Regression Trend on Covid-19: A Case Study of India

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Abstract:

COVID-19 pandemic represents an unexampled world health crisis. It has caused large panic with in the world by infecting many individuals with a varied mortality and having a vast impact on our health systems and economies. Mathematical models have played an important role within the current crisis. Presently we have used polynomial model to extract out the information of the rate of confirmed and death cases of corona virus disease. We have plotted Confirmed and Death Cases of COVID-19 of present and past year of India. Two waves are obtained, one peak is complete and the second wave is of rising trend.

Keywords: Pandemics, Corona Virus, Covid, Death Rate, Respiratory Disorder

Introduction:

Corona virus disease (COVID-19) occurred because of the severe acute metabolism Syndrome corona virus -2 virus (SARS-CoV-2).These viruses are infective for both humans and animals and are responsible for infections that cause flu-like symptoms in infected people. The symptoms of this malady typically fit as that of cold and cough. Along with symptoms of respiratory disorder, COVID-19-infected people may experience a loss of taste or smell, even nausea, congestion and generally diarrhea .SARS-CoV-2 which is the cause of corona virus disease 2019 (COVID-19) mutated to transmit from animals to humans. This virus was supposed to have transferred to human beings through bats from the meat market in Wuhan, China [1]. The outbreak of this disease was announced by The World Health Organization (WHO) after one month from the reporting of the first case on Dec. 31, 2019, in Wuhan, China and later as a pandemic on March 11, 2020 [2], which further spread across the whole country and the other parts of the world. This is a fatal corona virus that was transmitted readily between humans all over the world and also resulted in global shutdowns.

It has been speculated in past analysis that environmental conditions of countries like temperature and humidness also sometime play a major role in dominant pandemics[3] .Quantitative COVID-19 impact analyses are scarce in literature, looking towards the seriousness of infection , a more statistical study in this area is needed. Epidemics are assumed to have an exponential growth at an early stage, and the number of infections reduces over time due to interventions like lockdowns, travel restrictions, awareness programs, etc [4].

Since these measures have brought immense pressure on the economy, so it is not only vital to maintain the spread of the corona virus however also to own quantitative estimates of the spread and to set up economic and health policies to reduce the distress on the economy. Indian Government has been proactive since the end of January 2020, when the first case of an infected person was detected in Kerala [5]. Careful measures [6] like screening of passengers at the airport, limiting public gatherings, suspension of transport as well as flights, trains and buses, increasing quarantine facility, devoted COVID-19 hospitals, increasing sample testing etc. were taken by the government of all countries throughout the period of lockdown. Several studies are recently reported by researchers to know the dynamics and statistics of this pandemic [7-12]. The forecast of COVID-19 within the context of India has been investigated by several researchers using mathematical and epidemiological models but have limited statistical studies of COVID-19. Looking at the demographical and geographical diversity in countries, a separate country-wise statistical study of COVID-19 epidemic is required.

Now, because the pandemic claims a lot of lives worldwide, the expansion of mortality may be compared between countries to get some insight into the effectiveness of various containment measures. Presently COVID-19 data of confirmed and death cases of India is collected[13-14].COVID-19 data is analyzed statistically and is also depicted graphically to conclude the results of dependence of COVID-19 virus on environmental conditions like climate changes, humidity, the variation in temperature etc.

Models:

Various mathematical models are being shaped to anticipate the longer term of corona virus disease 2019 (COVID-19)[15] . So as to happening management and policy development, mathematical models are producing quantitative information and providing helpful guidelines during this matter. Particularly, variety of modeling studies are performed for COVID-19, for example, Nuno Crokidakis(16) introduced a Susceptible-Infectious-Quarantined-Recovered (SIQR) model to investigate the COVID-19 dynamics .Wu *et al.* (17) found a SEIR model to explain the transmission dynamics of COVID-19 in China and therefore the spread of disease at national and world levels, that is predicted on reported information from December 31, 2019 to January 28, 2020. Read *et al.* (18) reported a value of 3.1 for the basic reproductive number of the early outbreak using an assumption from Poisson-distributed daily time increments in their data fitting. Tang *et al.* (19) incorporated the clinical progression of the disease, the individual epidemiological status and lots of different intervention measures into their model. Imai *et al.* (20) conducted computational modeling of potential epidemic trajectories to estimate the happening size in Wuhan, China. Li *et al.* (21) applied a meta-population SEIR model and theorem reasoning to infer crucial medicine characteristics in China. Leung *et al.* (22) quantified the transmissibility and severity of COVID-19 in mainland Chinese locations outside Hubei province and simulated the potential consequences of restful restrictions in anticipation of a second epidemic wave in China. Presently, the data of confirmed and dead cases in India is being depicted with the help of graphs by using different degrees of polynomial equations. An expression of the form p(x) $=a_0x^n + a_1x^{n-1} + \ldots\ldots + a_{n-1}x + a_n$,$(a_0 \neq 0)$ where a_i's are constants and n is a positive integer is called a polynomial in x of degree n.

Regression Line Trend Setter:

Confirmed Cases:

Feb -May 2020

$y = 3E\text{-}09x^6 - 4E\text{-}07x^5 + 8E\text{-}06x^4 + 0.008x^3 - 0.533x^2 + 8.904x - 30.17$
$R^2 = 0.987$

June – Sept 2020

$y = -1E\text{-}06x^6 + 0.000x^5 - 0.060x^4 + 3.411x^3 - 74.01x^2 + 847.8x + 7140.$
$R^2 = 0.976$

October 2020-February 2021

$y = 7E\text{-}08x^6 - 5E\text{-}05x^5 + 0.011x^4 - 1.379x^3 + 82.68x^2 - 2761.x + 85943$
$R^2 = 0.946$

Death cases

Feb-May 2020

$y = 4E\text{-}09x^6 - 1E\text{-}06x^5 + 0.000x^4 - 0.010x^3 + 0.284x^2 - 3.029x + 8.092$
$R^2 = 0.962$

June – Sept 2020

$y = -5E\text{-}08x^6 + 2E\text{-}05x^5 - 0.002x^4 + 0.177x^3 - 5.715x^2 + 82.63x + 23.74$
$R^2 = 0.729$

October 2020-February 2021

$y = -1E\text{-}09x^6 + 5E\text{-}07x^5 - 3E\text{-}05x^4 - 0.005x^3 + 0.747x^2 - 35.57x + 1126.$
$R^2 = 0.945$

Results:

The first case of COVID-19 in India was reported on **30th January 2020**[23]. The growth rate of confirmed cases of India are presented in three time intervals from February 2020 to February 2021 and shown in figures (fig. 1–fig. 3).The growth rate of confirmed cases of past one year is plotted in fig. 4.From these figures, it is clear that how the diseased cases grow or fall down day by day. Data is fitted well in polynomial equations as justified by R^2 values ($R^2 > 0.9$).

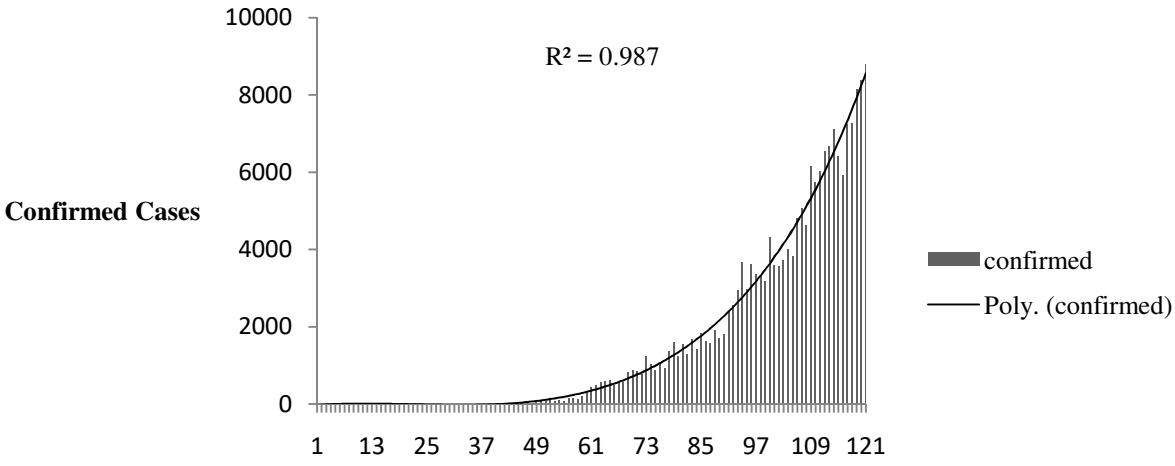

Fig. 1 Days
February 2020-May 2020

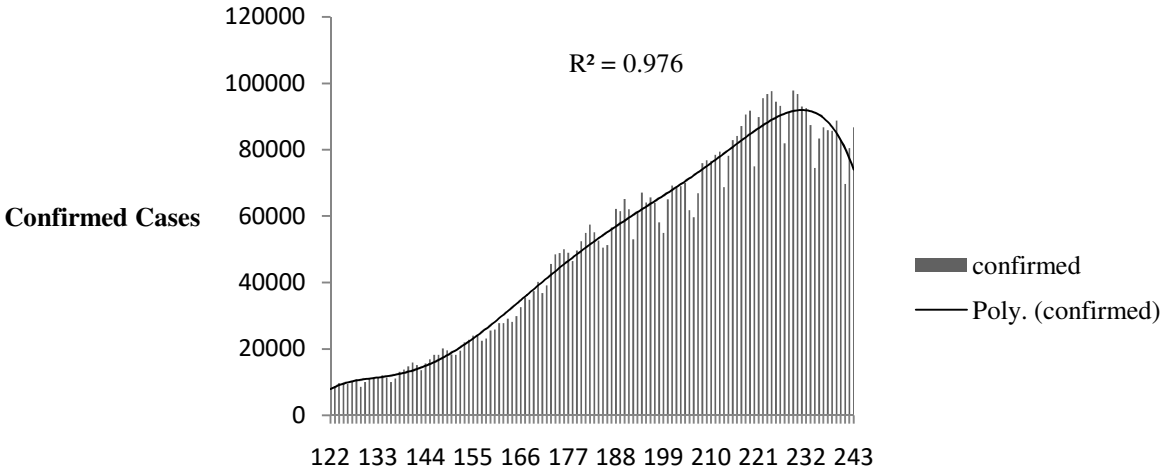

Fig. 2 Days
June 2020-September 2020

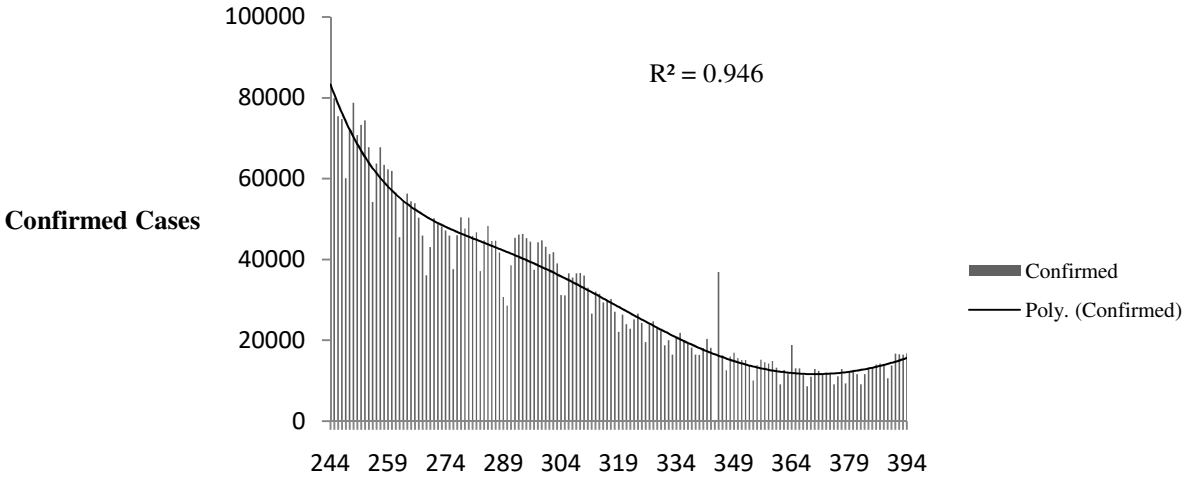

Fig 3 Days
October 2020-February 2021

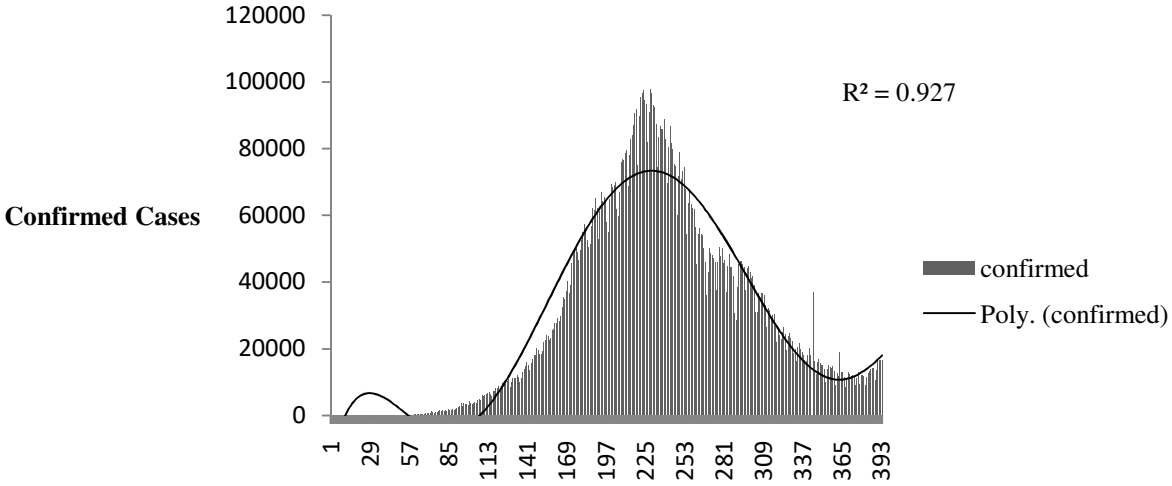

Fig. 4 Days
February 2020-February 2021

The death rate of COVID-19 cases of India (February 2020-February 2021) are presented through fig 5 –fig 8.The whole span is split into three sub parts (fig 5 –fig 7) and figure 8 representing the death cases of the past year (2020-21). From these figures, it is clear that how

the death cases grow or fall down day by day. Data of death cases is poorly fitted in polynomial equations as depicted by R^2values .

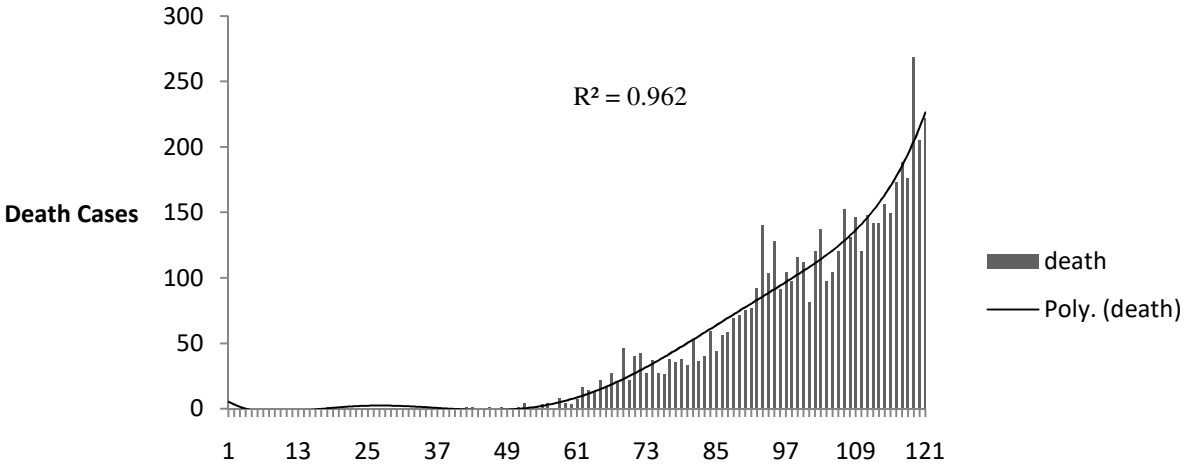

Fig.5 Days
February 2020-May 2020

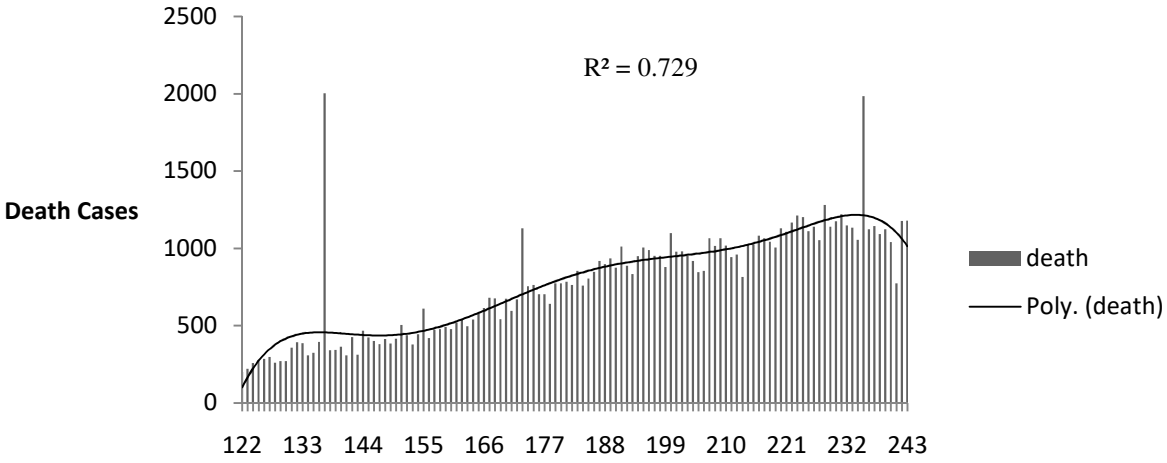

Fig.6 Days
June 2020-September 2020

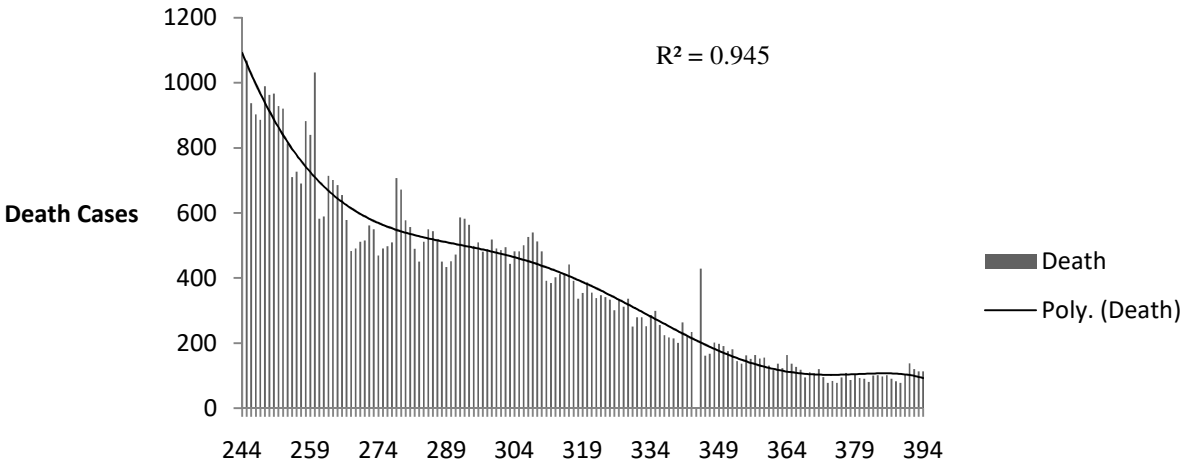

Fig. 7 Days
October 2020-February 2021

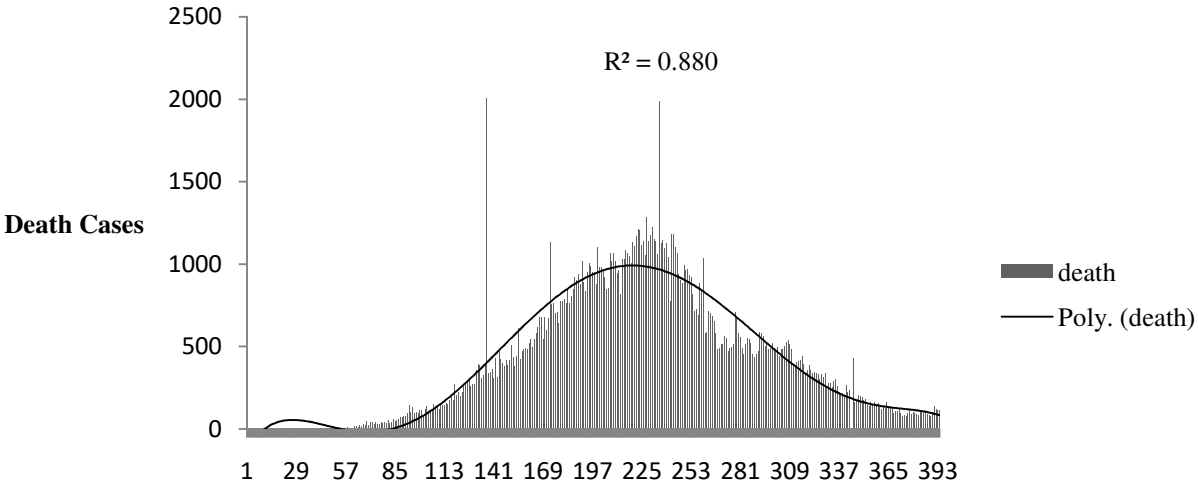

Fig. 8 Days
February 2020- February 2021

The growth rate of confirmed cases of India has been found by two waves, 1st wave is from June 26, 2020 to August 9, 2020 and 2nd wave is from March 9,2021 to March 28,2021(continued) shown in figure (fig.9). Data is fitted well in polynomial equations as justified by R^2 values ($R^2 > 0.9$).

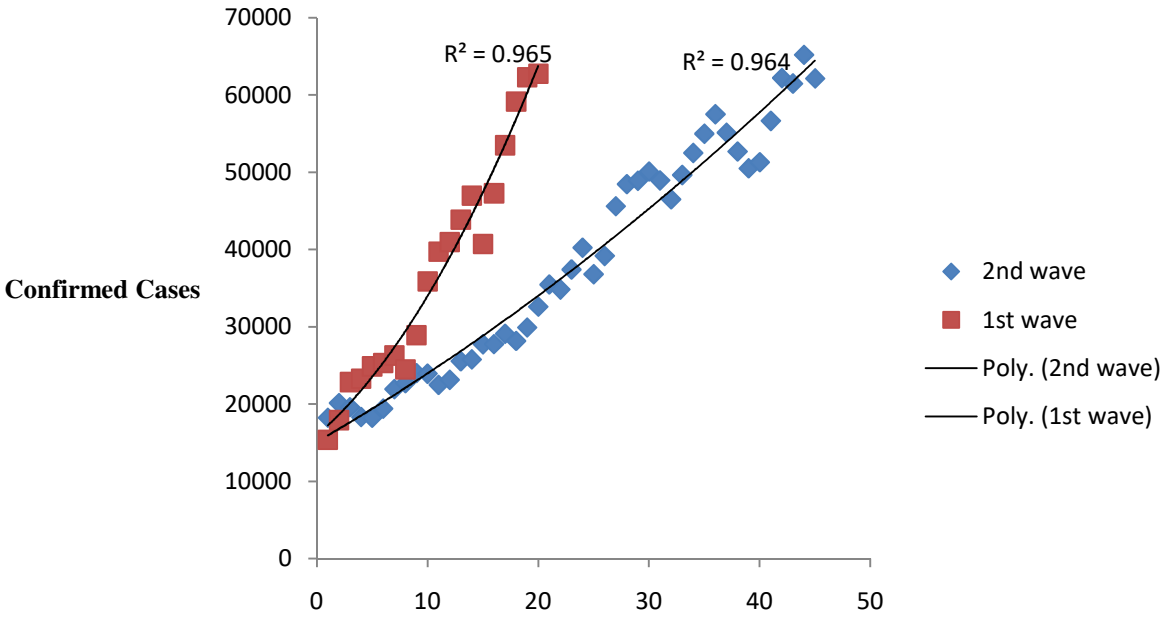

Fig . 9

1st wave (June 26, 2020 to August 9, 2020)

2nd wave (March 9, 2021 to March 28, 2021)

Discussion:

As Wu et al. [17] forecasted the national and global spread of COVID-19 virus in their SEIR model. Tang et al. [19] found that intervention strategies such as intensive contact farming followed by quarantine and isolation can effectively reduce the control reproduction number and transmission risk. Li et al [21] applied a meta-population SEIR model which showed that about 86% of all infections were undocumented prior to January 23, 2020. Presently polynomial model is used, when it is operated on COVID -19 cases in India then it showed that rate of confirmed cases were of increasing trend from February 2020-May 2020, started with 0 cases on 1st day (1st February, 2020) and gone to 8789 cases on 121th day (31st May, 2020) shown in fig 1. Polynomial model degree 6 is fitted well with this data $R^2 > 0.987$ (fig 1). Increasing trend continued till 30th September, 2020, when there were 86748 cases, polynomial of degree 6 satisfied this data (fig.2). In India, the data of COVID -19 confirmed cases from October 2020 to February 2021 showed an decreasing trend and fallen continued to 394th day i.e. up to 28th February, 2021, when there were 16752 cases, is cleared in fig. 3. Polynomial of degree 6 also fitted with this data with $R^2 > 0.946$ (fig 3). The whole year data fitted well with polynomial model of degree 6 shown in fig 4 with $R^2 > 0.927$.

Polynomial model, when operated to death cases of COVID -19 for India then it showed that the rate of death cases were of an increasing trend from February 2020 to May 2020, started with 0 on 1st day (1st February, 2020) and gone to 222 cases on 121th day (31st May, 2020) shown in fig 5. Polynomial model degree 6 is fitted well with this data $R^2 > 0.962$ (fig 5). An increasing trend continued till 30th September, 2020, when there were 1179 cases, polynomial of degree 6 now poorly satisfied this data $R^2 > 0.729$ (fig. 6). COVID -19 death cases showed a decreasing trend during October 2020 to February 2021 and fallen to 113 cases at 394th day i.e. on 28th February, 2021 shown in fig. 7. Polynomial of degree 6 also fitted with this data with $R^2 > 0.945$ (fig 7). The whole year data fitted poorly with polynomial of degree 6 shown in fig 8 with $R^2 > 0.880$. Polynomial model fitted well in the data of Covid-19 confirmed cases whereas showed poor fitting to the rate of death cases. The Growth rate curve (Fig.4) showed one complete peak and second has been started and is continued First wave is from June 26,2020 to August 9, 2020 with variation of rate of confirmed cases 18255 to 62117 and second wave is of data from March 9 ,2021 to March 28,2021 with variation of rate of confirmed cases 15388 to 62714. The slope of polynomial of 2nd wave is more than that from 1st wave, showed that there is a great increase in intensity of rate of confirmed cases in March 2021(fig.9) and still it is continued. So to prevent this, we should follow the instructions given by WHO.

Conclusion :

It is found that the slope of polynomial of 2nd wave is more than that from 1st wave, which results a great increase in intensity of the rate of confirmed cases in March 2021. The cause of high intensity of second wave could be the presence of the 2nd variant of corona virus. Under present pandemic, it is vital to take care of necessary precautions to prevent from this second variant of COVID-19.

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