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CORONAVIRUS DISEASE: GENERAL OVERVIEW AND A GLANCE AT THE SITUATION IN INDIA.

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Abstract

Background: *COVID-19 is one among the biggest pandemic that has affected the entire planet placing the livelihood of mankind at stake. The World Health Organization (WHO) declared COVID-19 a pandemic on 11th March 2020. The purpose of this study is to assess and analyze the physical and social impact of COVID-19 worldwide with a focus on Indian demographics.*

Materials and months: *In order to study the trend of infection, we plotted the number of cases reported in various countries and found that India was able to curb initial spread of Covid-19 by an effective lockdown procedure across the country. The data collected for the analysis was from Jan'20 to April'20. The growth of infection in India and in the state of Kerala were studied through a line graph and it showed that the infection can be brought under control when the line of recovery rate overtakes the line of infection rate. The state of Kerala achieved this state in a period of over two months. Various mathematical and statistical representations of the infectious disease were studied to understand the trend of infection and its economic impact in the society. By simply counting the doubling time to the usage of differential equations in the calculation of R0 was studied as the number of parameters considered in the growth of the infection varies. It was found that by enforcing a strict lockdown in the country, the public, the healthcare facilities and the government were able to make up time for managing the impending spread of infection and its impact in the society.*

Conclusion: *The measures adopted by the government of India has efficiently and effectively helped in controlling COVID-19 from becoming a community spread nationwide. The economy has dropped down drastically, but the government has initiated some steps to help the citizens survive during this pandemic.*

Key words: *Covid-19, Demographics of COVID-19 worldwide, Economic impact in India by Covid-19, Physical impact of COVID-19 in India, Rate of growth of infection, R0 value of infectious disease, Statistical analysis.*

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Introduction

The novel CoronaVirus Disease (COVID - 19) is an unpredictable infection that affects the respiratory system causing mild to severe symptoms. This disease was first observed in Wuhan, China in December 2019. COVID–19 was declared a pandemic by the World Health Organisation (WHO) on 11th March 2020. The first case of COVID–19 was reported in India on 30th January 2020.

Clinically, COVID–19 has a range of symptoms like fever, dyspnoea, dry cough and fatigue. A few symptoms like Upper – respiratory tract infection and diarrhoea were also reported. Imaging of both lungs depicted multiple ground glass shadows and infiltration shadows. The disease was transmitted through various channels such as; droplets, oral mucus membrane, faeces and aerosols. In severe cases, acute respiratory distress syndrome and septic shock were observed.

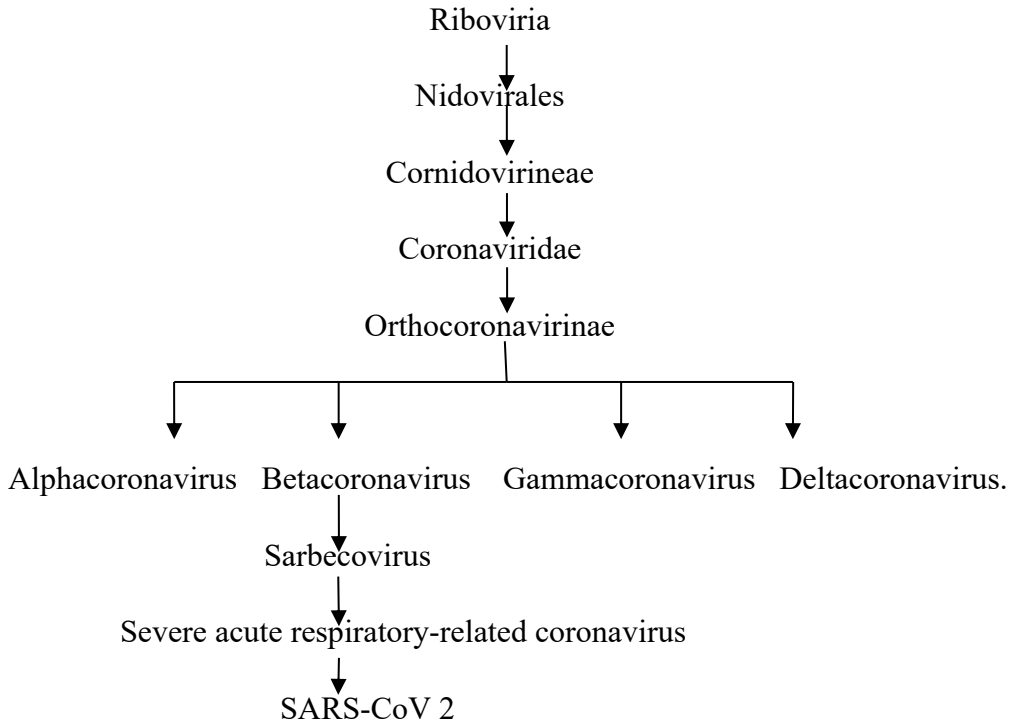
Objectives :

To assess and analyze the physical and social impact of COVID–19 holistically with a pivot on the Indian demographics.

COVID taxonomy, structure and pathogenesis

Coronavirus, a zoonotic pathogen, is an RNA virus, belonging to the family Coronaviridae (subfamily Coronavirinae) under the order Nidovirales. Even though it was identified in the early 1960s, the recent outbreak of COVID-19 is creating havoc globally due to lack of proper risk assessment and treatment options. (Yan Y et al.,2020)

Around 39 species of Coronavirus have been identified and sub-classified under Betacorona virus based on their serological and genomic properties. (Yan et al., 2020). Betacoronavirus is further divided into A, B, C and D lineages. (Fig.1) These species undergo frequent recombination and mutation and are found in large numbers with great genetic diversity. Mutated coronavirus is potent enough to infect humans resulting in mild to serious respiratory disease depending on the health status of the person as well as the lineage of the coronavirus. There are seven species of coronavirus discovered that can infect human hosts. (Vellingiri et al., 2020, Lu R et al.,2020)



. Figure 1

COVID-19 shows a receptor-binding domain, ACE2, similar to SARS CoV and MERS CoV. (Paules et.al.,2020). According to a study conducted by Phan Tung (Phan T., 2020), a pair wise sequence analysis conducted exhibited 88% nucleotide sequence similarity to SARS CoV compared to another coronavirus.

CoV-19 is a spherical particle with a single stranded enveloped RNA virus of size 100- 160nm in diameter with a positive-sense RNA genome (ssRNA). It is characterized by the largest RNA genome with size ranging between 26kb to 32kb. This virus has four primary structural proteins consisting of: (i) a spike protein (S) (ii) membrane glycoprotein (M) (iii) an envelope protein (E) and (iv) nucleocapsid protein (N). Genomic RNA is encased within the Nucleocapsid protein. A few subsets of Betacoronavirus consists of hemagglutinin-esterase dimer protein (HE), which help enhance the binding properties of S protein to host receptors. (Jin Y.et al.,2020)

Spike protein is the distinct and largest protein-mediated viral complex found at the outermost surface, important for cell adhesion and virulence. It plays a key role in host cell attachment and is heavily glycosylated. **Nucleocapsid protein** helps the virus to develop the capsid. It is heavily phosphorylated and binds to the genome of the viral particle in the form of strings. This

protein binds the viral genome to replicate transcriptase complex and encases the viral genome into viral particles (Li et.al., 2020). **Envelope protein** is a transmembrane protein mediated with ionic channel that help in viral transmission. These are very few in number and have limited role in viral replication. **Membrane Protein is a** structural protein and is found in large quantity. They mostly exist in dimer form and maintain the membrane curvature. They also aid in binding to the nucleocapsid. **Haemagglutinin dimer protein** is found in subsets of Betacoronavirus. It assists the host cell entry of the viral particle mediated by S protein and enhances the spread via mucosa. (Shareen M A. et al.,2020)

Etiology and Pathogenesis

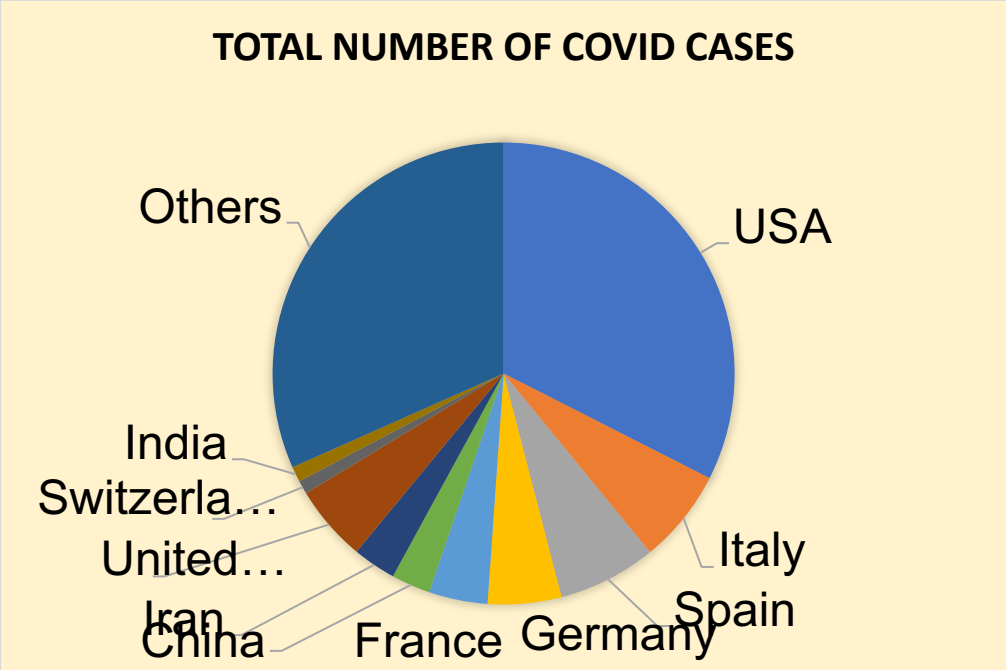
The similarity between SARS-CoV and SARS-CoV-2 is its affinity towards ACE2 receptors in the human or host cells. In humans, this protein is mainly expressed in lungs, kidney, intestines and are thus prime target for attack (Vellingiri et al., 2020). Studies prove that SARS CoV-2 shows a 10–20-fold higher affinity to human ACE2 compared to SARS-CoV, resulting in increased human transmission. As soon as the virus enters the host cell, the viral RNA genome is released into the cytoplasm and gets translated into two polyproteins and structural proteins further undergoing replication. (Wrapp, D et al.,2020). The newly built envelope glycoprotein gets inserted into the endoplasmic reticulum or Golgi, where the genomic RNA and nucleocapsid protein combine to form the nucleocapsid. This is followed by germination of viral particles in the endoplasmic reticulum–Golgi intermediate compartment. Finally, the vesicles containing virus fuse with plasma membrane and gets released (Walls et al., 2020).

The APC (antigen presentation cells) of the host along with MHC (major histocompatibility) soon recognizes the viral entry and starts stimulating the humoral and cellular immunity. It triggers a strong immune response resulting in cytokine storm syndrome. There is an observed uncontrolled release of pro–inflammatory cytokines leading to hypercytokinemia and acute respiratory distress syndrome (ARDS) and multiple organ damage. There is a great challenge to the total number of T cells with decrease in CD4 T cells and CD8 T cells and functional loss in existing T cells. This leads to secondary infection thereby worsening the status of victims. (Wang H.et al.,2020)

Looking at Covid-19 Numerically and the Measures Taken.

The novel corona virus infection has spread worldwide and according to WHO 213 countries/ territories have reported the infection so far. As of April 30 2020, there are 3,090,445 confirmed cases of Covid-19 with 217,769 deaths across the world. The

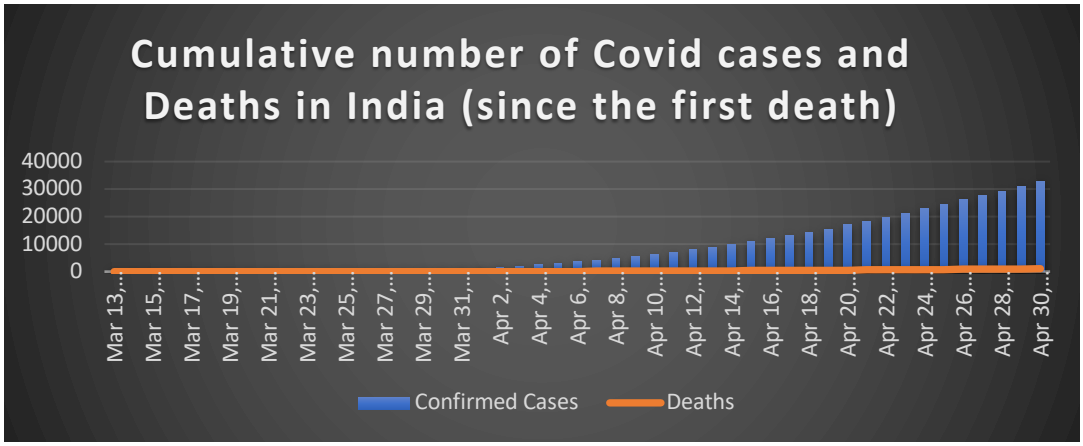
distribution of this infection is not uniform around the globe, which is clear from the fact that the most number of cases have been reported from US, Italy and Spain. India has the number of confirmed cases to be a slightly worrisome 33,050. But the case fatality rate of India is not alarming (3.24%) with 1074 total deaths.



Graph 1

The pandemic of Covid-19 started in China in December 2019, but it started spreading to all over the world by January 2020. Due to the high degree of similarity of corona-virus with SARS virus, it was calculated that corona-virus has an infection rate 57.87 times faster than SARS (Yue et al.,2020) seeing rise of COVID-19 cases in China the WHO declared COVID-19 to be a pandemic and alerted all countries about the infection.

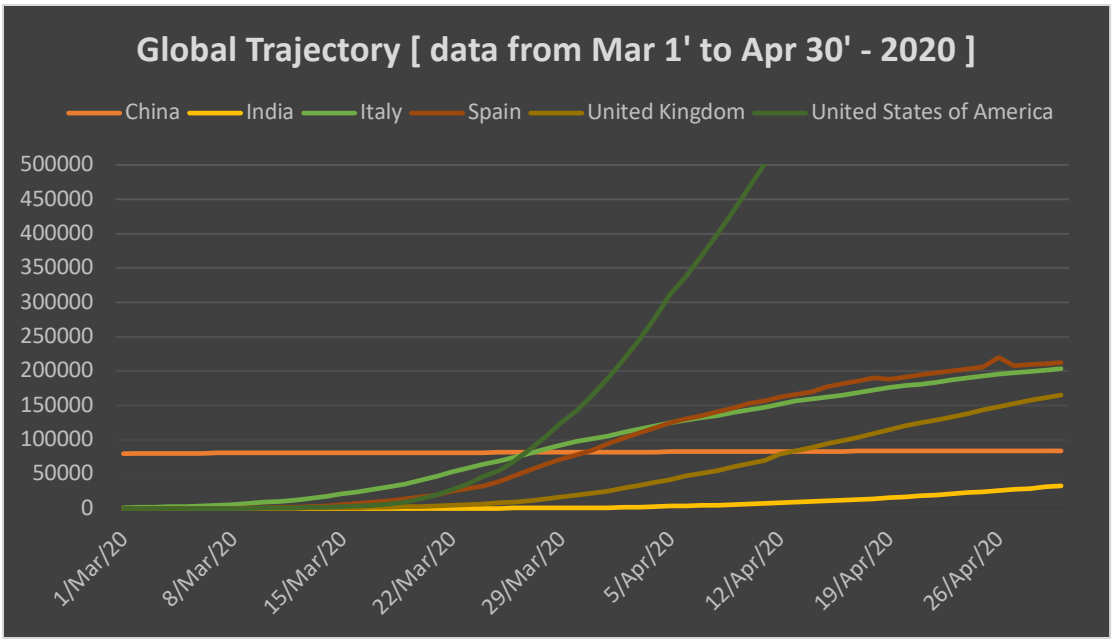
The first case in India was reported on 30th January 2020 in the state of Kerala. The preventive measures of screening for COVID-19 cases at the International Airports were already in place which helped in isolating the infected persons and increasing the vigilance across the country. Yet the infection of COVID-19 spread across India in the last two months with Maharastra reporting highest number of cases since mid-March.



Graph 2

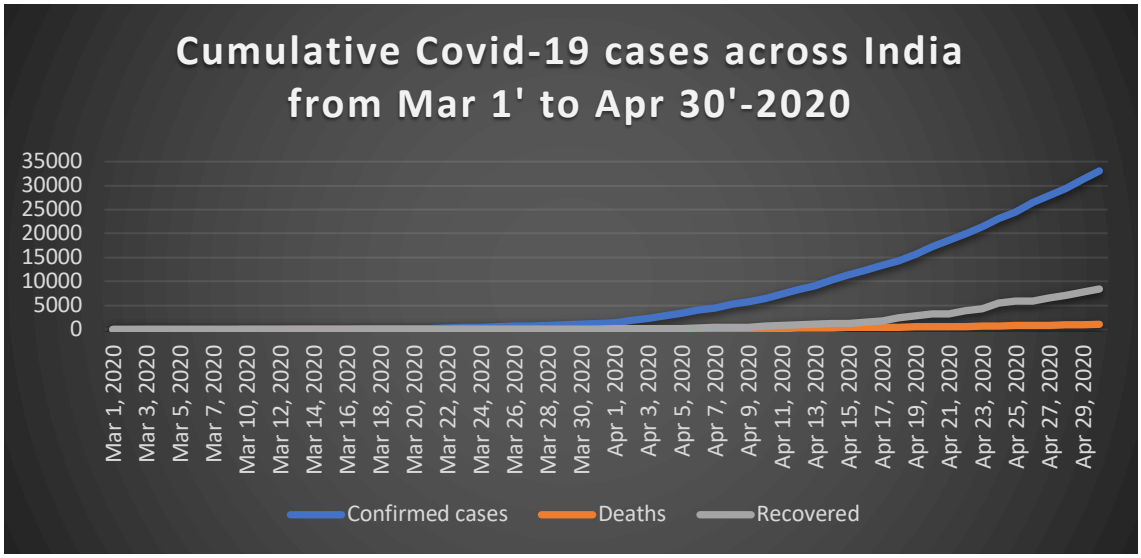
The number of reported cases have steadily increased since March. The graph for the number of cases in India was predicted to follow that of US with a 13 days lag, which could have been a big disaster. But the government ordered a complete lockdown of the country on March 23, 2020, which could be the reason for making a difference in India's current graph. The central and state governments have carried out the lockdown procedure quite meticulously. Restricting any movement across the country was a huge task but the Police force ensured the orders were followed. Back tracking of individuals who had come in contact with a confirmed cases and follow-up for isolation and observation of symptoms development was handled by the health care professionals (Chatterjee et al. 2020).

The number of confirmed cases increase over a period of time reaching a peak value and then the number reduces. This is the common pattern found during a pandemic. Studies show that it is when the curve starts to flatten and the line representing recovering cases stands above that of confirmed cases, that we can say the infection is under control. In the graph we see that China has reached a flat line at a total number of cases of 80,000. But in the case of US and few European countries, the curve is yet to stabilized.

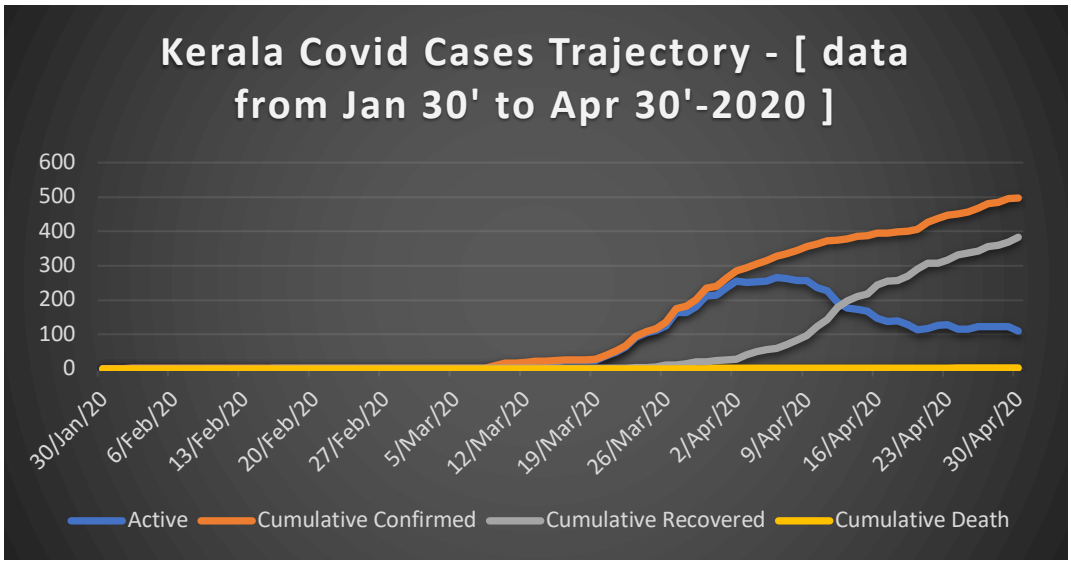


Graph 3

In case of India, we see an increase in confirmed cases towards end of March 2020, but the numbers have still not grown to be alarming. A few isolated incidents of citizens breaking the lockdown restrictions or pre-curfew social gatherings could be the reason for the infection to continue. The WHO has already labelled India under the category ‘Clusters of Cases’ which means we have avoided Community spreading of COVID-19 to a larger extend. If we are to compare the graph of Kerala, we can clearly see the trajectory and flattening of the curve for the COVID-19 infection coming true (refer Graph 4 and 5). The number of recovered cases have started outnumbering the confirmed cases of COVID-19 in Kerala by the second week of April 2020. This is a big relief but the scare of infection is not long gone. The containment measures must be taken seriously in order to curb the rate of increase in the number of new cases and thereby providing effective medication to larger number of people (Borges et al. 2020).



Graph 4



Graph 5

A mathematical representation to study a pandemic like COVID-19 is the infection rate value, commonly known as R0 (R naught) (Aronson et al. 2020). Infection rate is the probability or risk of infection in a population posed by a single infected case. It is also known as transmission rate because it gives the number of cases that are to be expected to occur on an average in a population where all are susceptible. The value is dependent on the proportion of susceptible cases/density of population, infectiousness of the organism and the rate of decrease in active cases, either by recovery or death. So higher the R0 value, the faster the infection is likely to spread. An ideal value of R0 for an infection like COVID-19 to be

contained is lesser than 1. The R0 value is also time dependent. The value must be measured at the beginning of the pandemic, when the population has 0 immunity against the infection. When the value is calculated in the due course of infection, it become Re (R effective) as the population starts getting immunity either by recovery or immunization. In India, the pre-lockdown period was found to have an R0 value of 1.66, but then 55 days after lockdown i.e, towards the end of April the value was reduced to 1.26. (Biswas. A 2020).

Another concept, borrowed from the business world, is to look at the number of days taken to double the number of confirmed cases to see how fast the infections is spreading. As of 30th April, the infection is doubling in the world at the rate of 20 days and if we see the case of India, it is 10 days (refer Table 1). The pace of infection spreading is studied to manage medical facilities and containment measures. The same idea is used to see the number of days it takes to double the number of deaths which can give the severity of the infection spreading at a faster rate (Roser et al.2020). The world's doubling time of deaths is 17 days while the same for India is found to be 10 days. The growth of infection in India has been at a steady rate and the doubling time did not vary erratically.

India		
Date	Confirmed Cases	Deaths
Apr 16, 2020	12380	414
Apr 17, 2020	13387	437
Apr 18, 2020	14378	480
Apr 19, 2020	15712	507
Apr 20, 2020	17265	543
Apr 21, 2020	18600	590
Apr 22, 2020	19984	640
Apr 23, 2020	21393	681
Apr 24, 2020	23077	718
Apr 25, 2020	24506	775

Apr 26, 2020	26496	824
Apr 27, 2020	27892	872
Apr 28, 2020	29435	934
Apr 29, 2020	31332	1007
Apr 30, 2020	33050	1074

Table 1

Early containment measures and arranging for essential treatment facilities are the key factors for keeping a tab on the infection. The fatality rate is the ratio of total deaths over confirmed cases in the country (Roser et al. 2020). Now the situation across countries varies in the fact that the testing of COVID-19 infection is not done to a larger share of the population. Testing is performed on a suspected set of population hence the rate we could calculate can be called case fatality rate (CFR). It shows the severity of the infection at a given time in a given place. The value is not constant. India's CFR is found to be 3.24% (as of April 30 2020). Though a ratio of this manner is suppose to tell us the risk of death for someone with the infection but in the current scenario that is not accurate because of India's low testing rate. When compared to the rest of the world, India's testing rate is merely 758 per million.

Kerala has a population of 33 million and 25973 tests have been conducted so far. It is calculated to be 870.1 tests per million for Kerala (Kannan. S 2020) Other states with higher tests per million are given in Table (2).

State	Tests per million
Delhi	2344
Andhra Pradesh	2030.4
Tamil Nadu	1807.4
Maharashtra	1247.4

Table 2

At the initial phase of the lockdown period, Kerala's doubling time for infected cases was 3 days but by the end of April, when the second phase of lockdown came to an end, the

doubling time was increased to 31 days. These numbers also confirm the effectiveness of the complete lockdown that was enforced strictly by the state government.

The country all over was economically affected during the lockdown period raising the unemployment in the country by 26%. About 45% of the household in India reported income drop(Vyas, M. 2020). The larger portion of this population fell under informal sectors and daily wage groups. In order to provide some relief, the government announced economic packages to many. The small businesses like perishable goods supply, electronics and construction goods supplies were forced to lock goods up as there was no demand in the market. Tourism sector, local transport facilities like rickshaws and taxis were also affected as movement across cities were also restricted. But many businesses found help with the latest trends of online services and home delivery apps that kept them alive. In Kerala a few of the response initiatives were Rs 20,000 cr relief package, testing centres where "walk-in" facility was provided for people to come test and an app named GoK Direct to provide updated COVID-19 status and awareness information(Srivatsava. T 2020).

With continued efforts in enforcing social distancing and personal hygiene routines among the general public, India may be able to suppress the infection spread. The challenge is to maintain the containment as India prepares to bring the stranded citizen from all over the world back home. The main aim was to not overwhelm India's scanty medical facility and this was achieved by providing a slow rate of increase in COVID-19 infected cases during the initial days of the pandemic, thus giving enough time for the medical sector to accumulate provisions to ensure equal treatment to all.

Conclusion

India, with a population equivalent to 17.7% of world population, has been fighting the COVID-19 infection with NPI (non-pharmaceutical intervention). The complete lockdown strategy enforced across the country is one of the major reason that held the infection under the radar. While other countries were reporting large numbers of cases and deaths, India was able to keep a tab on COVID-19 by increasing the doubling time of infection to up to 10 days. The state of Kerala showed by example that in spite of being the first state to report COVID-19 cases, they were able to curb the spread and flatten the statistical graph by bringing down the number of active cases below the number of recovered cases. The country awaits the next challenge posed by the return of non-resident Indians due to various hardships they encountered in the foreign lands. Opening of businesses in India may also lead to change

in the current COVID-19 situation. The citizens of India must take up the responsibility to bring the change and support the efforts of the government.

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