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Review Article

COVID-19 outbreak in India: an early stage analysis

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ABSTRACT

The COVID-19 outbreak in several countries of the world is facing a challenging task to control the virus transmission as 3.7 million people are tested positive in all over world at the time of writing. India is also suffering with the virus outbreak in different states as on January 30, 2020, India reported its first confirmed case of coronavirus deadly disease (COVID-19) in Kerala state where three students returned from the epicentre of the disease, Wuhan, China. During the first week, India experienced a slow growth in the infected cases but soon after an outbreak has been found in several states and union territories, although strict measures are being made to control the outbreak. This study presents a comprehensive analysis to explore the current status of virus transmission at state and country level, infection growth, most affected age groups, available datasets and prediction models and strict control measures. Several data sources are analysed to collect the pandemic data such as Johns Hopkins University, Ministry of Health, COVID-19 India, Worldometer and media. The analysed study will be significant for scientist, researchers and health workers of India and also for the administrative tasks to consider the different strict measure to control COVID-19.

Keywords: Pandemic, Infection growth, COVID-19, Coronavirus, Datasets, Prediction models

INTRODUCTION

COVID-19, novel coronavirus was reported in Wuhan, China in December 2019 as a cluster of deadly respiratory infection and spread rapidly as a pandemic in all over world.[1] Corona viruses are found zoonotic in nature and easily transmitted among people and animals. It is still under investigation, to explore how it is transmitted into animal reservoirs and others.[2] As there is no vaccine and fixed treatment for COVID-19 identified till yet, hence social distancing has declared most accepted strategy for its control and prevention.[3] It is necessary to isolate the person, who has a travel history and contacts with the infected patient. Social distancing, quarantine and isolation play a vital role to control and prevent the infection of COVID-19 deadly disease.[4] Monitoring and tracing the social network and news about the transmission of disease is also an effective way to control and prevent the pandemic. As of current status, total 3.5 million peoples are positively infected and 2.4 lakh by this deadly disease in all over world according to John Hopkins University and other tracker sources.[5] It is identified that 10 most affected countries are United States, Spain, Italy, UK, France, Germany, Russia, Turkey, Brazil and Iran.

In initial stage, the transmission was steady in India rather than other countries while this country is too close with China. In the month of 30 January 2020, the first case in India was reported from Kerala.[6,7] as the patient had a travel history from Wuhan, epicentre of China. After confirmation of the first case in India, some strict measures were applied at the international airports of the country such as thermal screening and quarantine the

passengers with travel history. As more cases were confirmed in the first week of March, government has announced a curfew and lockdown (for 21 days) to prevent the transmission of the disease in the community and implemented a layered approach of social distancing such as isolation of confirmed cases, quarantine of contacts, closure of workplaces, educational institution and many more. These significant measures are playing a vital role to control the transmission in the country. As prevention, Indian government has suspended to issue new visas and issued visas for foreign nationals of Iran, Italy, Japan and South Korea on 3 March 2020.[8] At present India is moving towards stage 3 and hence this study presents the analysis from 30 January 2020 to 5 May 2020. We have analysed all confirmed cases, active cases, recovered cases and total fatalities to the fixed date with the infection growth and transmission dynamics within different regions of India. This analysis has presented state wise information for all types of cases and also presented the infection growth rate, recovery growth rate and fatality growth rate as well. After conducting a comprehensive analysis of most affected gender and age-group it is observed that most of the infected cases found in men at 31-40 age range.[26] Several datasets and prediction models are made available to analyse the infected records and to enable the study by researchers. Prediction models supports to make the quick decision for managing the infections related information such as; beds in hospitals, ICUs, medical staff etc. To identify the growing landscape of infection of COVID-19, this study contributed to 3 major objectives; methodology of strict measures to control pandemic; analysis of infection, recovery and fatalities; most affected gender and age group in India; an overview of existing datasets and prediction models.

Rest of the study is organised as follows section 2 discussed about COVID-19 background such as history of disease, material, methods, diagnosis. In section 3, a methodology to present the strict measures taken by Indian government. In section 4, an infection growth analysis of COVID-19 has been presented within the different regions of India and most affected gender as well as age group. Section 5 discussed about existing datasets and prediction models. Finally, section 6 presented a discussion and section 7 concluded the analysis.

BACKGROUND

Corona virus is integrated with three basic units, a protein CASID, the genetic material and lipidic envelop to preserve them outside of the host. Soap is an effective method to restrict the transmission of virus. COVID-19 is a family of coronavirus which is first identified in 2019 as viruses are not considered completely dead. These viruses have genes, can reproduce and grow by natural selection. COVID-19 has a single strand of genetic material that is measured 27-34 kilo bases long and makes it the biggest in the corona family. It also exposed to more mutation as RNA is found as a genetic material in this virus which is identified as a single stranded only in spite of double helix.[9] According to WHO, it is the world's biggest pandemic, over half of a million people are restricted to be lock down, more than 3700000 are infected and nearly 250000 fatalities globally.[10] In India, the total number of COVID 19 infected people are 49391 and 1694 fatalities (as on 5 May 2020, 10 pm).

A short study presented after diagnosing 43 pregnant infected women in New York between March 13-27, that revealed, 37 (80%) women have a mild stage of COVID-19, 4 (15%) found in severe stage and 2 (5%) found in critical stage. But it is observed that their new born babies were not infected based on their first day test.[41]

A study of seven clusters in Singapore reveals that virus can transmit to others before showing the persons showing any symptoms.[42] Although WHO said the risk of getting infected with no symptom's person is "very low", it is still an on-going research during transmission of virus. Early identification and isolation of patients and tracing their contacts are important to control the virus transmission. However, it is challenging to trace contacts of pre-symptomatic or asymptomatic transmission

The transmission dynamics of COVID-19 is very high and most of the serious cases may become widely unsustainable for future in a very short duration. A combative regulation strategy is required to control the transmission of COVID-19. The Chinese government in Wuhan controlled the transmission dynamics by widespread testing and quarantined all people even if they had mild symptoms of disease. Testing and contact tracing of both asymptomatic and symptomatic exposure to positive cases assisted to prevent the infection growth. Without these measures new cases can rise rapidly. There was an annual religious event at Hazrat Nizamuddin, New Delhi during the period 13-15 March 2020.[43] It is believed that about 9000 members attended this year's event and many of them were tested COVID positive. There were also many foreigners attending this event. 1023 positive cases identified in 17 states/union territories have been connected to the captured cluster in India. It is still a challenge to identify such large clusters.

MATERIALS, METHOD AND DIAGNOSIS

To prevent the pandemic, different types of data are required such as epidemiological data, clinical characteristics, laboratory and imaging results. Several methods are followed to identify the infected people and to isolate them by testing procedure such as lab confirmed test, clinical confirmed test and confirmed test. By distributing patients into two groups: pneumonia and non-pneumonia. Three types of diagnosis are required to confirm the pandemic. For mild type; slight clinical symptoms without no pneumonia symptoms. For common type; manifestation such as fever or respiratory presentation within pneumonia or radiography. For

severe type; respiratory failure and need mechanical ventilation shock combined with another organ failure and an ICU is required.[13-15]

METHODOLOGY FOR CONTROL MEASURES IN INDIA

Since the first case was confirmed, the essential control measures such as contract tracing, social distancing measures (school closure, workplace non-attendance, Janta Curfew etc.) and isolation have been implemented according to the protocol. Due to these control measures, it is observed that the transmission is steady in India rather than other countries while this country is too close with China. We have presented a methodology in (Figure 1) to show the implemented control measures in India.

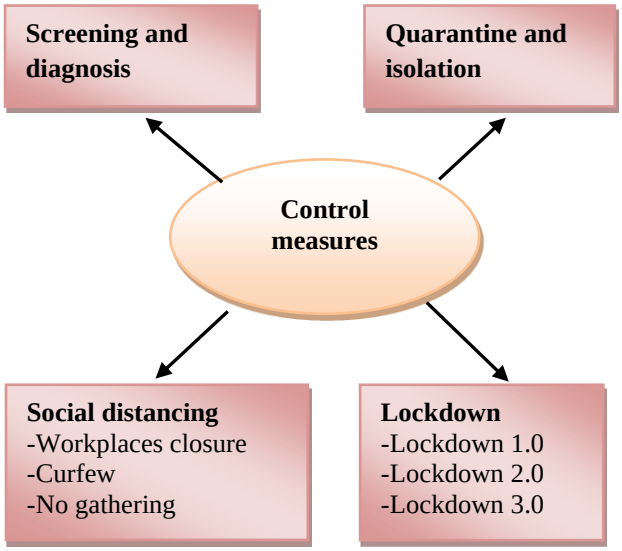

Figure 1: Methodology of control measures.[18]

A steady growth has been reported in the month of 1 March 2020 to 31 March 2020 as different social measures were planned to fight against COVID-19 in India. After 3 February 2020, 2 cases are found on 2 March 2020 from Delhi and Telangana and were 5 cases in total from the country on 2 March 2020. All these cases had a travel history from other countries. So, this is a strong point why infection was not transmitted rapidly in India. After confirmation of the first case in India, some strict measures were applied at the international airports of the country such as thermal screening and quarantine the passengers with travel history. As more cases were confirmed in the first week of March, government has announced a curfew and lockdown (21 days) in three phases to prevent the transmission of disease in the community and implemented a layered approach of social distancing such as isolation of confirmed cases, quarantine of contacts, closure of workplaces, educational institution and many more. These significant measures are playing a vital role to control the transmission in the country. As prevention, Indian government has suspended to issue new visas and issued visas for foreign nationals of Iran, Italy, Japan and South Korea on 3 March 2020.[7]

GROWTH ANALYSIS OF INFECTION, RECOVERY AND DEATH

Early stage infection growth in India was very slow as prevention measures were applied in January for seven international airports. A thermal screening is specially conducted for 500 Indian medical students in Wuhan, China.[17] Three cases were reported on 3 February 2020 in India, whom were the medical students who came back from Wuhan, China. It is noticed that after 3rd February, next case was reported in 2 March 2020. We have presented several illustrations to show the infection growth of India from 30 January 2020 to 5 May 2020 (at 9 pm) in this section. We also focused to present state wise infection growth. As Italy is the first country with largest and deadly outbreak while Spain is second largest country which has deadly outbreak and overtakes the infections and fatalities of China. As of now United States found the largest infection in all over world as it has crossed 3700000 infections and 250000 fatalities (May 5, 2020).

In this section a statistical analysis has been presented for showing the infection growth of COVID-19 in India. We have categorised the analysis in two parts: state and country wise information of India. As available from the best government data sources, 31 states with union territories (UT) are presented with the number of active cases, deaths, recoveries and total confirmed cases from 30 January 2020 to 5 May 2020.[5,18,19]

RECORD OF INFECTED CASES

Figure 2 shows recorded cases (active, death and recovered) of all states, it is found that Maharashtra is the most infected region in India (12089 active, 617 death, and 2819 recovered) and Arunachal Pradesh, Dadra Nagar Haveli is least infected region of India that have only one active case in each region.

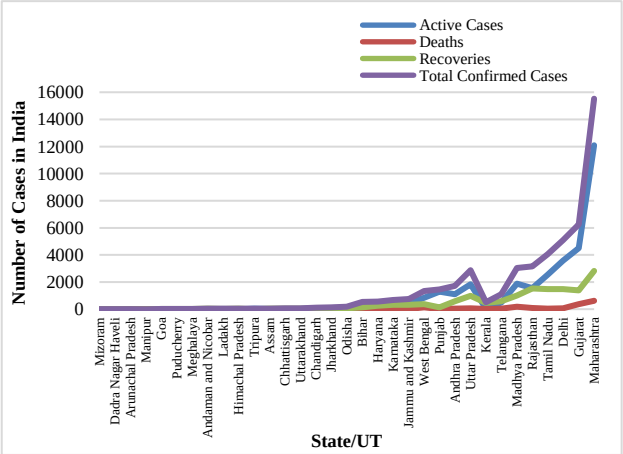

Figure 2: State wise record of cases.[18]

Figure 3 depicted the records of new cases per day. It is identified that cases increased regularly from 20 March 2020.

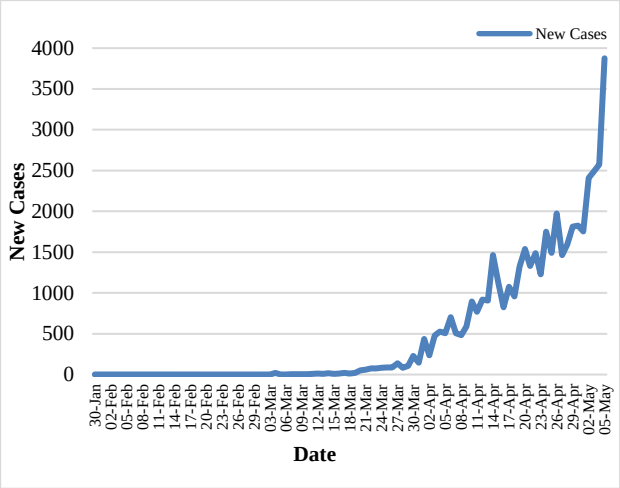

Figure 3: Record of new cases per day.[18,19]

Figure 4 depicts that the total cases per day and it is identified that infection growth has increased from 24 March and it crossed 49000 on 5 May.

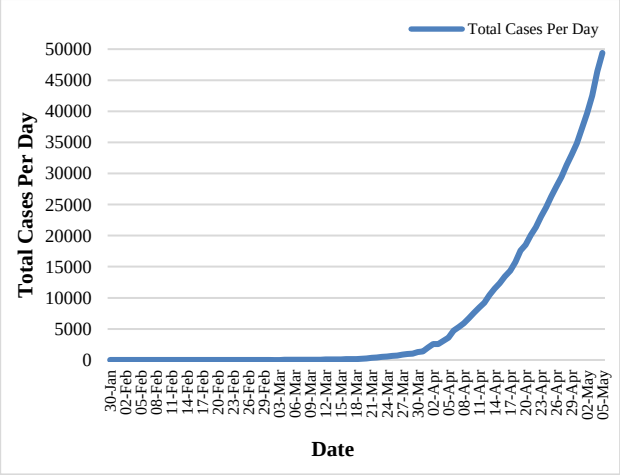

Figure 4: Total infected cases.[5,18,19]

GROWTH RATE RECORD OF INFECTION, RECOVERY AND DEATH

We have calculated the infection growth rate, recovery rate and death rate after collecting the data as of 5 May 2020. The data was recorded from John Hopkins website as follows.[5,18] Total number of confirmed cases (N) is equal to 49391. Total number of death cases (D) is equal to 1694. Total number of infected cases (I) is equal to 33515. Total number of recovered cases (R) is equal to 14182.

We have found the total number of infected cases, death cases and recovered cases from the data source but it is required to calculate current accurate number of infected cases after excluding death cases and recovered cases to calculate the infection growth rate. All formulas are followed from the to calculate infection growth, recovery growth and death growth rate.[39,40] Figure 5 shows the infection growth rate of cases per day.

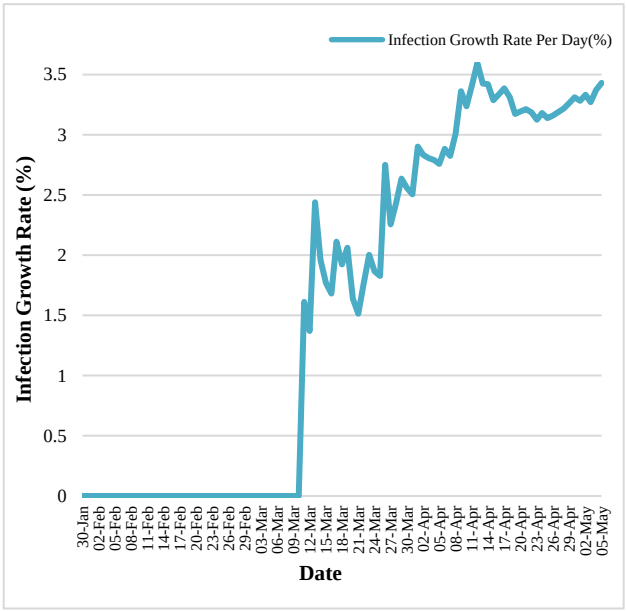

Figure 5: Infection growth rate.[10,18,19]

Figure 6 presents recovery growth rate, as first recovery cases was identified on 16 February. There were 3 infected cases and all were recovered. Table 3 presents the complete information about the calculated recovery rate.

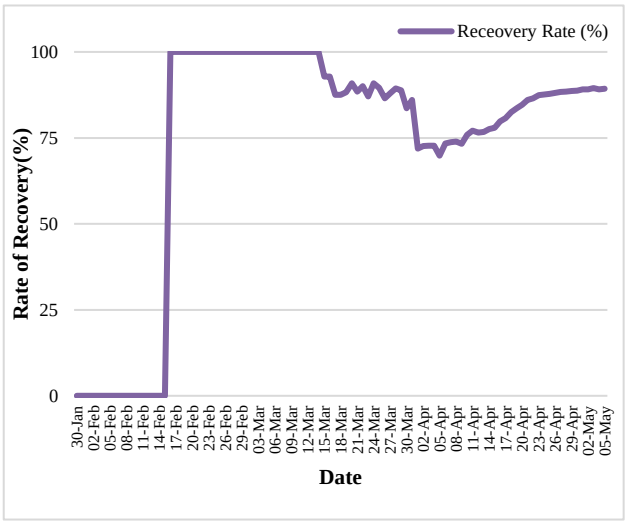

Figure 6: Recovery rate.[10,18,19]

Figure 7 presents the death growth rate. First case of death in India was recorded on 11 March 2020, although it was confirmed on 13 March 2020.[5,18] Death growth rate is varying according to the recorded death per day.

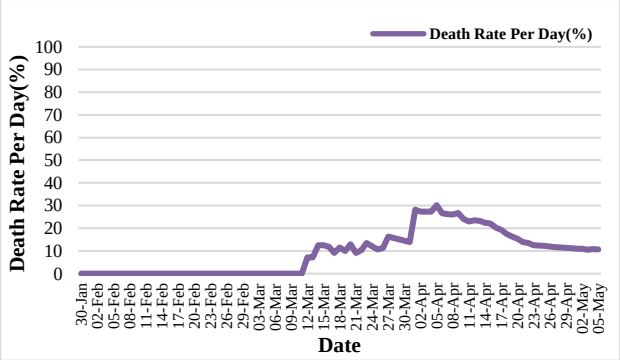

Figure 7: Death rate.[10,18,19]

MOST AFFECTED GENDER AND AGE GROUP

It is analysed by taking some common samples of patients to find the most affected gender and age group. Out of 5313 patients, 3547 male patients were infected while 1766 females were infected, hence it is found that 66.8% men and 33.2% women are caused by the disease.[26] It is also analysed the most affected age group by the 2344 samples of patients.[26] Figure 8 shown the complete age wise infected graph and it is identified that age range 31-40 is highly infected in all age groups.

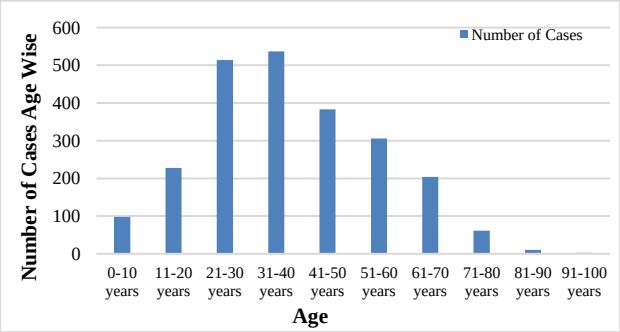

Figure 8: Most affected age group.[26]

OVERVIEW OF DATASETS AND PREDICTION MODELS

Numerous datasets are existing to track the growth of infections, recovery and fatalities. The data is collected and shared by all affected countries and shown on different datasets. The most widely used dataset is John Hopkins University which shows the infected, recovered, and death with their rates on regular basis for all countries.[20] Kaggle is another source dataset to provide the information of COVID-19.[21] Another dataset nCOV2019 presents the geo-location, symptoms, travel history and date.[22] These datasets are presenting the country wise data; a list of prominent datasets is discussed in (Table 1).[23]

Most of the datasets are managed by governmental administrations to update and maintain the accurate data. Healthcare systems need accurate models to face and control the COVID-19 outbreak. It is observed in literature, that the compartmental models are frequently used model in epidemiology.[28] SEIR model is also used for modelling of COVID-19' transmission to manage the flow of people in four compartments "susceptible (S), exposed (E), infected (I), and recovered (R)".[29] Some websites are providing forecasting and prediction model to predict what can be happened in upcoming situations such as: an idea of infected cases, bed and ICU requirements for next two weeks. These models have uncertainty about the predictions and the limitation of these models is slowly updated with current status.[30,31] According to the literature, there are three models are available for forecasting and predictions of the future circumstances. Table 2 had discussed these existing prediction models.

It is identified that only two models providing the projection for India while IHME model is not considering India in their projections. Although they are predicting more features than others.

Table 1: List of datasets.

Data sets	Country	Parameter	Reference
Corona-virus 2019 dataset	All countries	location, travel history, date, and patient info	21
JHU CSSE COVID-19 data	All countries	Infection count, recovery count, death count, and location	20
Coronavirus source data	All countries	Daily confirmed cases	24
CHIME	All countries	Daily infected and recovery count	25
nCoV2019 dataset	Japan, China, South Korea, Taiwan, Hong Kong, Singapore, and Thailand	Patient info, travel history, date, and location	22
COVID-19 India dataset	India	State-wise data, confirmed, recovered, and death	26
Covid-19 knowledge graph set	All countries	Daily infected, recovered, death cases and location	27

Table 2: List of prediction models.

Models	Source	Comment
Worldwide peak forecasting	32	Peak forecasting, infection rate, and growth rate
COVID-19 projections (IHME)	33	Projection of beds, ICU but not available for India
PRACRITI	34	Prediction and assessment of Corona infections and transmission in India

DISCUSSION

Table 3 presented a complete history of confirmed cases after a specified interval from 30 January to 5 May, 2020. This data is used to present the infection growth rate, recovery growth rate and death growth rate. This study reveals that the infection growth is very slow in the early stage of pandemic due to strict control measures implemented. It is evident that if all the external connections with infected persons are restricted, the pandemic can be controlled within a few weeks. Social intervention is a key to control the transmission of infections. If outbreak is small it will take only a short duration to control.[4] But due to some social events it is observed that an accidental growth has reported in few states of India from the last week of March and first week of April.

This study was motivated from China and Italy and also to understand the early phase transmission and infection analysis in India.[35,36] It highlights that the infection growth is slow rather than other countries. Some other studies (example; Boston consulting) predicted the peak of the disease in India can be observed only in June 2020.[37] The overall conducted analysis has been put online for future access.[38]

Table 3: Complete history of confirmed cases.

Date	Total confirmed cases	Death cases	Recovery cases	Current infected cases	Recovery growth rate (%)	Infection growth rate (%)	Death growth rate (%)
30-Jan	1	0	0	1	0	100	0
4-Feb	3	0	0	3	0	100	0
8-Feb	3	0	0	3	0	100	0
12-Feb	3	0	0	3	0	100	0
16-Feb	3	0	3	0	100	0	0
20-Feb	3	0	3	0	100	0	0
24-Feb	3	0	3	0	100	0	0
28-Feb	3	0	3	0	100	0	0
3-Mar	5	0	3	2	100	40	0
7-Mar	34	0	3	31	100	91.17	0
11-Mar	62	0	4	57	100	91.93	0
15-Mar	113	1	13	98	92.85	86.72	12.50
19-Mar	194	2	15	175	88.23	90.20	10
23-Mar	499	4	27	462	87.09	92.58	13.46
27-Mar	887	10	73	794	87.95	89.51	16.39
31-Mar	1397	20	123	1239	86.01	88.69	13.98
05-April	3588	99	229	3260	69.81	90.85	30.18
10-April	7598	246	774	6578	75.88	86.57	24.11
15-April	12322	405	1432	10485	77.95	85.09	22.04
20-April	18539	592	3273	14494	84.68	79.15	15.31
25-April	26283	825	5939	20059	87.80	74.26	12.19
30-April	34863	1154	9068	24641	88.71	70.67	11.28
05-May	49391	1694	14182	33515	89.32	67.85	10.67

CONCLUSION

Prevention is always adopted over care. COVID-19 has raised a situation like time bomb and transmitting all around the world. It is a challenge for every affected country to control and prevent this disease. In fact, no one can stop this pandemic except the social intervention of human beings. Early measures are significant solutions to control this deadly disease. This study has presented an early stage analysis of COVID-19 outbreak in India and also illustrated the different growth rate such as infection growth rate, recovery growth rate and death growth rate. It is observed that in India the infection growth is slow as compared to other countries and the main cause of this because of the strict measures India has implemented. We have analysed individual data of all the states since 30

January 2020 to 5 May 2020 as an early stage of pandemic. This study also discussed about existing data sets and prediction models related with COVID-19 outbreak. This complete analysis is also made available online, which might be useful for future applications.

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