to persistent new cases and unresponsiveness to the treatment of patients.

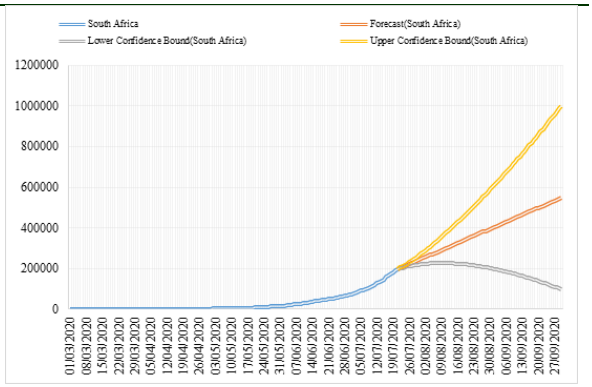

Fig. 20: Analysis of Prediction of COVID-19 Recovered Cases in South Africa at the end of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of recovered cases in South Africa at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of recovery cases in South Africa. This may be attributed to the trial of clinical methods and better management cases of COVID -19 patients.

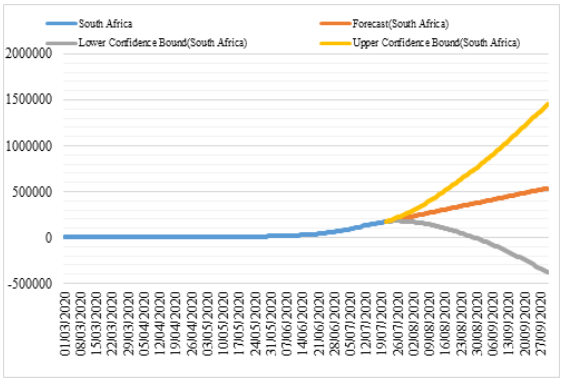

Fig. 21: Prediction of Active Cases in South Africa at the end of September 2020

The above figure shows the analysis of the trend of COVID -19 prediction of active cases in South Africa at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in South Africa. This may be attributed to new cases and the unresponsiveness of patients.

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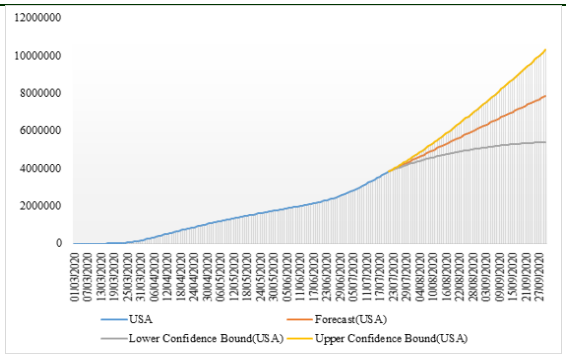

Fig. 22: Prediction Analysis Of Deaths In The USA At The End Of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of active cases in the USA at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of infected cases in the USA. This may be attributed to non-compliance with WHO safety rules.

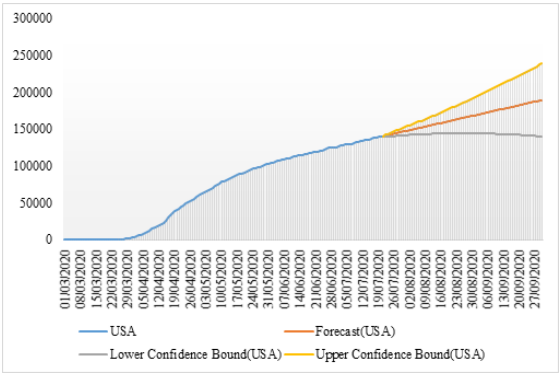

Fig. 23: Prediction Of Deaths In The USA At The End Of September 2020

The above figure shows the analysis of the trend of COVID -19 prediction of death cases in the USA at the end of September 2020. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in the USA, attributed to new cases and unresponsiveness to the treatment of patients.

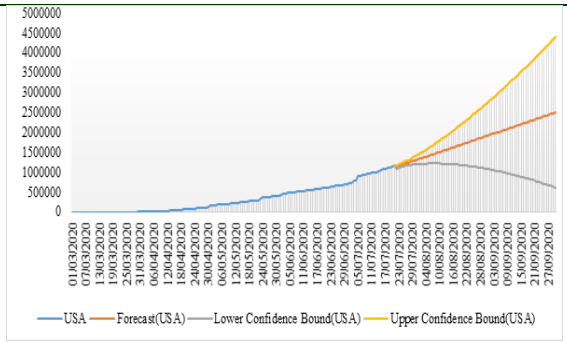

Fig. 24: Prediction Of Recovered In The USA At The End Of September 2020

The above figure shows the analysis of the trend of COVID-19 prediction of recovered cases in the USA at the end of September 2022. From the graph above, it can be observed that there would be continuous rises in the number of recovery cases in the USA. This may be attributed to the trial of clinical methods and better management cases of COVID-19 patients.

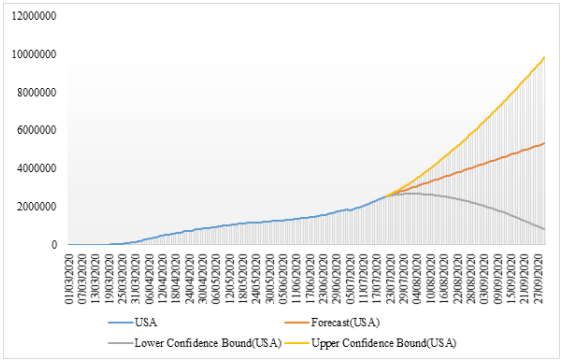

Fig. 25: Analysis Of Prediction Of Active Cases In The USA At The End Of September 2020.

The above figure shows the analysis of the prediction of active cases in the USA at the end of September 2022. From the graph above, it can be observed that there would be a continuous rise in the number of death cases in the USA, attributed to new cases and unresponsiveness of patients.

5. INSIGHTS of RESULTS

The COVID-19 effects are predicted to be at peak between the third and fourth weeks of September 2020 in the study area. This outbreak is predicted to be controlled around the end of October 2020. The total number of predicted infected cases of COVID-19 might reach around 1,049979 in Brazil, 4,504,268 in India, 1203379 in South Africa, and the number of deaths due to COVID-19 are predicted to be 145449 in Brazil, 73140 in India, 14914 in South Africa around September 30, 2020, in the study. If this outbreak is not controlled by the end of September 2020, then the study

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area may be facing a severe shortage of hospitals, and it will make this outbreak even worse.

6. VALIDATION

To validate the forecasting done by the proposed model were compared with the actual numbers reported by the countries for the time period, and after the comparison it was found that the actual number was well in the range forecasted by the model. The actual number of the reported cases in general was higher than mean in and towards the higher bound for each of the categories. While as deaths are concerned the actual cases are little lower than the forecasted values, a reason for that would be partial success of few of some of the drugs in the treating the COVID-19 patients.

7. CONCLUSION AND RECOMMENDATIONS

Based on the data analysis of the study, the total predicted infected cases of COVID-19 to reach 1,049979 in Brazil, 4504268 in India, 1203379 in South Africa, and the USA as well. The total death due to COVID-19 is predicted to be 145449 in Brazil, 73140 in India 14914 in South Africa, and at the end of September 2020. If the pandemic cannot be controlled by the end of September 2020, it may continue to spread and may stress the available medical facilities in these five affected countries and beyond. The study recommended that the prediction about the pattern of the outbreak may help policy-makers take comprehensive and necessary action. The number of deaths may be controlled as compared to China because of the precautionary measures that have already been taken. The further study of other factors like education, economic conditions, medical facilities, climatic conditions, religious beliefs may strengthen the prediction and help in controlling the outbreak of COVID-19. Also, this study may further be extended for predicting the outbreak in other countries which the present study didn't cover. The present study is in support with the work of Xu, Ran, Youfa, Yan, Jing, Zhong-Dao, Pei-Long, Tie-Ru, and Members of Steering Committee, Society of Global Health, Chinese Preventive Medicine Association, (2020) which states that COVID-19 is a new disease that has caused great impacts to the people's daily life extraordinarily. We, as a community of shared future for mankind, need to take collectively and quickly strong emergency responses as a battle against our common enemy, the new coronavirus, not only in China but also in the world. All partners of the international community and country leaders are encouraged to proactively take strategic actions as soon as possible to fight the COVID-19 together. Hard times will end finally, and we will meet each other in the blooming spring soon. Due to the time constraints, the present work focused on just four countries, as an extension to the work it is pretty appealing to include more countries in the list. And also, use the current data to make recommendations for the year ahead. As with every forecasting model, the proposed work is totally driven by the collected data used to make predictions. Some of these countries may have conducted some un-announced efforts to control the pandemic. So, the correctness of the proposed model is heavily influenced by number of factors, that are simply beyond the gathered data. This is an area for further enhancements of the proposed model.

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