Case Study on COVID-19 Scenario over Highly Affected States of India

Jayshree Kharche, Shubhangi Kharche, and Mrinal Kharche

1 Introduction

COVID-19 pandemic has affected 213 countries and territories with a total of 10,583,932 confirmed cases and a death toll of 513,861 deaths as on July 1, 2020 [1]. It is an infectious disease caused by Corona virus 2019. The commonest symptoms of COVID-19 are dry cough, fever, and tiredness. Other symptoms are body ache, nasal congestion, runny nose, loss of taste sensation, sore throat, or diarrhea [2]. As per the latest report, backache, nausea, and rashes may also be COVID warning signs [3]. It is observed that symptoms begin gradually and are mostly mild. Even after getting infected, few patients do not develop any symptoms and are asymptomatic; 80% of infected population recover from the disease without special treatment. Approximately one out of every six COVID patients becomes seriously ill and develops breathlessness. Development of serious illness is observed in older people, and in patients with high blood pressure, heart problems, or diabetes. Patients having fever, cough, and breathlessness should seek medical attention [2]. According to WHO, primary human-to-human transmission occurs via respiratory droplets. When a person with infection coughs, sneezes, or talks, virus is released in the respiratory secretions. Also, if a person touches an infected surface and then

J. Kharche (✉)
Physiology Department, Symbiosis Medical College for Women (SMCW), Symbiosis International (Deemed University), Pune, Maharashtra, India
e-mail: jayshree.kharche@smcw.siu.edu.in

S. Kharche
Electronics and Telecommunication Department, SIES Graduate School of Technology, Navi Mumbai, Maharashtra, India
e-mail: Shubhangi.kharche@siesgst.ac.in

M. Kharche
Self Employed, SPACE, Pune, Maharashtra, India

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touches facial parts, the person may get infected. Droplets can travel maximum 6 ft or about two meters. The coronavirus disease 19 (COVID-19) is a highly transmittable disease. With 18,256 COVID-19 fresh cases as on July 1, 2020, India's confirmed cases rose to 585,792, including 17,410 deaths. The number of active COVID-19 cases are 220,546, and 347,836, patients have recovered [1].

Following states are worst affected in India:

Maharashtra state is found to be the worst-affected state with 6364 new cases taking the total to 192990 cases, with 104687 recovered and 8376 deaths.
Tamil Nadu has 102721 with 1385 deaths and 58378 recovered cases.
Delhi has 94695 cases with 2923 deaths and 65624 recovered cases.
Gujarat 34600 has total cases with 1904 deaths and 24933 recovered.
Rajasthan has a total of confirmed 19052 cases with 15281 recovered cases and 440 deaths [4]. In India, the case doubling time is 15 days. Also, case fatality rate for COVID-19 is reduced from 2.83% in contrast to 6.19% worldwide. In India, the recovery rate for COVID-19 patients is 48.19% [5]. The recovery rate in India has increased from 11.42% on April 15 to 26.59% as on May 3 and to 38.29% on May 18 to the present 48.19% [6].

2 Specific Healthcare Problems/Difficulties in Indian States

High infectivity of corona virus and large population (about 1.2 billion) of India has posed a great challenge to Indian healthcare system. As compared to other countries, India spends about 3.6% of GDP on healthcare which is very low. The average for other countries for the same was 8.8% of GDP in 2018 [7]. National Health Profile–2019 data showed that in India, in total, there were 7, 13,986 government hospital beds available. This shows only 0.55 beds per 1000 population [8, 9]. The population aged 60 and above is vulnerable and there are higher chances of more complications in the age group. For elderly population, beds available in India are 5.18 beds per 1000 population. [8].

Low hospital beds in India and a pandemic-like coronavirus can lead to hospital bed crisis and may complicate the situation. Also, a major challenge will be that one COVID-19 positive admitted patient will occupy the bed for minimum 10 days. As per prediction 5–10% of total patients may require critical care and also ventilator support. India also lacks severely on ventilator support which may be needed hugely in this pandemic [8].

In one of the studies by Public Health Foundation of India, it was found that in the last two decades, free medicine availability in public healthcare facilities has reduced from 31.2% to 8.9% for inpatient department. Also, it declined from 17.8% to 5.9% for outpatient department [10].

As per the Indian government directives, COVID-19 patients are treated in three types of COVID dedicated facilities viz: confirmed clinically mild cases are admitted to COVID care centers (CCC), moderate cases are hospitalized to

dedicated COVID health center (DCHC) and dedicated COVID hospital (DCH) for clinically assigned severe cases [11].

Therefore, for Indian scenario, prevention stands to be the best available option to fight the battle against corona. With growing counts of coronavirus cases, Indian policymakers are disseminating knowledge about preventive practices such as frequent hand washing and not touching the face. It is suggested that social distancing is an effective tool to "flatten the curve." These measures will prevent the health system from being overburdened. To delay community spread in India, Indian prime minister imposed lockdown in India in four stages starting from 25 March 2020. Lockdown is one of the important nonpharmacological interventions to reduce spread of infection and delay community outbreak. During lockdown, along with personal protective measures, transmission reduction strategies [12] include:

- Strict social distancing
- Stay home orders
- Social places and nonessential services closure
- No public gatherings
- Interstate travel restriction with screening at exit and/or entry
- Extensive case identification and isolation
- Contact tracing and quarantine
- Face covering with mask
- Work from home

As per ICMR scientist statement about peak in India, "We are very far away from the peak. Our preventive measures to curtail the disease are very effective and we are better positioned in comparison with other countries [13]."

For the assessment of the extent of spread of COVID-19, ICMR is conducting a sero-survey and almost 34,000 people are being tested as a part to study community transmission and will put up findings of it shortly [13].

Healthcare Facilities and Challenges in Maharashtra to Take Care of COVID-19 Scenario in Maharashtra

It was observed that Maharashtra lies below the national average of 0.55 beds per 1000 population. Maharashtra has only 11587 ICU beds. Maharashtra being the worst hot state by COVID-19, Mumbai and Pune have a maximum number of COVID cases. Mumbai has run out of hospital beds with increasing number of cases reported by health section in science wire news bulletin [14].

As reported in Indian express on May 30, 2020, Maharashtra is the first state to offer 100% free treatment to COVID-19 patients by bringing all residents of the state under the Mahatma Jyotiba Phule Health Insurance scheme. Also, an agreement with General Insurance Public Sector Association (GIPSA) for Mumbai and Pune city patients had been reached to help patients [15].

As on June 20, 2020, Mumbai recorded 1190 new cases, taking the total count to 65329. Mumbai also recorded 136 more deaths pushing the death toll to 3561. Considering bed scarcity, huge population, and increasing cases in Mumbai, a 30,000-bed Covid-19 care center for self-isolation has been created for those who do not have facility to self-isolate. Also, in a fortnight, the first open hospital in the country has been created by the Mumbai Metropolitan Region Development Authority (MMRDA) at Bandra Kurla complex. This open hospital is with 1,000 beds and 200 ICU beds. Similar initiatives to increase isolation facility have been implemented in cities like Pune and Nagpur [16].

Healthcare Facilities and Challenges in Tamil Nadu to Take Care of COVID-19 Scenario

Tamil Nadu has an average of 1.1 hospital bed per 1000 population which is better than the national average [9]. In the state, it was observed that, 10% of COVID patients require hospitalization, 20% require health centers, another 50% can be managed at care centers, and the rest can be put under home quarantine. Still, to arrange these many beds is a challenge for the state government. Many public places have been converted to isolation center and measures are taken by the state government to augment hospital beds on a daily basis, depending on the daily count of positive cases [17].

The Tamil Nadu government has announced that Chief Minister's Comprehensive Health Insurance Scheme (CMCHIS) will cover the treatment for COVID-19 in nongovernment hospitals. According to the government, under this scheme, treatment for COVID-19 can be availed in private hospitals that are empanelled under the scheme without making any payment [18].

Healthcare Facilities and Challenges in Delhi to Take Care of COVID-19 Scenario

Delhi has 1.05 hospital beds per 1000 population which is above the national average [9]. Even after additional funding, there is inadequacy of medical investment and healthcare infrastructure which is posing challenge to combating an effective response against the pandemic in Delhi. In addition, there is lack of health insurance coverage for more than 80% of the population, and approximately 68% of Indians have shortage or no access to essential medicines which may further worsen the pandemic [10].

Healthcare Facilities and Challenges in Gujarat to Take Care of COVID-19 Scenario

Gujarat has less number of hospital beds compared to the national average which is 0.3 per 1000 population [8]. For better treatment and hospital services to Corona patients, the Gujarat High Court directed the state authority that 50% of the total bed should be reserved to treat COVID patients in all the nongovernmental and private hospitals. Also, the court directed the Gujarat government to make the healthcare facility cheaper, available, and reasonable [19]. This move has improved the availability of hospital beds for the affected people.

Healthcare Facilities and Challenges in Rajasthan to Take Care of COVID-19 Scenario

Rajasthan has 0.6 hospital beds per 1000 population [8]. In the state, "Bhilwara model" won applause across the country by showing good control on the spread of pandemic. In the first phase of COVID-19 outbreak, Bhilwara district was among the most affected places in India. Rajasthan government imposed a curfew in the district. Curfew restricted essential services, facilitated substantial screening and house-to-house surveys to find out possible cases. Detailed contact tracing of each positive was carried out. This resulted in converting Bhilwara from most number of coronavirus cases to only one positive case since March 30 [20].

In addition to it, hospitals from the private sector in the state volunteered to join the fight against COVID-19 [21].

Other Measures to Control Spread of COVID-19

Aarogya Setu App is COVID-19 tracker launched by the Government of India. This app, depending on user's location, predicts risk for COVID-19. Also, it informs about COVID positive cases in the proximity of user [22]. For containment of COVID-19, new guidelines were laid down by the Government of India by which districts were divided into red, orange, and green zones depending on risk profiling of districts [23]. Further details of the zones are as follows:

1. Green zones: Districts with zero confirmed cases till date or districts with no confirmed case in the last 21 days.
2. Red Zones or Hotspot Districts: Depending on count of active cases, doubling rate of confirmed cases, efficiency of testing, and surveillance feedback, districts will be labelled as red zone.
3. Orange Zones: Districts which are neither red nor green are orange zones.

Based on this zonal classification, activities were permitted or restricted in the zones. This has helped to track the cases and contacts in the highly infected zone. Also, zoning of districts has reduced the spread of infection.

3 Challenges in Controlling COVID-19 Cases

Large numbers of COVID-19 cases are found in six states of India viz; Maharashtra, Tamil Nadu, Delhi, Gujarat, Uttar Pradesh, and Rajasthan. Fig. 1 shows the number of confirmed cases, recovered cases, and active COVID cases in the highly affected states of India as on May 31, 2020 [24]. Figure 2 shows the number of deaths and the number of new COVID cases in the highly affected states of India as on May 31, 2020. As seen, the highest number of COVID cases are found in Maharashtra (Figs. 1 and 2), as it shares 9.23% of India's total population (Fig. 3) [25] and 42% of its population resides in slums. As on May 31, 2020, Tamil Nadu reported second highest COVID cases (Figs. 1 and 2) Tamil Nadu shares 5.93% of India's total population (Fig. 3), that is, 8, 22, 47, 613 as seen in Fig. 4. In the initial stages, large number of COVID cases emerged in Tamil Nadu due to the people gathering at the market places. It was a challenging task for the frontline workers to maintain social distancing at such places. Delhi reported third highest COVID cases as on May 31, 2020 as seen in Figs. 1 and 2. It shares 1.38% of total India's population (Fig. 3). The major challenge for social distancing in Delhi is its highest population density as seen in Fig. 5. Gujarat and Rajasthan reported a large number of COVID cases as on May 31, 2020, occupying the fourth and

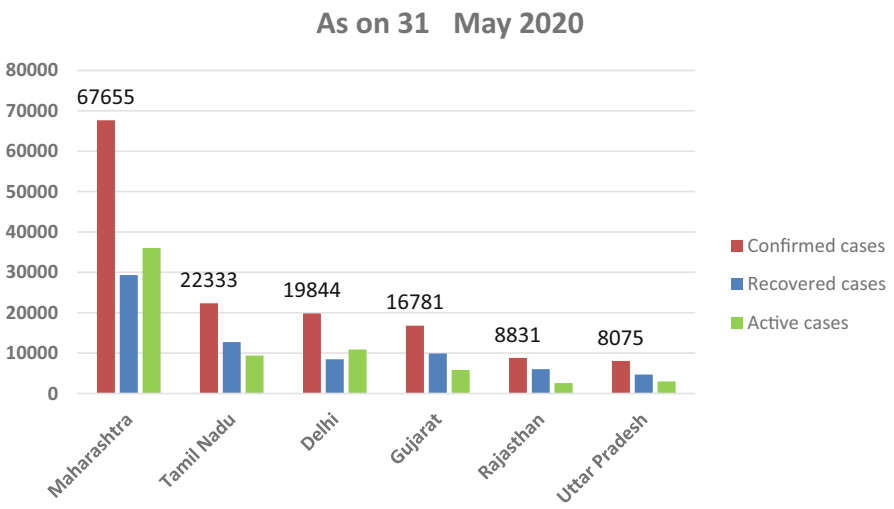

Fig. 1 Confirmed, recovered, and active cases in the six states of India

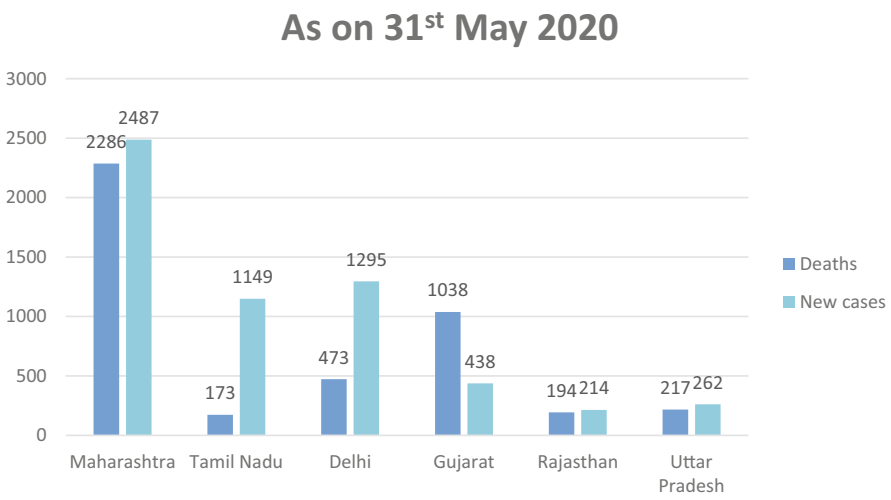

Fig. 2 Deaths and new cases in the six states of India

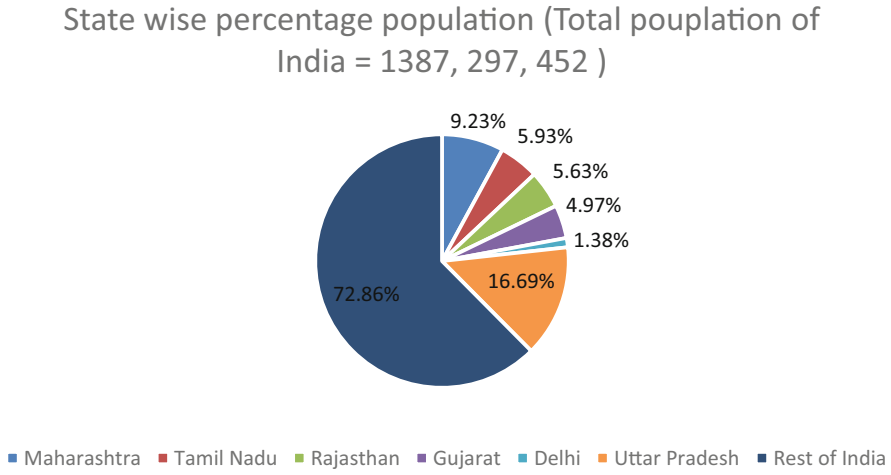

Fig. 3 Percentage share in total population of India

fifth highest positions, respectively, in India. Population wise, Rajasthan is ahead of Gujarat (Figs. 3, 4 and 5), but higher numbers of cases were reported in Gujarat due to foreign country migrants in the initial stages. Social distancing is a challenging task in the nonnotified slum population of 3.84 lakhs in Gujarat. In the initial stages, Uttar Pradesh (U.P.) reported comparatively a lower number of cases. But as on May 31, 2020, U.P. occupied the sixth highest position in COVID cases in India because its large number of migrant laborers returned, giving rise to social distancing challenges in the state.

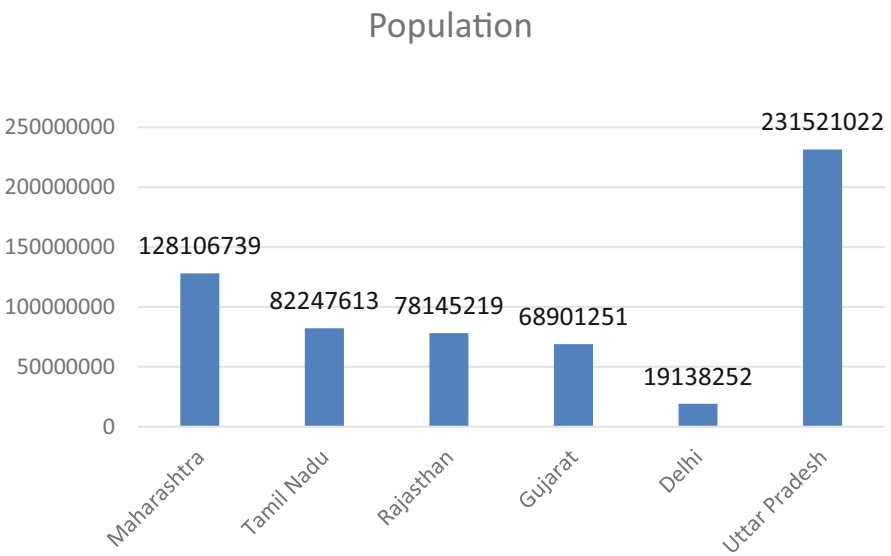

Fig. 4 Population in the six states of India

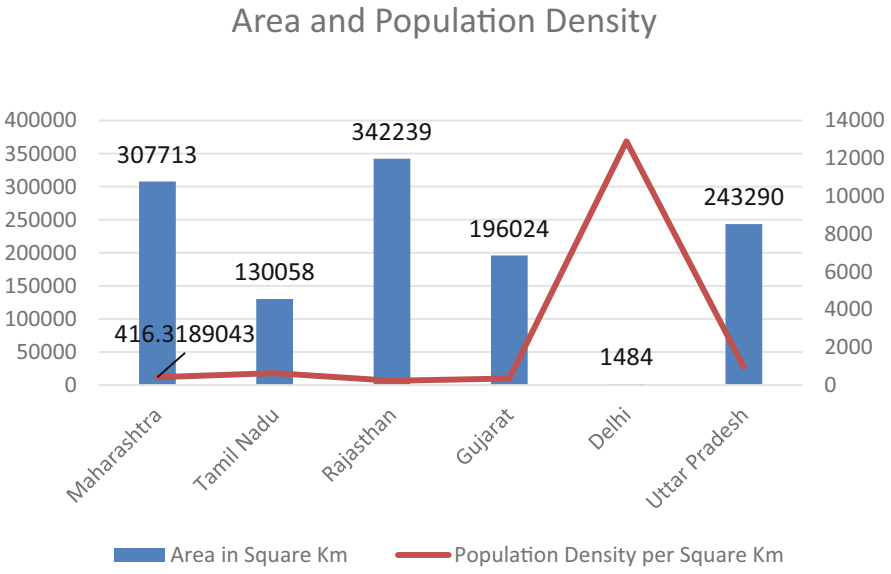

Fig. 5 Area and population density in the six states of India

Reasons and Challenges for Large Number of COVID-19 Cases in Mumbai, Maharashtra

Mumbai, the capital of Maharashtra, is the economic hub of India. So, it has huge number of migrants and has high population density of 32303 persons per square kilometer. There is huge inflow of lower economic class workers from other states in Mumbai. Near about 42% of its population belongs to the slum area. The middle-class and high-class businessmen, traders, and IT professionals from other states and abroad keep visiting Mumbai. So, during the initial phase of COVID-19 scenario, there were social distancing challenges at the airports, railway stations, bus stations, malls, shops, etc. Social distancing norms were not followed at vegetable markets and state transports. The COVID-19 cases increased gradually in Mumbai due to these social distancing issues. Few people from Mumbai were found attending the Tablighi Jamat gathering at Nizamuddin in Delhi. Social distancing is a big challenge in Dharavi which is part of Mumbai and is the biggest slum in Asia. Large number of shops in Dharavi are without toilet facilities. Many households are without proper drainage systems. The overall atmosphere in Dharavi is unhygienic. In Dharavi, the houses are of maximum 10 $\times$ 10 ft with common toilet facilities and no ventilation. About 10–12 people live in a small-sized room. To maintain social distancing in such densely populated slum is a great challenge. Initially, when police tried to maintain social distancing in Dharavi and tried to stop community transmission, people pelted stones at them. Most of the policeman tested positive for COVID-19 due to not maintaining social distancing in congested slums like Dharavi. Police also faced challenges in solving domestic violence cases occurring due to the lockdown, in order to maintain social distancing. The Worli Koliwada is another slum in Mumbai where social distancing is a challenge and most of the COVID-19 cases are found here. Other reasons for COVID-19 spikes in Mumbai include not following social distancing at airports, bus transports, railway stations, vegetable markets, malls, shops etc. during the initial stages when lockdown was not declared. After declaration of the first lockdown in March 2020, proper norms were not followed by the people. This was observed in all subsequent lockdowns in Mumbai. Low testing rate is also one of the reasons for COVID-19 spikes in Mumbai. Cases increased but the tests did not increase at that rate.

Reasons and Challenges for Large Number of COVID-19 Cases in Tamil Nadu

The initial spikes in COVID-19 cases in Tamil Nadu were due to the Tablighi Jamat returnees who tested positive after the gathering at Nizamuddin event in Delhi. About 1500 people attended the meeting out of which 1130 people returned to Tamil Nadu, 515 people were traced, 615 people were untraceable, and 50 people were infected with COVID. Erode from Tamil Nadu was one of the hotspots

for COVID due to the Tablighi Jamat gathering. These Tablighi Jamat returnees infected other people, as they travelled by road, train, and air. Opening of liquor shops (TASMAC beer shops) in Tamil Nadu was the reason for COVID-19 spikes during the second week of April 2020. Insufficient social distancing at Koyambedu market was another reason for COVID-19 spikes in Tamil Nadu where huge number of people gathered on April 25, 2020 during lockdown 2.0. About 1867 COVID positive cases were reported by May 9, 2020 [26]. Multiple religious clusters were found during lockdown 3.0 in Tamil Nadu which led to COVID-19 outbreak. Asymptomatic cases encountered in house-to-house-screening in every containment zone and aggressive and extensive testing in Tamil Nadu are the reasons for COVID-19 spikes. To maintain social distancing at Koyambedu market and at the liquor shops was a major challenge for avoiding COVID-19 spread in Tamil Nadu.

Reasons and Challenges for Large Number of COVID-19 Cases in Gujarat

One of the reasons for spikes in COVID-19 cases in Gujarat is that it is a globally connected state from India. So there is huge inflow of people into Gujarat from abroad. Other reasons are the mismanagement over lockdown and laxity in identifying COVID-19 cases. Initially, the major reason for COVID-19 cases was the gathering of 1500 people from Gujarat at Tablighi Jamat Markaz Nizamuddin in Delhi. One more reason is the high-density, low-income population areas in Ahmedabad, Gujarat, where social distancing is challenging task.

Reasons for Large Number of COVID-19 Cases in Delhi

COVID cases initiated with two Chinese nationals tested positive in month of January 2020 in Delhi; 16 Italian tourists and large number of flyers from Delhi were reported at the airport [27]. Despite thermal scanning of passengers at airports, people having high fever could have been missed out. Almost 50% of the initial infected cases in the month of April 2020 were from Tablighi Jamat meeting at Markaz Nizamuddin, Delhi [28]. Markaz is a religious place where preaching takes place. People from different states of India particularly Hyderabad, Maharashtra, Tamil Nadu, Gujarat, and Karnataka attended the Tablighi Jamat meeting at Markaz. On identifying the COVID cases at Markaz, 1584 people were evacuated as on march 31, 2020. Aggressive testing is also the reason for the large number of COVID cases in Delhi. The number of tests per million is put at around 5200 in Delhi (highest in India) [29].

Reasons for Large Number of COVID-19 Cases in Uttar Pradesh

Uttar Pradesh state of India is well known for its highest population of 231, 521,022, that is, 23.15 crores, determined in year 2020. It has the population density of 2100 people per square mile or an average density of 828 persons per square kilometer calculated over an area of 243290 square kilometers or 93930 square miles. Around two lakh migrant workers returned to UP from other states in May 2020, leading to sudden spikes in COVID cases.

Reasons for Large Number of COVID-19 Cases in Rajasthan

There are large asymptomatic cases (around 80%) in a mild form with no outward manifestation of virus like cold, fever, or shortness of breath. The asymptomatic super-spreaders such as daily booth managers, vegetable vendors, milk suppliers, provision store owners, and health workers are the cause for COVID spread in Rajasthan. Foreign (Oman) returned people, lack of social distancing at Tablighi Jamat meeting, and other hidden travel histories [30] are the major reasons for COVID spread in Rajasthan.

4 Use of Technology to Handle Challenges During COVID-19 in India

Robots are used in many hospitals across a number of cities in India to protect the healthcare workers from the COVID-19 infections and intensify the screening process. The robots perform the screening for each and every visitor entering the hospital including the nurses, patients, and doctors, and medical and nonmedical staff. Robots are designed to deliver food and medicines to COVID-19 patients. Some robots are designed to help doctors treat COVID-19 patients remotely using the Internet. The robots first ask questions to the patients related to their body temperature, status of cough, cold, respiratory problems, etc. and depending on the answers, direct the patients to enter the consulting rooms. Other robots in the consulting rooms interact with the doctors using the Internet. Some robots can answer general questions which are asked by the patients like Google Alexa and also can serve water to them. Some robots are used to spread awareness on COVID-19 and display ways to contain the pandemic while some others are used to distribute sanitizers and masks.

Drones which are the unmanned aerial vehicles are used to combat COVID in India. Drones are used for surveillance to ensure that the lockdown is followed and social distancing is maintained. Drones are used to monitor densely populated areas and crack down on lockdown violators. Drones are preferred for sanitization, as

they are efficient, fast, and less labor intensive. It also avoids exposing sanitation workers to possible infection. Drones can also be fitted with loudspeakers to issue instructions to the general public. A 28 KG drone with 10 l capacity can disinfect the 500 m × 500 m area in 10–11 min or 1.5 km–2 km straight line with 10-m periphery to disinfect the whole area. Drones are used in disinfecting government buildings, tall structures, and hospitals almost in 26 cities of India. Some drones have a payload capacity of 15–20 l with a flight duration of 40–45 min and maximum ceiling height of 450 ft. The drones are actually used for spraying from 6.00 am to 6.00 pm every single day. Human beings can cover 3–4 km distance to spread disinfectants, whereas drones can cover 20 km distance every single day. A fleet of 300 drones covers 20 km a day, covering a total distance of 6000 km. The drones also come with thermal imaging which helps to identify and manage crowds and detect body temperature.

In Mumbai city (Maharashtra state), drones are used to monitor Dharavi area which is one of the biggest slums and a containment zone where police cannot enter small streets. The police worked with the members of drones federation to handle this monitoring task. The police use drones to monitor the overall situation during lockdown. The police used the drones to make announcements about the lockdown and used the footages from drones to keep vigil on the lockdown situation. The police also used the drones to spray disinfectants in slums, railway stations, markets, bus terminals, busy streets, and government hospitals which are the most publically used.

In Gujarat, drones are used to make announcements for the norms to be followed during the lockdown. They are also used to spray disinfectants in the most crowded areas of Ahmedabad and in the un-notified slums. Drones are used for surveillance during the lockdown and take appropriate actions from the observed footages.

In Tamil Nadu, the Cuddalore police used drones to curb the illegal liquor sales under the lockdown period. The drones kept vigilance on the villagers of Alagianatham, Chavadi, Commandanmedu, Marundhadu, and Vaanpakkam located near the interstate border of Puducherry from where the tipplers have been sourcing the liquor illegally during the lockdown. In Chennai city (Tamil Nadu state), drones are used to spray disinfectants on hospitals and crowded public places. This helped to avoid the spread of COVID and reduced the work burden on the frontline workers: doctors, nurses, sanitization workers, and policeman during the fight against COVID-19.

Technological Challenges During COVID-19

Heavy Load on Internet

Due to the wide spread of COVID-19, initially, a complete lockdown was declared at the national level giving rise to new challenges in management of IT, connectivity and security. Millions and millions of people started creating heavy Internet traffic.

Online workers, Information Technology (IT) professionals, doctors, school and college teachers and students, private coaching classes, YouTubers and many other Internet Protocol-based APP users started using the Internet on a larger scale. This became the cause of trouble for high-technology companies to offer online gaming, video streaming services, and offline remote conferencing services, etc.

Information Technology

The Information Technology (IT) professionals faced lot of problems to work from home during the COVID-19 lockdown period. Reputed companies usually provide the infrastructure required by the professionals to work from home (WFH), but not all employees have it at sufficient level. In most of the companies, freshers are not given the facilities to work from home. Some companies provide high-end laptops loaded with required software and the broadband dongles to work from home. The employees in such cases can use the set Virtual Private Networks to complete the work from home. But all these facilities are not made available to all employees by IT Company nor have all IT companies made such prior arrangements giving rise to too many challenges to work from home during the lockdown periods. It is challenging to work with very old laptops, computers, poor connectivity, and outdated and unsupported software. Some professionals used tablets with lack of security patches to complete the tasks. The WFH includes the use of equipment which is shared with family members. This leads to challenge in securing company's data. WFH also leads to Wi-Fi connectivity issues, as the bandwidth is shared among multiple devices at home. Many employees are not familiar with the use of computing devices, connecting to core systems, using videoconferencing systems collectively and securely, leading to massive requirements in user training; IT professional lost lot of their fruitful time to set requests for Virtual Private Networks (VPNs), setting up laptops, and training people for the proper and secure use of the resources instead of working on new things. The remote work involves the use of VPNs, VoIP (Voice over IP) virtual meetings, cloud technology, work collaboration tools, facial recognition technologies, and many more. Another challenge for IT professionals is to provide sufficient cloud storage to tackle the dramatic increase in online orders. Increase in online purchases posed a new challenge of saving jobs of shopkeepers and vegetable vendors. Online shopping during COVID-19 situation poses a new set of challenges. In online shopping, there can be in-person delivery of goods which is not virus-free and needs proper sanitization. Another option for delivery of goods is the use of robots which can ensure sufficient level of safety against the coronavirus pandemic. Remote work for IT professionals provides advantages of avoiding COVID-19 spread, saving commute time, and increasing work flexibility, but on the other hand, it leads to lack of work–life balance and loneliness.

Distance Teaching-Learning

Distance teaching-learning is a big challenge in COVID-19 situation. At the initial spread of coronavirus in India, the teaching-learning was in progress by adopting the usual traditional ways in all the educational Institutes except for the online courses offered by IIT like National Program on Technology Enhancement and Learning (NPTEL). As the COVID spread reached its first spike in mid of March 2020, all of a sudden, the educational institutes were brought to closure due to the national-level lockdown. In order to complete the syllabus, various educational institutes including schools, colleges, and coaching classes had to adopt the online teaching learning environments. It was a big challenge for many schools to conduct the year-end examinations. Some schools that had already completed the year end exams before the lockdown could manage to declare the results online. But the schools which were lagging behind had a great challenge ahead for completing the syllabus, conducting the exams, and declaring the results. Many schools promoted the students to the next higher class failing to adopt the sudden change in the system and requirements. Many professional educational institutes and universities offering undergraduate, post graduate, doctoral, and post-doctoral courses had to adopt to the distance teaching learning techniques to complete the syllabus. In this process, the faculty and students faced lot of challenges with respect to the use of online tools and software. The immediate and heavy demand of online platforms and tools for educational purposes posed a challenge ahead of big IT companies. Google provided free use of Google meet for stipulated time, Cisco allowed free use of Cisco Webex platform, and Microsoft offered the use of Microsoft teams. Many use Zoom platform for conducting meetings and conducting lectures in spite of its security issues and use for limited time and for limited number of users.

Rural Area Distance Education Problems

- Lack of smart phones, laptops, computers, and tablets
- No Wi-Fi connectivity
- Frequent power cuts
- Difficulty-to-use technology
- No proper earphones, mikes, and speakers
- No silent sitting place for attending online class

Urban Area Distance Education Problems

Pre-primary school children are unable to understand use of technology, and every time, parents' assistance is required. If both parents are working, then it becomes problematic for them, as they have to take time out of their office work. Students are unable to concentrate on the PowerPoint presentations due to distractions at home. Students cannot cope with the online teaching speed. Many times, there exists a time

Table 1 Impact of COVID on frontline workers

State	Frontline workers infections	Date
Maharashtra	42% of infected doctors, 70.5% of infected nurses and 84% of infected medical workers	April 23, 2020 [31]
Delhi	At least 500 doctors infected as per Indian Medical Association (IMA)	June 05, 2020 [32]
	106 total employees of hospital were tested positive including doctors and nurses.	May 12, 2020 [33]
Chennai City (Tamil Nadu state)	Delhi reported 69 infected doctors from 548 total in India	June 05, 2020 [34]
	At least 37 doctors were infected.	May 10,2020 [35]
	112 health workers (including doctors, nurses and emergency management technicians, hospital staff, and ambulance drivers)	June 05, 2020 [34]
	18 nurses and 57 paramedics	

delay between the content delivery and the moment of listening. Some delay due to poor Internet connections. When the teacher projects the PowerPoint presentations while online teaching, the students are unable to understand the teachers' power of expressions nor can the teacher read students face to get real feedback on teaching-learning. Another issue in online teaching is that the teachers are really unaware whether the students are listening to the content delivery or not. Teacher cannot continuously monitor the video screens of all students. In an online class, let us say, of 45 min, the teacher is hardly able to monitor the video screens for 2 to 3 times at the maximum, otherwise the teaching content is left aside.

Impact of COVID on Frontline Workers in India

Higher number of COVID infections are found among the frontline workers, which include cops, doctors, nurses, other medical staff (ward boys), and cooks in hospitals, sanitization workers, vegetable vendors, and pharmacy. A total of 548 doctors, nurses, and paramedics were infected as on May 6, 2020 across India [36] including ward boys, field workers, security guards, sanitization workers, lab attendants, laundry, peons, and kitchen staff (Table 1).

COVID Cases Forecasting

The forecasting for COVID cases is performed for India and its highly affected states from the Kaggles dataset [37] by considering the data up to June 16, 2020 as seen in Figs. 6, 7, 8, 9, 10, 11, and 12. The Auto Regressive Integrated Moving Average (ARIMA) model [38] in Python is used for predicting the COVID cases till end of July 2020 and till the end of October 2020 as seen in Table 2.

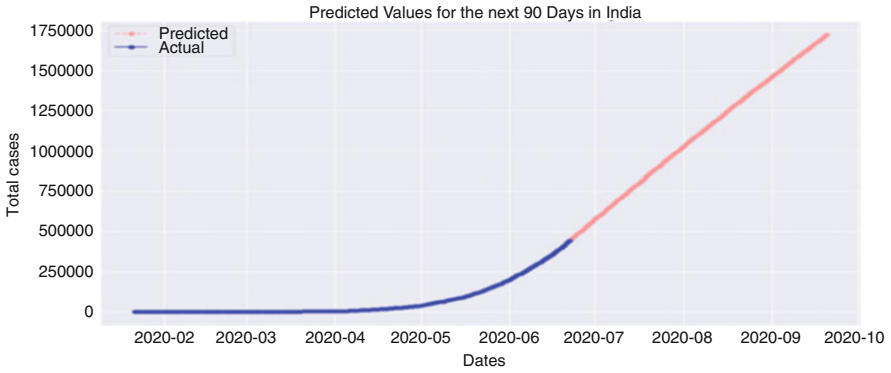

Fig. 6 Forecasting for COVID cases in India by October 2020

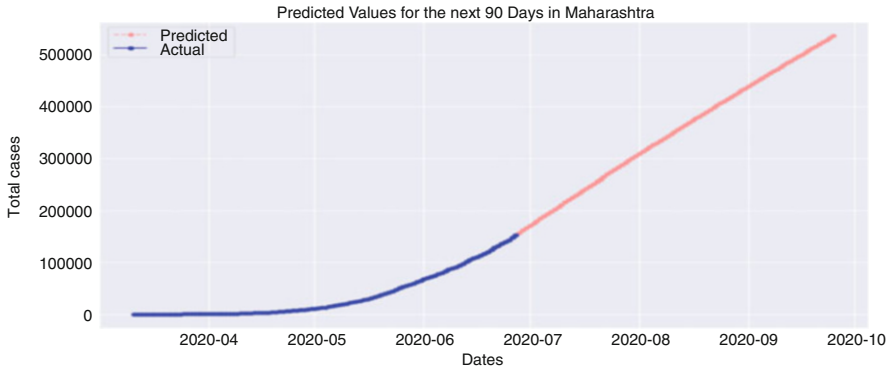

Fig. 7 Forecasting for COVID cases in Maharashtra by October 2020

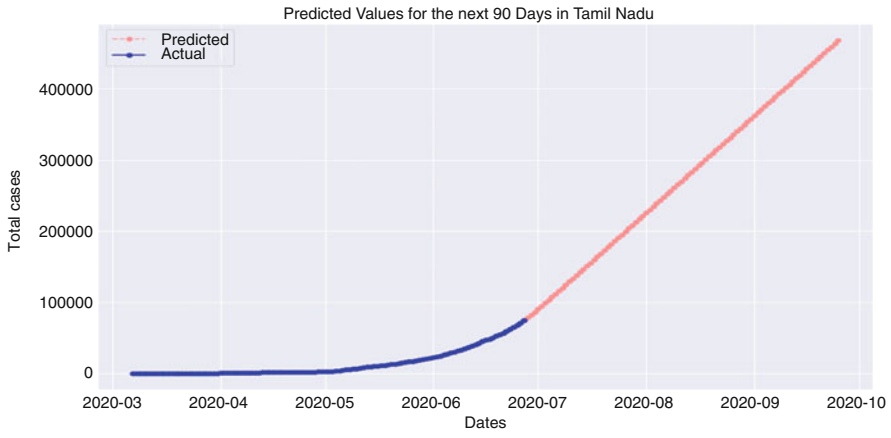

Fig. 8 Forecasting for COVID cases in Tamil Nadu by October 2020

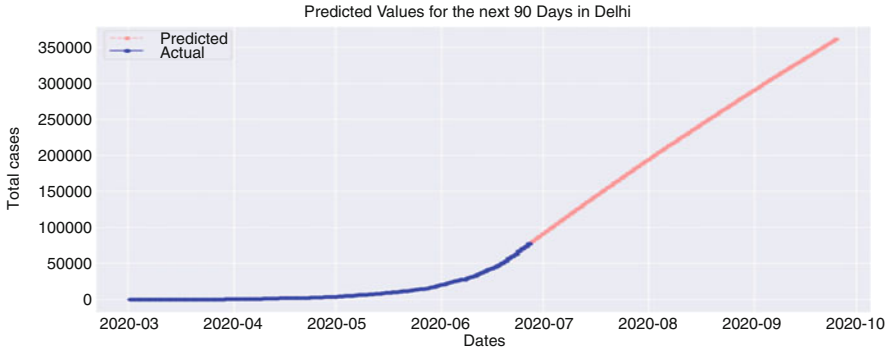

Fig. 9 Forecasting for COVID cases in Delhi

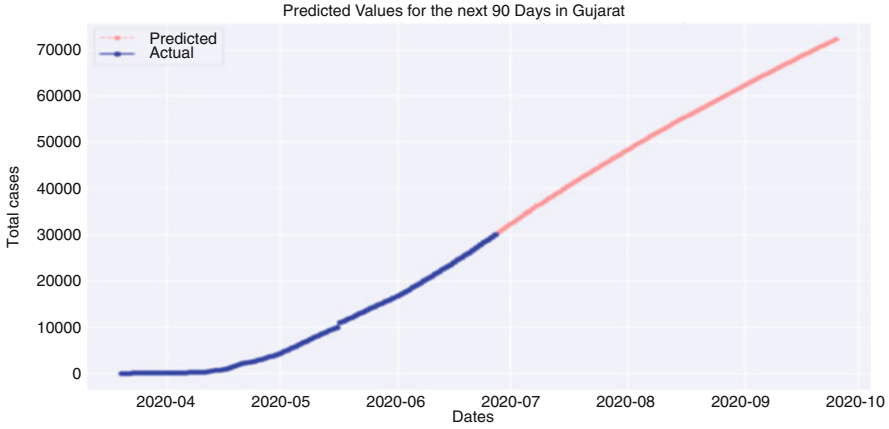

Fig. 10 Forecasting for COVID cases in Gujarat by October 2020

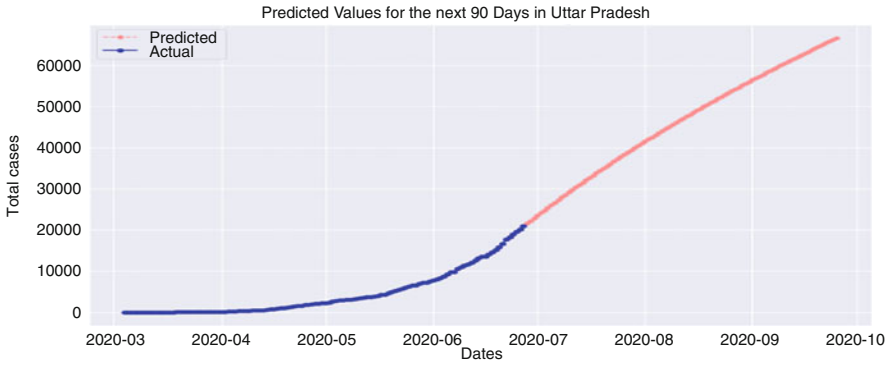

Fig. 11 Forecasting for COVID cases in Uttar Pradesh by October 2020

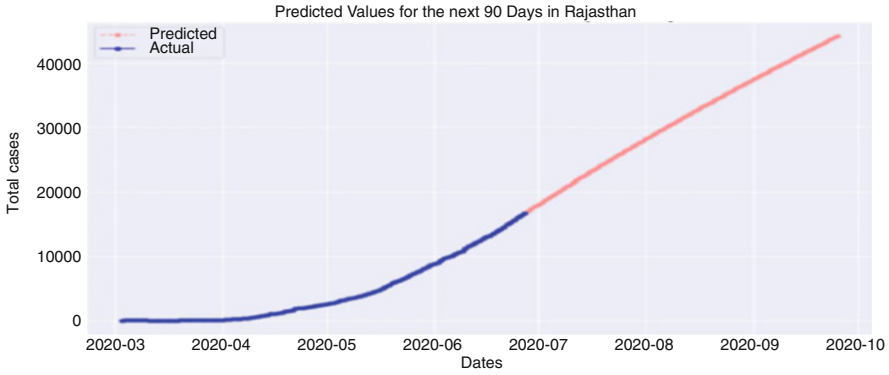

Fig. 12 Forecasting for COVID cases in Rajasthan by October 2020

Table 2 Forecasting for COVID cases based on data available till June 16, 2020

Place	Predicted COVID cases July 15, 2020	COVID cases as on July 22, 2020	Forecasting for COVID cases by end of October 2020
India	80,000	11,90,000	17,50,000
Maharashtra	2,00,000	3,19,000	5,00,000
Tamil Nadu	1,00,000	1,76,000	4,00,000
Delhi	1,00,000	1,24,000	3,50,000
Gujarat	35,000	50,465	70,000
Rajasthan	25,000	30,390	70,000
Uttar Pradesh	25,000	51,160	66,000

5 Architectural Design and Planning Challenges Related to COVID-19

Types of infrastructure primarily affected due to COVID-19 are:

1. Hospital/healthcare infrastructure
2. Public gathering spaces like cinema halls, malls, religious places, institutes, etc.
3. Work places like offices, industries, factories, etc.
4. Transportation infrastructure:
   (a) Airplane, bus, cabs, trains
   (b) Airports and railway stations
5. Hotels and restaurants
6. Tourism places

Following are the suggestions which can be adopted / incorporated:
General recommendations:

- To have separate entry and exit.
- Each entry point should facilitate proper sanitization of people.
- Thermal scanners should be installed at entry points.
- Touch-me-not type of infrastructure like doors with automatic opening / closing sensors, voice-operated elevators
- Wider stairs/ escalators to minimize use of railing contact in public buildings.

Planning Aspects for Slums Related to COVID-19

The informal settlements or slum areas of the India mostly in Mumbai and Pune in Maharashtra are the least prepared for the pandemic of COVID-19 since basic needs such as water supply, toilets, drainage, and waste collection are to be shared and inadequate. There is shortage of adequate and secure housing. Inadequate space causes overcrowding in slums which is responsible for inability for physical distancing. Due to all these factors, it is practically impossible to advice self- or home quarantine. These infrastructure challenges in urban slums cause rapid spread of an infection [39].

Scientific policy suggestions have to be made to dampen the spread of COVID-19, to improve availability of medical care to urban poor irrespective of the infection status. To improve long-term well-being of urban slums, provision of social and physical improvements in infrastructure is needed which comes with better economy.

Immediate measures to protect urban poor from COVID-19 include:

1. To improve social distancing to set up slum emergency planning committee
2. Ensure payment to poor and provision of things of daily living like food
3. Training and deployment of community health workers
4. Improvement in sanitation and hygiene
5. Implementation of a solid waste collection strategy

Planning Aspects for Buildings Related to COVID-19

Organisms get transmitted between rooms on different floors of a building, carried within the system airflow. Contamination of surfaces in rooms and systems by droplets results in spread of infection. This is of particular concern in high-risk transmission settings such as hospitals and healthcare buildings. One important factor identified was the interconnectedness of all parts of the building by the wastewater plumbing system and, therefore, the potential for contaminated air to travel throughout the building unhindered. Also it is identified the short-duration burst of contaminated air from the wastewater plumbing system that caused the cross-contamination.

It is recommend that the following steps be taken to ensure that transmission through the wastewater plumbing system is minimized: (1) do not ignore unexplained foul smells in bathrooms, kitchens, or wash regions; (2) It is good if water appliances in kitchens and bathrooms are fitted with a functioning U-bend; (3) to prevent the loss of the water trap seal within a U-bend, open a tap on all water appliances for at least 5 s twice a day (morning and evening), paying special attention to floor drains in bathrooms and wet rooms; (4) in case wastewater pipe from an appliance seems to be damaged or open, it should be sealed immediately (5) if there appears to be any crack or leak in pipework, seal with tape or glue; and (6) continuous monitoring of system performance is needed especially for large or tall buildings [40].

6 Conclusion

With all the challenges like vast population, limited healthcare infrastructure, limited healthcare workers, India has achieved a better control over COVID-19 as seen from the current and forecasted statistics. India has improved the cure rate by effective strategies. Still, India has to go a long way to achieve an effective control on the spread of COVID-19.

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