Comparative analysis and epidemiological study of SARS-CoV-2 in first wave among different states of India

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Research Article

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Abstract

Over the past few years, Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) has shown a global spread. While various governments and medical organizations are still attempting to control the disease's spread to overcome the global health crisis, the development of vaccines has also contributed in decelerating the spread. India has been among the top death-toll nations caused due to SARS-CoV-2. Among the global data, India was found to be the third country with the highest mortality cases of 157 thousand, and Maharashtrawas having the most higher number of mortality cases followed by Tamil Nadu and others. Retrospective study on data from 28 Indian states and 8 Union Territories (UTs) provided a detailed look at the transmission pathways and case fatality rate (CFR) of the SARS-CoV-2. The percent distribution of CFR calculated in each geographical zone of India i.e. Central, Eastern, North Eastern and Northern, Southern and Western zone was 17%, 14%, 7%, 22%, 12%, and 28%, respectively. The CFR was significantly (P<0.01) higher in period II comprising April to June of the year 2020. We calculated the CFR for every month using a standard formula and noted that the CFR varied significantly across different times of year (P<0.01). Moreover, CFR was also evaluated spatially across different geographical zones in India. We observed that western zone showed the highest CFR as compared to other zones. The epidemiology of SARS-CoV-2 was evaluated in patients of various ages and co-morbidities. Patients >21 years had the highest age-specific positivity rate. The prevalence of SARS-CoV-2 patients in acute and chronic diseases was 12.87 and 87.13 percent, respectively. Thus, this analytical epidemiological study serves specifically in establishing a relationship between SARS-CoV-2 infection and other precipitating factors causing morbidity and mortality during the given time frame in the first wave, in the year 2020 (Jan-Dec, 2020).

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection, that arose in Wuhan, China in late 2019, completely spread all over the world, creating an emergency situation and worst-ever pandemic of modern times\textsuperscript{1}. This pandemic caused 3.2 million deaths and infected more than 158 million people worldwide by May 11, 2021\textsuperscript{2}. During the early stages of the pandemic, epidemiologic studies and disease surveillance were conducted in China\textsuperscript{3-5}, Europe\textsuperscript{6-7}, and North America\textsuperscript{8-10}, to better understand the current SARS-CoV-2 pandemic. The majority of confirmed cases occurred in low and middle-income countries (LMICs), where a significant number of individuals were at increased risk of outcomes and faced barriers to accessing high-quality health care\textsuperscript{11-13}. Although many more studies are needed to assess how SARS-CoV-2 affects individuals and communities\textsuperscript{14-16}, there is almost no fundamental approach available to explore strategies for SARS-CoV-2 transmission dynamics and clinical outcomes\textsuperscript{17}.

In the initial spells, the clinical diagnosis of SARS-CoV-2 was based on clinical symptoms, fundamentally, fever (99%), fatigue (70%), dry cough (60%), myalgia (44%), and dyspnea were identified as the most common symptoms of SARS-CoV-2\textsuperscript{18-20}. Headache, dizziness, diarrhea, nausea, and vomiting are the additional symptoms of SARS-CoV-2 were less common\textsuperscript{21}. Symptoms of severe illness
include pharyngeal pain, dyspnea, dizziness, abdominal pain, and anorexia. Elderly patients with co-morbidities such as hypertension, diabetes, cardiovascular disease, and cerebrovascular disease experienced negative outcomes. Lymphopenia, prolonged prothrombin time, elevated lactate dehydrogenase, and elevated D-dimer were found in SARS-CoV-2 patients who were hospitalized, which is similar to SARS-CoV-1 that caused an outbreak in 2003 in China and MERS-CoV infections. Chest imaging showed some bilateral patchy shadows and ground-glass opacities. Acute respiratory distress syndrome, acute cardiac injury, arrhythmias, acute kidney injury, and shock, were among additional SARS-CoV-2 complications. The virus reportedly spread at a rate of 40% in hospitals. In hospitalized patients, the mortality rate was around 4% during that period in India (the first wave of COVID-19), there was a dearth of holistic data to associate them with the various clinical pictures manifested by patients affected with the disease. Eventually, it becomes necessary to make a holistic analysis based on the existing health system vis-à-vis the clinical picture, co-morbidities, and other vital parameters during the first wave, where the clinical infrastructure was unprepared for such an emergency.

In India, the total cases were 10.3 million, recovered 9.9 million, and 148.4 thousand death (until the development of this manuscript). Non-pharmaceutical measures (traveling restrictions, public transport closure, and workplace closing) taken for limiting the spread of this pandemic incur social and economic costs. Hence, vaccination was used as an alternative (after conducting clinical trials on the duration of infectivity, the safety of the vaccine, the severity of resultant disease, and the efficacy of infection reduction) to overcome the spread of infectious SARS-CoV-2. However, the haste of limiting the pandemic left us with many questions and lack of detailed epidemiological and spatio-temporal analysis of the data, which could refine the and evaluate the strategies as well as enhance the preparedness for the future. Therefore, the present study was designed to analyze the retrospective data on mortality and morbidity vis-à-vis spatio-temporal occurrence data of India along with various age groups and co-morbidities of patients across the timeline of the year 2020.

**Materials And Methods**

SARS-CoV-2 data was collected from online available sources (https://api.covid19india.org), co-morbidities and age group of SARS-CoV-2 patients data were taken from the website of the National Centre for Disease Control, New Delhi. SARS-CoV-2 data for twelve months of the first wave was collected from January to December 2020 and also, classified into four different periods. Period I contained January to March; period II contained April to June, period III contained July to September, while period IV contained October to December of the year 2020. Further, data of SARS-CoV-2 was analyzed in different geographical zones of India as well as information based on different states of India cutting across co-morbidities and different age groups. The geo-epidemiological analysis was done using open-source software, QGIS (Quantum GIS development Team, 2021).

**2.1 Statistical analysis**
2.1.1. Case Fatality Ratio

The CFR of SARS-CoV-2 was calculated by the given formula:

\[
\text{CFR\%} = \frac{\text{number of deaths}}{\text{Confirmed cases}} \times 100
\]

2.2. Percent of Distribution

Percent of distribution is a measure of how a variable (Such as total cases) is distributed among the component parts that make up the total. The calculation of percent distribution is relatively simple and is derived from the division of each part by total to get a percent of the distribution.

2.3. Least Squares Means Analysis

Least squares mean analysis was used to estimate the variance components and parameters (LSMLMW, version-2.0)\textsuperscript{27}. The following model was used to analyze the effect of various SARS-CoV-2 factors.

Model 1:

\[
Y_{ij} = \mu + \text{Period}_i + \text{month}_j
\]

Where \(Y_{ij}\) is the observation of \(i^{th}\) period (Jan-March, April-June, July-September, October-December 2020, \(j^{th}\) month)

\(E_{ij}\) = random residual error associated with observation with mean 0 and variance 1

\(\mu\) = population of mean

\(\text{Period}_i\) = fixed effect of \(i^{th}\) period (Jan-March, April-June, July-September, October-December 2020, \(i=1,2,3,4\))

\(\text{Month}_j\) = fixed effect of \(j^{th}\) period (Jan to Dec 2020, \(j=1\) to 12)

Results

3.1 Epidemiology, different geographical zones of India

The data of case fatality ratio (CFR) was calculated in 36 Indian states/UTs. Punjab, Maharashtra, and Sikkim had highest 3.22, 2.44 and 2.20 case fatality percent in India as compared to other states of India (Fig.1). Similarly, the CFR in India's various zones were calculated in all the six geographical zones used in the current study viz., Central Zone, Eastern Zone, North Eastern Zone, Northern Zone, Southern Zone, and Western Zone. The western zone of India had the highest CFR percentage as compared to other
zones (Fig. 2). The CFR percent of the Central Zone, Eastern Zone, North Eastern Zone, Northern Zone, Southern Zone, and Western Zone were 1.42, 1.15, 0.60, 1.77, 0.94, and 2.33, respectively.

### 3.2 Case Fatality Ratio

Least squares mean of case fatality ratio (CFR) rates were examined from January 2020 to December 31, 2020, spanning 337 days. Coefficient variation, R squared and an average of CFR were 17.91, 0.884, and 1.908% respectively over the year. The CFR was calculated for every month of the year 2020. CRF% was at its highest between April-June (Fig. 3). ANOVA of month-wise data showed a significant effect ($p<0.01$) on CFR (Table 1). Furthermore, the least squares means were examined in different periods of months and classified into 4 (four) distinct periods, namely period I (Jan to Mar 2020), period II (Apr to Jun 2020) period III (Jul to Sept 2020), and period IV (Oct to Dec 2020). CFR of the period was calculated as per the data of deceased, eventually ‘zero’ deceased or ‘zero’ CFR data were removed from the data analysis for least squares means. Coefficient variation, R squared, and average of CFR in the different period were 27.97, 0.768, and 1.908%, respectively. The least squares mean of CFR of different periods were presented in Table 2. The CFR was significantly ($p<0.01$) higher in period II comprising April to June of the year 2020. Also, it was observed that there was a significant difference in the CFRs while comparing month-wise data (Table 3). The CFR percentage was calculated for each state by period, as shown in Fig. 4. The CFR of Indian states was comparatively higher from April to June as compared to January to March, July to September, and October to December of the year 2020.

### 3.3 Percent of distribution of SARS-CoV-2 cases in India

In the current study, we estimated the case fatality ratio (CFR) percent in various geographical zones of the country. In India, the Percent distribution of CFR in Central, Eastern, North Eastern, Northern, Southern, and western were 17%, 14%, 7%, 22%, 12%, and 28%, respectively (Figure 5). Maharashtra had a significantly ($p<0.01$) higher percentage of SARS-CoV-2 positive cases than the other states. By December 2020, India had reported several million cases of SARS-CoV-2; with cases, trending showed their percent distribution among different zones of India. The percent of the distribution of SARS-CoV-2 positive patients was 7.0% in the Central Zone, 8.0% in the Eastern zone, 12.0% in North Eastern, 25.0% Northern, 24.0% in the Southern zone and 24.0% in Western Zone (Fig. 6A). The highest positive SARS-CoV-2 cases were found in Northern zone (25%) followed by Western zone (24%) and the Southern zone (24%) of India. The percent of the distribution of mortality was highest in the Western zone (38%) followed by the Northern zone (29%) than others (Fig. 6B).

### 3.4 Effect of SARS-CoV-2 in various age groups

The trend of SARS-CoV-2 cases was estimated in different age groups based on the limited data available online. There were four age groups identified: <20 years (including aged below 20 years), >21 years (including aged 21-50 years), >51 years (including aged 51-80 years), and >81 years (including aged 81-90 years). The incidence rate among different age groups was evaluated in the Indian population. Age-specific estimates ranged from 12.37% at ages <20 years to 0.09% at ages >81 years. Age-specific
SARS-CoV-2 incidence rate showed that the >21 years age group was most affected, while the old (>81 years) age group was the least affected in India (Fig. 7). Similarly, age-specific data showed an almost similar trend on the Statista website (India: COVID-19 cases by age group 2021 | Statista).

**Co-morbidities in SARS-CoV-2 patients in India**

Co-morbidity data were classified into two different categories in the present analysis i.e. acute and chronic. The acute diseases included cardiac affections, Asthma, Bronchitis, and Neuromuscular affections, while chronic diseases included Hypertension, Diabetes, Liver disease, chronic renal diseases, Chronic obstructive pulmonary disease (COPD), Immuno-compromised conditions, and Malignancy. The incidence percent of SARS-CoV-2 patients in acute and chronic disease exhibited 12.87 and 87.13 percent, respectively (Fig. 8). The chronic patients were significantly affected by SARS-CoV-2. Of the all co-morbidities, hypertension was the most reported followed by diabetes and liver disease. CFR for SARS-CoV-2 was shown to be increased with the presence of co-morbidities [28-30] such as hypertension (CFR=6.0%), diabetes (CFR=7.3%), cardiovascular disease (CFR=10.5%), chronic respiratory disease (CFR= 6.3%) and neoplasm (5.6%)28.

### 3.5 SARS-CoV-2 trend over the period

The SARS-CoV-2 trend was analyzed from January 2020 to December 2020. We plotted the trend of SARS-CoV-2 cases and analyzed its impact across the timeline of 2020. However, the trend of SARS-CoV-2 confirmed cases was slightly elevated after the month of May 2020 than earlier. Similarly, SARS-CoV-2 patients had the same mortality trend as SARS-CoV-2 confirmed cases (Fig. 9 and Fig.10).

**Discussion**

Our findings are based on extensive surveillance and contact-tracing data collected from 36 Indian states/UTs. The present investigation was carried out in different states of India and comparative analysis was conducted cutting across various age groups and co-morbidities with comparisons drawn from a previous study which conducted a similar analysis but only in two states viz., Andhra Pradesh and Tamil Nadu 1.

SARS-CoV-2 had been reported from 58 countries and territories around the world as of February 28, 2020, and one international conveyance, the Diamond Princess Cruise Ship 31. As of December 29, 2020, there had been 4 million new SARS-CoV-2 cases and 72,000 new deaths were reported. This brings the cumulative numbers to over 79 million reported cases and over 1.7 million deaths globally since the start of the pandemic. This study shows that in India, a total number of 11.06 Million SARS-CoV-2 cases, total of 0.16 Million death cases and 10.75 Million recovered cases have been reported. Out of the total cases, 2.13 Million cases were mostly reported from Maharashtra, with 51,993 death cases. Similarly, the vast majority of cases (78,824 out of 83,704; 0.9416 - 95 percent CI 0.94 to 0.9433) and deaths (2,790 out
of 2,859; 0.9758 95 percent CI 0.9696 to 0.9809) have been reported from mainland China \(^2\). The first U.S. cases of non-travel-related SARS-CoV-2 were confirmed on February 26 and 28, 2020, which clearly suggested the community transmission in U.S. by late February \(^3\). The aforesaid data is very important that elucidates the severity of the first pandemic wave of Covid-19 in states majorly affected. Hence, in the current study to get a clear picture, we analyzed all the 36 Indian states/UTs of the country for a comprehensive analysis of various parameters vis-à-vis SARS-CoV-2 infection.

Further, this study compared the CFR among the states that reported a large number of SARS-CoV-2 cases at 12 months of the pandemic, namely Jan 2020 to December 2020. As per our current analysis, it is reported that Maharashtra (2.441%), Punjab (3.215 %), and Sikkim (2.201 %) had the highest CFR than other states of India. In a previous study, a similar analysis has been conducted for the southern states viz., Tamil Nadu and Andhra Pradesh. The findings showed that CFR in all ages was 2.06 (1.98 to 2.14%), and CFR in various ages was also examined\(^1\). However, the global picture for CFR as far as the first wave of Covid-19 was also studied in a specified period (12\(^{th}\)-23\(^{rd}\) of March, 2020) of the pandemic which showed higher CFR rates in Italy (6.22%), China (3.91%), Iran (3.62%), USA (3.07%) and Spain (2.12%)\(^4\). The case-fatality ratio was calculated in Turkey as well as European countries including the findings in Turkey, Italy, Spain, the UK, Germany, France, Switzerland, Belgium, Netherlands, Austria, Portugal, and Norway were 1.85, 3.95, 4.01, 4.40, 0.41, 1.979, 1.019, 3.393, 3.496, 0.660, 2.249 and 0.531 percent, respectively\(^5\).

To begin, assume that the number of deaths reported is equal to or very close to the actual value in the investigation, which may not be the case in many countries. The CFR was calculated for each period, namely period I (January to March 2020), period II (April to June 2020), period III (July to September 2020), and period IV (October to December 2020). Our finding also proved that the CFR was significantly increased due to a lack of facilities in the initial days and thereafter the CFR trend decreased as facilities were getting improved. Ideally, the CFR should be low at first due to the incubation time and delay in developing complications from the infection, which was gradually increased until it reaches a plateau that will eventually become the ultimate CFR for the diseases. Although the number of cases started increasing in period II and III, it is also to be noted that the number of samples tested were also proportionally higher during that period. From the first case reported in India in January 2020 to the start of the first wave, the number of labs equipped to test the samples were very less in number, but eventually, the testing centers increased in India\(^6,7\). The first wave in India occurred relatively for an extended period of time, and the reasons may be due to multiple lockdowns and restrictions. The nationwide lockdowns during the second quarter of the year 2020 and further lockdowns down the year have slowed down the spread of SARS-CoV-2, which has contributed to the extended period of the first wave.

In the present investigation, SARS-CoV-2 patients suffered from several co-morbidities which were further classified into two: Acute and Chronic. The incidence percentages of acute and chronic were 12.87% and 87.13%, respectively. In India, it is important to know the mortality rates related to different
age groups and underlying co-morbidities. Further, the first wave saw a high risk for co-morbid patients affected with SARS-CoV-2, which is due to the dearth of knowledge attitude, and practices (KAP) for a relatively new disease with less proven treatment protocols. Hence, it is important to analyze the data on COVID-19 in co-morbid patients, so that it could be a model for implementation in high-risk populations. Also, the lessons learned from the first wave of COVID-19 is altogether different compared to the second wave, with the first wave having the unmutated strain of SARS-CoV-2 that showed fewer positive cases but more CFR. The Omicron BA.1 strain thus exacerbated the condition in patients with co-morbidities due to a lack of KAP and clinical infrastructure.

Furthermore, elderly patients with underlying co-morbidities such as diabetes, hypertension, cerebrovascular disease, and cardiovascular disease, are more likely to have negative outcomes. People of any age who have underlying medical conditions such as hypertension or diabetes have a worse prognosis. Diabetic patients have higher morbidity and mortality rates, as well as more hospitalizations and intensive care unit (ICU) admissions. Diabetic patients are more prone to the deleterious and severe effects of the Covid-19 which is due to the fact that the inflammatory processes are elevated because of constant glucose recognition by C-type lectin receptors and advance glycation end products (AGEs) that subsequently culminates into an uncontrollable proinflammatory response leading to ‘cytokine storms’. Despite having a huge number of COVID-19 patients, it is surprising that there are currently just a few sizable published studies available regarding the prevalence of comorbidities in patients with COVID-19 from India. The presence of comorbidities was reported in 14% (95% CI, 11.1-17.2) of the 522 confirmed COVID-19 patients from a large medical college and hospital in Jaipur, India. Of these, hypertension (42.5%), diabetes (39.7%), past history of tuberculosis (20.5%), COPD/asthma (16.4%), CAD and CKD (13.7%), and hypertension were the most common. Similarly, patients affected with hypertension are medicated with anti-hypertensive drugs that increase the expression of ACE2 receptors and release of proprotein convertase, which eventually aids the entry and multiplication of SARS-CoV-2 through these receptors, leading to a high risk of infections and other clinical complications in them. Because in Italy alone the mortality associated with hypertension due to covid-19 is 73.8 percent which is much alarming. People with chronic obstructive pulmonary disease (COPD) or any other respiratory illness are more likely to develop severe SARS-CoV-2 illness. The severity of SARS-CoV-2 infection is more likely to be increased by four times in patients with COPD than in patients without COPD. The elderly, particularly those in long-term care facilities and people of any age with serious underlying medical conditions are at a higher risk of contracting and developing severe SARS-CoV-2, according to current research and clinical expertise. The poorly orchestrated immune response coupled with severely elevated ACE2 receptor and furin expression exacerbates the lung condition leading to COPD, hypoxemia, and mortality. The population having chronic health conditions like cardiovascular, diabetes, or lung disease is not only at a higher risk of developing severe illness but also has higher chances of mortality if they become ill. People with uncontrolled medical conditions such as hypertension, diabetes, lung, liver, and kidney disease, pathogenic co-infections, smokers, transplant recipients cancer patients on chemotherapy, and patients on long-term steroid therapy are
more likely to contract and develop severe SARS-CoV-2 infection\textsuperscript{46,48}. Chronic obstructive pulmonary disease (COPD), among other co-morbidities, has been linked to poor disease progression. A four-fold increase in mortality in patients with pre-existing COPD who were diagnosed with SARS-CoV-2 has been found in a meta-analysis of multiple Chinese studies\textsuperscript{45}. Similarly, obesity with a higher BMI predisposes to all the risks including hypertension, diabetes, and hypothyroidism all of which are excellent playground for risk and associated severity of Covid-19 related complications and mortality\textsuperscript{49}.

The influence of age on number of positive cases and disease severity has also been analysed in this study. The age criteria were classified into 4 different class intervals namely: <20 years, >21-50 years, >51-80 years and >80 years. Out of these, the incidence percentage was higher in >21-50 years class of interval followed by others. It is essential to know the critical age groups which are most affected during the pandemic situation, so that effective preventive measures can be undertaken for the high-risk group. It is shown that the CFR of SARS-CoV-2 increases with ages\textsuperscript{46,50} across different countries. The Italian population (23%) was either 65 years of age or older\textsuperscript{51}. This would explain the higher mortality rates in Italy compared to other countries. A similar study has been reported by Russell and his coworkers, for the detection of infection and CFR for SARS-CoV-2 in February 2020 using age-adjusted data (0-9 years, 10-19 years, 20-29 years, 30-39 years, 40-49 years, 50-59 years, 60-69 years, 70-79 years, 80-89 years) from the outbreak on the Diamond Princess cruise ship. The highest CFR of 14.8% was detected in the age group between 80-89 years, and the contrasting findings in the children with mild symptoms and less positivity show the age-specific affection during the first wave of the pandemic\textsuperscript{52}. Similarly, the CFR rate of SARS-CoV-2 is reported to be higher in older adults than younger individuals i.e. 42% for those <65 vs 65% > 65 years; and the association of chronic conditions and risk of dying across different age groups follows the same trend\textsuperscript{53}. This study also reported that the global mortality cases stood at 2.68 million. The mortality cases were higher in United State (538 thousand) followed by Brazil (282 thousand) and India (157 thousand). This depicts that India has the third highest mortality rate globally during the reported period. In India, Maharashtra recorded high mortality followed by Tamil Nadu and others. Similarly, earlier studies reported that in Tamil Nadu, the crude death rate was 2.44 per lakh population; while the elderly (> 75 years) showed a mortality of 22.72 percent. Also, the study pin points that around 85% of affected were reported to have one or more comorbidities including a higher proportion of diabetes followed by hypertension and others\textsuperscript{54}. Whereas in one study conducted in Maharashtra, it was reported that the age group from 31-60 years were majorly affected due to Covid-19 during the first wave with the mean age being 45.8 years, while hypertension was the most common comorbidity followed by diabetes\textsuperscript{55}. And the overall percentage of mortality due to SARS-CoV-2 cases was significantly higher in the Western zone as compared to other zones. Wuhan had a higher mortality rate of 4.9 percent, while its’ province Hubei had a lower mortality rate of 3.1%. In China, a significant proportion of deaths (26%) occurred in people over the age of 60. However, at this stage in the epidemic’s evolution, temptations to make policy decisions based on mortality data should be avoided\textsuperscript{56}. The age-specific SARS-CoV-2 death rate in Korea was higher among patients over 70 years of age with underlying diseases in their circulatory system such as arrhythmia, cerebral infarction, hypertension, and myocardial infarction\textsuperscript{57}. A recent study
has proved the highest mortality rate per million inhabitants of SARS-CoV-2 cases in Belgium between April 11, 2020, and August 26, 2020\textsuperscript{58}.

Similarly, two groups of countries emerged, one with a higher mortality rate (Spain, Italy, and the United Kingdom) and the other with a lower mortality rate (USA, Germany, China). This analysis showed that the mortality in Maharashtra was higher because of the poor adherence to the safety norms and due to the most visited, crowded place in India. Furthermore, countries like Iran began to report or test cases only after higher fatalities\textsuperscript{59}. It is also to be noted that higher CFR values were reported at the initial stages of the pandemic.

There lies a relational trend between higher CFR rates and advancement of the pandemic in the first wave of 2020. This could be largely due to the temporal adaptation of the virus in the population. This explains why period II showed the peak CFR, followed by a decreasing trend in the CFR.

Similarly, the first wave in India has non-immunization control, where vaccination was not practiced widely in the population. The pandemic dynamics of the first wave actually represents the Omicron BA.1 that created the pathogenesis without any herd immunity. This data can further be compared with the second wave CFR and disease pattern caused by a novel strain (delta and delta plus variant) in the future. The comparison of these data on CFR vis-à-vis the immunization that was started at various stages of second wave could provide a meaningful conclusion on the pandemic dynamics and herd immunity.

**Conclusion**

SARS-CoV-2 is an infectious disease that poses a significant threat to global health and will most likely persist until an effective vaccine is developed or herd immunity is achieved. India was the third highest country with respect to mortality cases. The overall CFR rate was higher during April to June 2020 period as compared to other periods. And the overall percentage of mortality due to SARS-CoV-2 cases was significantly higher in the Western zone as compared to other zones. Many factors played a key role in the transmission dynamics, and one reason may be due to imposing lockdowns that led to large-scale migration of people from western India to other parts, precipitating higher spread and mortality. Besides, the western zone (cities like Mumbai, Ahmedabad etc.) is an important business hub and international gateway for the Indian sub-continent. Hypertension was the most commonly reported co-morbidity, followed by diabetes and liver disease. In India, it is important to know the mortality rates related to different age groups and underlying co-morbidities. As a result, this study could be implemented for high-risk populations which are predisposed toward viral pathogenesis that would be helpful in effectively utilizing the limited resources in developing economies. Moreover, the study shall also be useful for future strategies and preparedness for future pandemics. This study may be validated using additional data and associated with other factors. Also, this study can be useful in containing and effectively devising strategies for future pandemics and outbreaks. This comprehensive study will provide researchers, clinicians, and other healthcare professionals to think rationally in recognizing the gaps which can be
fulfilled by proper management and effective use of the already existing system that we have till newer and effective medications are not available.

Declarations

Conflict of interest

The authors declared no conflict of interest.

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Disclaimers

The views expressed in the submitted articles are own and not an official position of the Institution of Funder.

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Tables

Table 1. ANOVA of CFR in different months of the year 2020

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<th>Source</th>
<th>D.F</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
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<th>P</th>
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<td>Month</td>
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<td>288.105</td>
<td>26.191</td>
<td>224.292</td>
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Month, January to December 2020; D.F, degree of freedom; F, F value; P, probability

Table 2. Least Squares means (LSM) of CFR in different period

<table>
<thead>
<tr>
<th>Period</th>
<th>Month</th>
<th>Year</th>
<th>Days</th>
<th>LSM</th>
</tr>
</thead>
<tbody>
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<td>0.622±0.605</td>
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<tr>
<td>Period 2</td>
<td>April-June</td>
<td>2020</td>
<td>91</td>
<td>3.094±0.499</td>
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<tr>
<td>Period 3</td>
<td>July-September</td>
<td>2020</td>
<td>92</td>
<td>2.045±0.497</td>
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<tr>
<td>Period 4</td>
<td>October-December</td>
<td>2020</td>
<td>92</td>
<td>1.464±0.497</td>
</tr>
</tbody>
</table>

Table 3. ANOVA of Case Fatality Ratio (CFR) in different period

<table>
<thead>
<tr>
<th>Source</th>
<th>D.F</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period</td>
<td>3</td>
<td>250.421</td>
<td>83.473</td>
<td>367.509</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

Period , January to December, April to June, July to September and October to December 2020; D.F, degree of freedom; F, F value; P, probability

Figures
Figure 1

CFR percentage in different states of India
Figure 2

CFR percentage in different zones of India
Figure 3

Least Squares Mean (LSM) of CFR% in various months of 2020.

Figure 4

CFR percentage in Period v/s different zones of India
Figure 5

Percent of Distribution of Case Fatality Ratio of SARS-CoV-2 patients in different zones of India
Figure 6

a. Percent of distribution of SARS-CoV-2 cases in different zones in India

b. Percent of distribution of SARS-CoV-2 mortality % in different zones in India
Figure 7

Histogram of SARS-CoV-2 cases in different age group in India

Figure 8

Percentage of distribution of different co-morbidities in SARS-CoV-2 patients in India
Figure 9

Trend of SARS-CoV-2 confirmed cases in different month of 2020

Figure 10
Trend of SARS-CoV-2 deceased in different month of 2020