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## Epidemiological impact of COVID-19 in India: Country with second foremost positive cases in the world



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### ARTICLE INFO

#### Keywords:

COVID-19 virus  
Epidemiological impact  
Measures  
Disease  
Toxic agents

### ABSTRACT

The WHO tentatively called the new virus 2019 novel corona virus (COVID-19), which is become a effectively contagious disease in global health concern. India is the world's seventh-largest country, with twenty-eight (28) states and eight (8) union territories. In India, the highest COVID-19 case was recorded on 6th may 2021 which is 4,14,433 cases in the single day. On September 2020th, Maharashtra (11,45,840), Tamil Nadu (5,25,420) and Delhi (2,34,701) have the foremost COVID-19, and on May 2021st, Maharashtra (51,01,737), Tamil Nadu (13,80,259) and Delhi (13,23,567) have the foremost COVID-19 in India. Also, these states show the high death rate than other states. The positive COVID-19 cases are very drastically increased and death cases in these states due to the high population density. Hand hygiene, social distancing, and quarantine are some of the precautions that must be taken to prevent the virus from spreading in society. By increasing the detecting and testing capacity of the COVID-19 positive patients are also the way to enable the reduction of secondary cases with stricter quarantine rules.

### Introduction

In December 2019, an unknown disaster was identified in Wuhan, China. The government of China acted quickly to suppress the pandemic and conducted etiological studies. The World Health Organization (WHO) tentatively named the new virus 2019 novel coronavirus (2019-nCoV) on January 12, 2020. On February 11, 2020, the 2019-nCoV disease was triggered in China and the WHO was named as the coronavirus disease 2019 (COVID19). In the meantime, the International Committee on Taxonomy of Viruses (coronavirus study group) named 2019nCoV as severe acute respiratory syndrome coronavirus 2 (SARSCoV2). COVID-19 is a virus family that primarily causes respiratory diseases in humans; symptoms of a common cold or pneumonia, as well as respiratory infections. Around 77,041 confirmed SARSCoV2 cases in China as of February 23, 2020. Further, it has shattered the health systems in all the major economies of the world (Sun et al., 2020; Gorbalenya et al., 2020; Carlos et al., 2020). However, due to the rapid dissemination of information and the growing scope of occurrences, tourists were quickly quarantined and screened, effectively halting the spread of the sickness.

In the future, the presence of new corona virus are the most common one for human beings because of climate change and human

and animal interaction (Chen et al., 2020). In some clinical circumstances, it has been discovered that some virus carriers are without any symptoms, with no fever and only slight symptoms of infection. Without identifying these asymptomatic patients, the unsuspecting virus carriers can spread very quickly and effectively. It also has the ability to increase the danger of disease transmission. As a result, in order to track down unknown COVID-19 sources, the rapid and precise screening of suspected virus carriers and diagnosis of asymptomatic patients is critical for prevention at the earlier stage (Chen et al., 2020; Mao et al., 2020).

Bhadra et al., have demonstrated the positive cases in India till September 2020. Also, the author discussed the population density and both infection and death cases during this period. In this present work, we demonstrate the positive cases till December 2021 in Indian states. Also, we show the death and discharge cases. Moreover, the lifestyle of the Indian states during the lockdown is also discussed (Bhadra et al., 2021).

### Methodology

The work is a literature-based study of the positive cases in India. This study is mainly focused on positive, active, discharge and death

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cases in Indian states with the available literature. Also, we discussed the life span of India during the lockdown situations. The external data is collected from online resources like articles, new and various materials.

*India’s COVID-19 scenario*

In India, metropolitan cities such as Delhi, Chennai, Bangalore, Mumbai, Ahmedabad, and Kolkata have been blamed for a large portion of total infections and mortality. These metropolitan cities have a large population and high population density, which causes greater infection and mortality compared with other places (Oran and Topol, 2020).

*Epidemiological characteristics of COVID-19 in India*

This report describes the current epidemiology of COVID-19 in India using preliminary data. India is the world’s seventh-largest country, with twenty-eight (28) states and eight (8) union territories (Bhadra et al., 2021). The Indian government has taken all necessary actions to ensure that all are prepared well to face the challenge and threat against the increasing pandemic situation of COVID-19. The government of India provides data on total positive, active, discharge, and death cases by state at <https://www.worldometers.info/coronavirus/country/india/>. (World Health Organization). From January 30 to July 31st, 1,93,58,659 samples were collected from all over India. Apart from this, 16,95,988 positive cases and 35,747 dead cases were recorded in India. Table 1 shows the overall COVID-19 positive cases in India from January 2020 to December based on the available data. On January 30, India reported its first COVID-19 positive cases in Kerala, and 3 cases were recorded on February 3, the day the students returned from Wuhan, also no cases were observed in the same month. Moreover, 14 Italian tourist group positive cases out of 22 positive cases recorded on March 4 were identified (Italian Tourists). The first death was declared by the Indian health ministry on March 12th in Karnataka (76-year-old) (Pulla, 2020). Furthermore, the 1000th case in India was recorded on March 29th (1024 cases). From Fig. 2, the graph represents the cases in India that predominately increased till April 9th. After that, the cases increased in large numbers, more than a thousand cases per day. Since May 1st, more than 2000 single day

cases have been reported. From May 1st to May 25th, the positive cases increased in a fast manner. At the end of May, 8,336 cases were reported on a single day. From Fig. 1, till May 31st, around 1,82,143 positive cases have been reported all over India. From June 1st onwards, positive cases and death rates in India increased faster than in previous years, as shown in Table 1. July 1st to July 31st, around 16,97,054 positive cases were recorded in India. Moreover, the highest number of cases was recorded in the month of September 11th, which recorded about 97,654 positive cases on a single day. This is the highest number of cases compared to the other days in India. After the day of September 18, 2020, the daily cases of COVID-19 in India gradually decreased till June 23, 2020. From the Table 1, at the end of December, 1,02,66,674 positive cases were recorded in the entire year. However, the daily cases recorded at the end of December were about 19,046 daily cases, and 2,57,656 active cases were recorded all over India.

The 2021 New Year was born with the COVID-19 cases with a lot of restrictions. As of January 3, 2021, India had 16,660 daily cases and 1,68,744 active cases. The daily cases in India were decreased till February 16, 2021. After that, daily cases were gradually increased till April 1, 2021. From April 2nd onwards, the daily cases drastically increased. In India, the highest daily case was recorded on May 06th (4,14,433), which is much higher than the previous days. The daily cases also decreased till June 21st. The daily cases decreased without increasing till December 20th (5,326). In contrast, 4,81,080 death cases were noticed till December end due to the SARS disease. Moreover, these positive case patients are hospitalised and separated from others to avoid spreading the SARS virus.

Table 2 shows the state wise COVID cases like total, active, discharge and death cases on September 11th in India. From the Table 2, foremost cases are recorded in Delhi (2,34,701), Maharashtra (11,45,840), Andhra Pradesh (6,01,462) and Tamil Nadu (5,25,420) on September onwards (Fig. 1a). These states are the most infected in India due to the high population and high population density per square feet. One report can show that in Maharashtra and Tamil Nadu has the population density of 365 and 555 people per square feet (Oran and Topol, 2020). This impact also reflects the death cases like 31,351, 8,618 and 4,877 which correspond to Maharashtra, Tamil Nadu and Delhi, respectively (Fig. 3). Fig. 2a shows the active cases and recovery cases vs Indian states, which shows the rate of recovery

**Table 1**  
Month wise cases in India first and second wave.

Year	Month	Total cases	Active cases	Discharge cases	Death
2020	January	1	1	0	0
	February	3	3	0	0
	March	1,397	1,238	124	35
	April	33,050	23,651	8,325	1,074
	May	1,82,143	89,995	86,984	5,164
	June	5,66,840	2,15,125	3,34,822	16,893
	July	16,38,870	5,45,318	10,57,806	35,747
	August	36,21,245	7,81,975	27,74,801	64,469
	September	62,25,763	9,40,441	51,87,825	97,497
	October	81,37,119	5,82,649	74,32,829	1,21,641
	November	94,31,691	4,46,952	88,47,600	1,37,139
	December	1,02,66,674	2,57,656	98,60,280	1,48,738
2021	January	1,07,46,183	1,68,784	1,04,23,125	1,54,274
	February	1,10,79,979	1,59,590	1,07,63,451	1,56,938
	March	1,21,49,335	5,52,566	1,14,34,301	1,62,468
	April	1,87,62,976	31,70,228	1,53,84,418	2,08,330
	May	2,80,47,534	20,26,092	2,56,92,342	3,29,100
	June	3,03,62,848	5,37,064	2,94,27,330	3,98,454
	July	3,15,75,929	3,96,745	3,07,55,519	4,23,665
	August	3,27,68,880	3,70,640	3,19,59,680	4,38,560
	September	3,37,39,980	2,77,020	3,30,14,898	4,48,062
	October	3,42,73,300	1,59,272	3,36,55,842	4,58,186
	November	3,45,87,822	1,00,543	3,40,18,299	4,68,980
	December	3,48,38,804	91,361	3,42,66,363	4,81,080

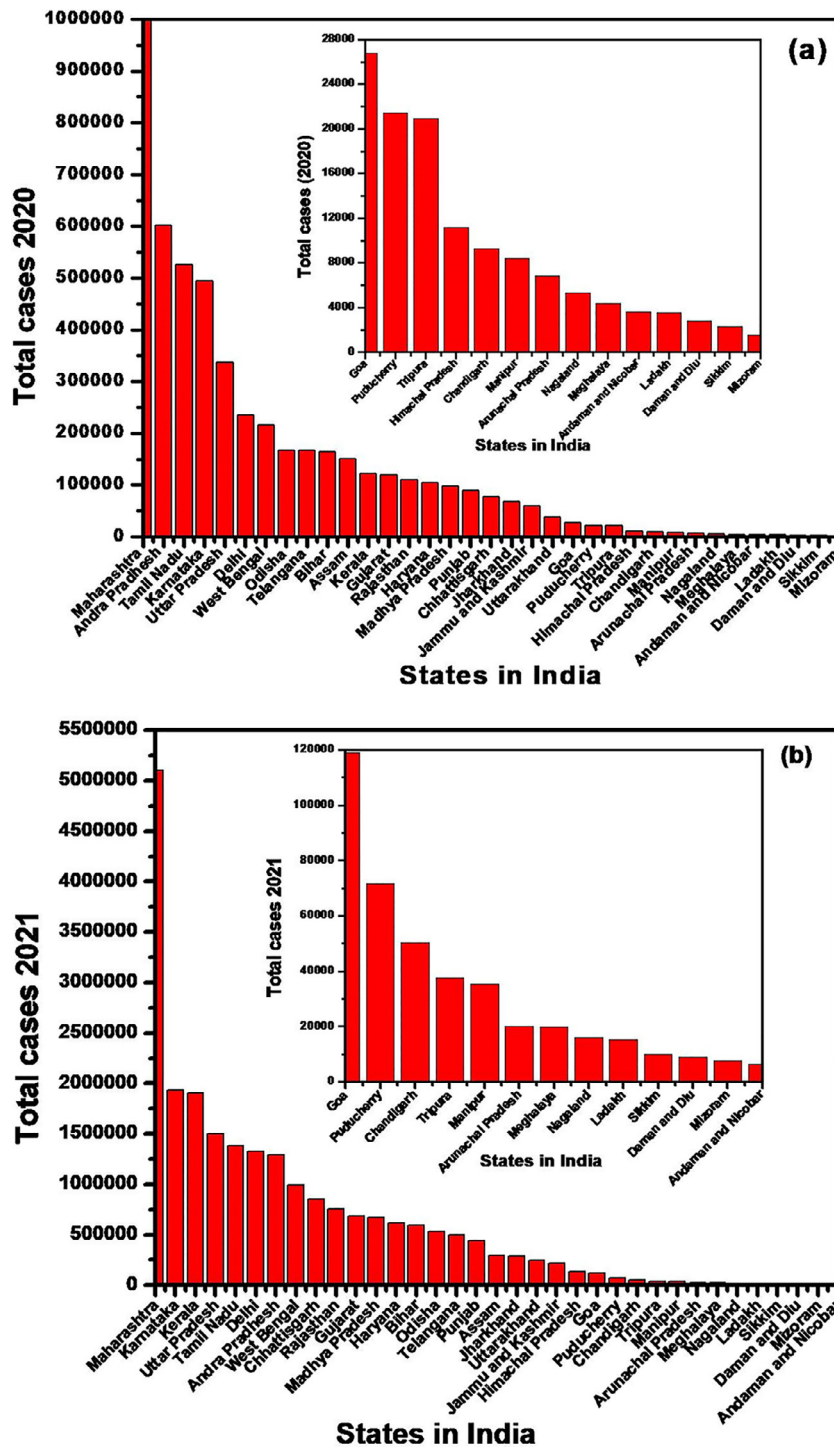


Fig. 1. Total cases vs states in India at (a) 2020 & (b) 2021.

cases has enormously increased in the Indian states. Furthermore, in Maharashtra (14,729) has the highest death cases in India (Fig. 3a). Moreover, Delhi (3,936) and Tamil Nadu (3,838) also have the highest death rates compared with other states.

In the case study, the decrease of COVID-19 cases till December in Indian states is for the people’s support and the state governments necessary actions. But, the new year of 2021 was born with the COVID-19 cases. Till the end of January 2021, the daily cases were decreased. At the starting of February 2021 the second wave of COVID-19 was formed with the modified SARS virus named as the omicron. It is more

efficient and more powerful than the first wave of the SARS virus. February 8th 2021, 8947 daily cases are recorded in all over India, this is the lowest case noticed after several months. After that, the daily cases increased to 10,510 cases on February 9th. On April 3rd, the daily cases were increased in terms of multiples of thousands. On April 4th onwards, the daily cases were attained as 103,793 cases noticed on the single day. The highest COVID-19 case was recorded on 6th May 2021 which is 4,14,433 cases in a single day from Indian states. These are the most cases recorded in Indian history when compared to other days. total cases that were noticed on the day of May 6th from the

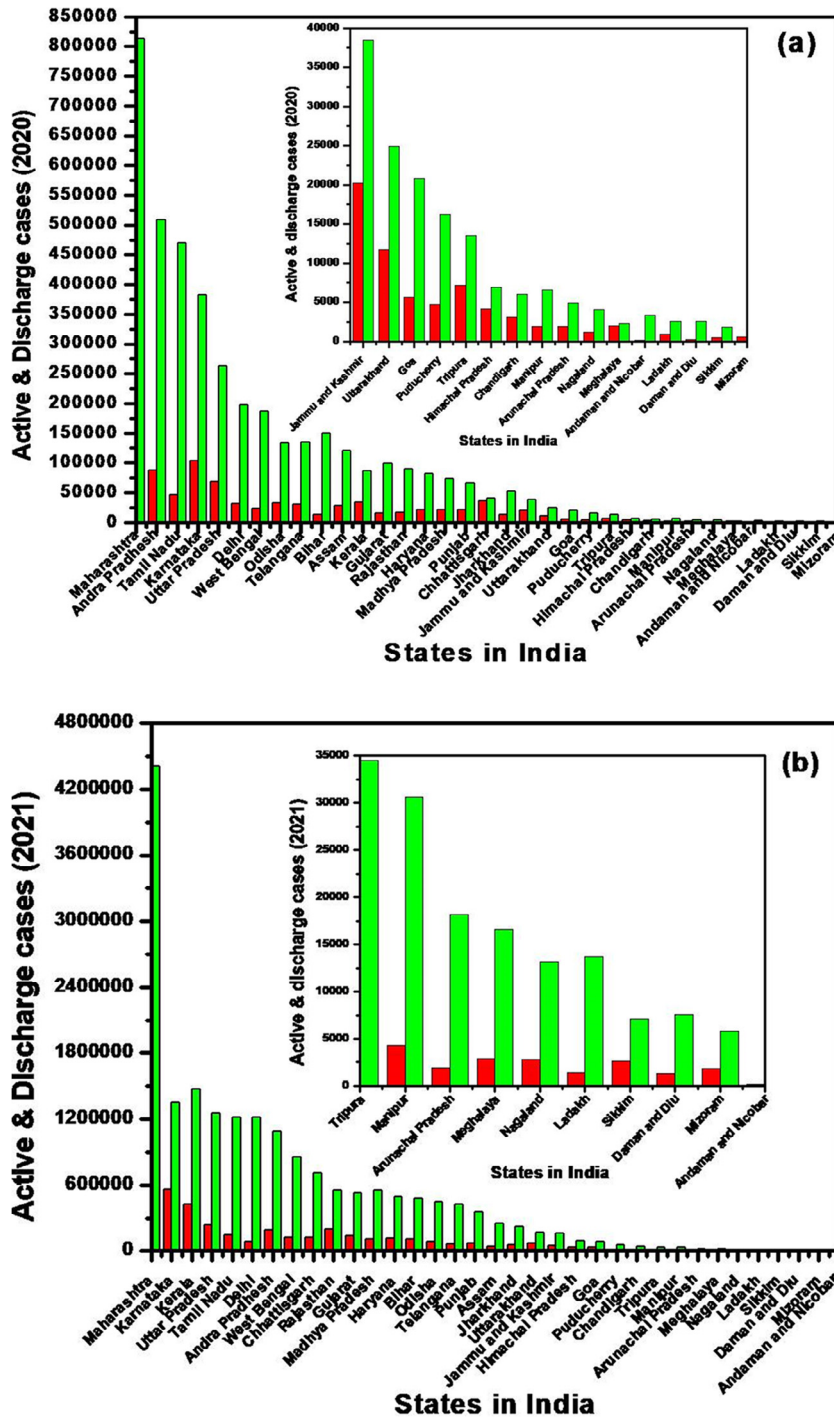


Fig. 2. Active and discharge cases vs states in India at (a) 2020 & (b) 2021.

Indian states are shown in Table 3, it shows that Delhi (13,23,567), Karnataka (19,34,378), Maharashtra (51,01,737), Andhra Pradesh (12,87,603), Kerala (19,02,628) and Tamil Nadu (13,80,259) are the most affected states in India, which are classified in the red zone. The governments are taking the necessary actions to prevent the spread of the SARS virus from these states to other states by closing all the borders with the Indian states to avoid the spread of the virus. Also, Fig. 2 shows the total cases, active cases, discharged cases and death cases vs States in India on 10th may 2021. However, the cases from Daman and Diu (8,847), Mizoram (7,623) and Andaman and Nicobar Islands (6,367) show the lowest COVID-19 cases compared

with the other states in India, also Dam and Diu (4) also have a higher death rate than other states.

*Life style during the COVID-19 situation in India*

In India, both the rural and urban sectors are facing a bad impact on human life. All human beings are tamed by COVID-19, lock down and social distance were strictly handled by the state governments, which was initiated by the Indian government to avoid the spread of the SARS virus. In India, the first lockdown (March 24th, 2020) was suddenly announced by the Indian government due to the spread

**Table 2**  
State wise COVID-19 cases in India on Sep 2020th.

State	Cases	Active cases	Discharge	Death
Maharashtra	11,45,840	3,02,135	8,12,354	31,351
Andra Pradesh	6,01,462	88,197	5,08,088	5,177
Tamil Nadu	5,25,420	46,610	4,70,192	8,618
Karnataka	4,94,356	1,03,650	3,83,077	7,629
Uttar Pradesh	3,36,294	68,235	2,63,288	4,771
Delhi	2,34,701	31,721	1,98,103	4,877
West Bengal	2,15,580	24,336	1,87,061	4,183
Odisha	1,67,161	33,026	1,33,466	669
Telangana	1,67,046	30,673	1,35,357	1,016
Gujarat	1,64,051	13,156	1,50,040	855
Assam	1,50,349	28,208	1,21,613	528
Kerala	1,22,214	34,380	87,345	489
Gujarat	1,18,926	15,975	99,681	3,270
Rajasthan	1,09,473	17,495	90,685	1,293
Haryana	1,03,773	21,014	81,690	1,069
Madhya Pradesh	97,906	21,631	74,398	1,877
Punjab	90,032	21,568	65,818	2,646
Chhattisgarh	77,775	36,036	41,111	628
Jharkhand	67,100	13,703	52,807	590
Jammu and Kashmir	59,711	20,239	38,521	951
Uttarakhand	37,139	11,714	24,965	460
Goa	26,783	5,612	20,844	327
Puducherry	21,428	4,744	16,253	431
Tripura	20,949	7,162	13,559	228
Himachal Pradesh	11,190	4,146	6,946	98
Chandigarh	9,256	3,085	6,062	109
Manipur	8,430	1,841	6,538	51
Arunachal Pradesh	6,851	1,871	4,967	13
Nagaland	5,306	1,193	4,098	15
Meghalaya	4,356	1,983	2,342	31
Andaman and Nicobar Islands	3,604	174	3,378	52
Ladakh	3,576	972	2,558	46
Dadra and Nagar Haveli and Daman and Diu	2,831	221	2,608	2
Sikkim	2,274	463	1,789	22
Mizoram	1,534	585	949	0

speed of the SARS virus (Pulla, 2020). 1.3 billion people's lifespans were totally changed from the first lockdown. However, social distance was maintained in India because it is difficult for the urban poor to live in slums or very close and small places. In particular, Mumbai is the capital of Maharashtra, it shows the high density of people's lives, which is 75,000 people per square mile. Also, in Chennai which has a population density of 26,553 people per square kilometre, it is the most densely populated city in Tamil Nadu (Wasdani and Prasad, 2020; City Size and Population Density in Mumbai).

In addition, the suddenly imposed lockdown was forced on millions of small-scale business people and migrant workers to face their future days without family, food and job. However, 50 million people migrated from Odisha, Punjab, Rajasthan, Bihar, Uttar Pradesh, Assam, Madhya Pradesh, and West Bengal to Maharashtra, Tamil Nadu and Delhi for work (City Size and Population Density in Chennai). Many regular but unprotected workers operate in the transportation industry. Long-distance movements of people and goods across state and district boundaries have been restricted during the crisis, resulting in job losses. However, due to the rising usage of home delivery services, some urban enterprises continue to function. Furthermore, due to the lockdown, these people are being relocated to their hometown by walking without access to transportation. Due to the pandemic situation lockdown, the education system was completely halted throughout India, and educational institutions were closed. Suggested that educational institutions conduct the classes in an online mode with some of the restrictions. But the rural area doesn't have the computer and network facilities. For these reasons, the government plans to conduct the classes via Android mobile phones using a 4G network. These impacts on online classes are followed by all the educational institutions in the states of India. On April 15th, 2021, the second

lockdown was made by the Indian government with some relaxations. The only positive impact from the lockdown is that people are spending their own time with their families (Kapasia et al., 2020; Ghosh et al., 2020). The Indian economy declined by 7.3 percent in the April-June quarter of this fiscal year, according to the ministry of statistics and programme implementation. This is the largest fall since the government began recording GDP statistics quarterly in 1996 (Impact of Covid-19 on Indian Economy, 2021).

However, the fears of non-resident Indians for their families and loved ones are "obvious and palpable" as India suffers from a devastating coronavirus outbreak. Unlike in the first wave of the COVID pandemic, both urban and rural regions have been badly impacted this time. The Indian government was battling a tremendous health and financial crisis with a creaking medical system and insufficient equipment due to a low vaccination rate and widespread COVID positivity. As a result, NRIs continue to be concerned and attempt to maintain contact with friends and family back home (As India struggles to contain Covid, it's time for NRIs to step up).

The Union Government has suspended all modes of road transport in India, including buses, minibuses, maxicabs, auto services, and cab services, till further notice. The most significant concern for road transporters is to keep the supply chain of vital and clinical items running in the most secure way possible in accordance with the most recent applicable government standards (Patel et al., xxxx).

#### Unemployment

India is facing a major problem with unemployment. Especially during the lockdown period, many of the companies are closed, and the domestic workers are facing unemployment during this period.

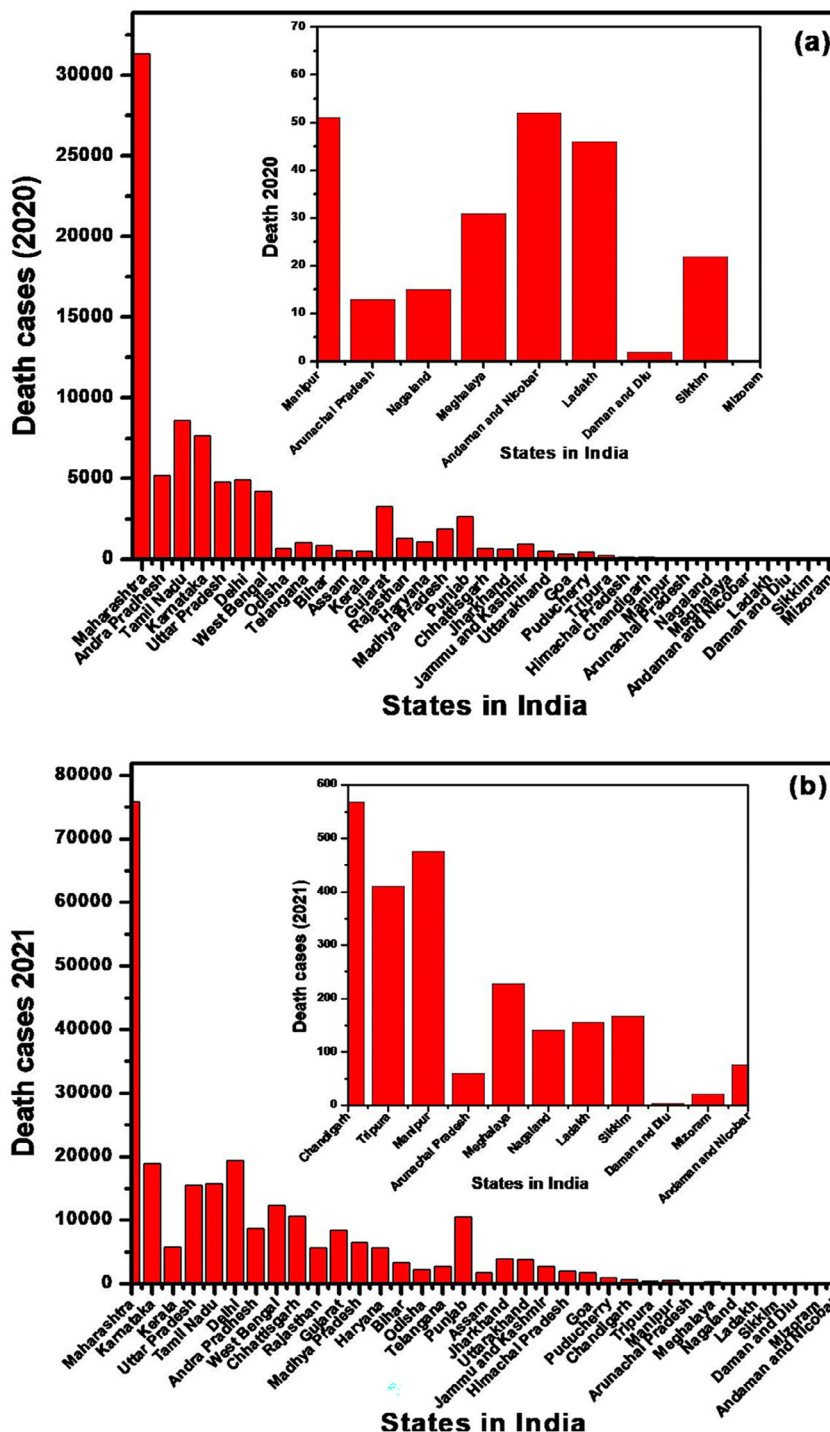


Fig. 3. Death cases vs states in India at (a) 2020 & (b) 2021.

Compared with the 2018 unemployment rate in India, 2020 has the highest unemployment rate as it was raised from 12 % to 20 % in the metropolitan areas and from 10.5 % to 25 % in the rural areas. According to the CMIE (Centre for Monitoring Indian Economy) report, India's unemployment rate has risen to 29 % since the country went into lockdown in March 2020. Because of the lockdown imposed to limit the corona virus spread, many industries have been forced to close, increasing unemployment across the country (Güner et al., 2020).

*COVID-19 prevention*

During the period of COVID-19, people need to self-protect and avoid body contact with others. For this reason, in the world wide was altered the hand shaking into Tamil Nadu traditional says “VANAKAM” (வணக்கம்). Which is separate the human contact also prevents the spread of the coronavirus. Also, all the governments have officially announced the lockdown to avoid the human contact from March 23rd, 2020. It was extended based on the positive cases. The

**Table 3**  
State wise COVID-19 cases in India on May 2021st.

State	Cases	Active cases	Discharge	Death
Maharashtra	51,01,737	6,18,070	44,07,818	75,849
Karnataka	19,34,378	5,64,505	13,51,097	18,776
Kerala	19,02,628	4,23,863	14,72,951	5,814
Uttar Pradesh	15,03,490	2,33,981	12,54,045	15,464
Tamil Nadu	13,80,259	1,44,547	12,20,064	15,648
Delhi	13,23,567	86,232	12,17,991	19,344
Andra Pradesh	12,87,603	1,90,632	10,88,264	8,707
West Bengal	9,93,159	1,26,027	8,54,805	12,327
Chhattisgarh	8,51,476	1,26,547	7,14,359	10,570
Rajasthan	7,56,707	2,00,189	5,50,853	5,665
Gujarat	6,81,012	1,39,614	5,33,004	8,394
Madhya Pradesh	6,71,763	1,08,913	5,56,430	6,420
Haryana	6,15,897	1,16,867	4,93,425	5,605
Bihar	5,91,476	1,10,805	4,77,389	3,282
Odisha	5,34,842	84,799	4,47,863	2,180
Telangana	4,97,361	65,757	4,28,865	2,739
Punjab	4,42,125	74,343	3,57,276	10,506
Assam	2,92,368	37,352	2,53,340	1,676
Jharkhand	2,86,343	58,806	2,23,684	3,853
Uttarakhand	2,44,273	74,114	1,66,431	3,728
Jammu and Kashmir	2,16,932	49,248	1,64,958	2,726
Himachal Pradesh	1,31,423	32,469	97,069	1,885
Goa	1,18,846	31,875	85,292	1,679
Puducherry	71,709	14,034	56,710	965
Chandigarh	50,207	8,511	41,128	568
Tripura	37,692	2,750	34,532	410
Manipur	35,354	4,280	30,598	476
Arunachal Pradesh	20,165	1,933	18,172	60
Meghalaya	19,720	2,899	16,593	228
Nagaland	16,150	2,809	13,201	140
Ladakh	15,317	1,443	13,719	155
Sikkim	9,878	2,637	7,074	167
Daman and Diu	8,847	1,320	7,523	4
Mizoram	7,623	1,847	5,755	21
Andaman and Nicobar	6,367	203	6,088	76

World Health Organization (WHO) was advised to prevent the spread of COVID-19 such as (Hafeez et al., 2020; Wang et al., 2020; WHO Coronavirus disease; Russia's Sechenov University has NOT 'completed' COVID vaccine clinical trials). Always cleaning the hands using soap and sanitize using alcohols frequently.

- Don't use the sanitizers before using fires or cooking, because of the alcohol based sanitizers are flammable.
- Be aware and keep distance those who sneezing behind of you.
- Always wear clean mask, when you're not keeping the physical distance with others.
- Without cleaning your hands do not touch your eyes, nose or mouth.
- Quarantine yourself when you are feel unwell.
- If anyone have mild fever, sneezing, and breathing problems WHO advise to seek medical attention.

#### A race of COVID-19 vaccine

In the initial stage of COVID-19, no vaccine and specific clinical treatments are available for SARS-CoV-2. For this reason, the fastest races have been held in the economically developed countries. A multifarious process has been done for the vaccine to prevent COVID-19. At first, the Russian government announced their first vaccine was succeeding and they started their first stage of vaccine testing using human beings. Around July 12, Russian medical universities such as Sechenov University have completed clinical trials of the COVID-19 vaccine. This report demonstrated the first vaccine in the world to complete human trials (Kumar et al., 2021). Furthermore, China, America, the United Kingdom, Australia, and other countries worked hard to develop their first COVID-19 vaccine.

Meanwhile, Bharat Biotech, an Indian biotechnology company, has received regulatory approval from the Drug Controller General of India (DCGI) to proceed with human clinical trials of its Covid-19 using the vaccine named "Covaxin". Human trials of this vaccine, human trials have been approved and can begin on July 7 (Voysey et al., 2021). Also, the vaccine named "Covishield" was manufactured by Oxford-AstraZeneca. Initially, they produced 50 million doses, after January 2021 it was increased over 100 million doses per month. The vaccine Covishield was placed under "at-risk manufacturing and stockpiling license" authorised by the Drugs Controller General of India and the Indian Council for Medical Research has granted Covishield under (ICMR) (Zhang et al., 2020).

#### COVID-19 treatment

As per the WHO suggestion, a person who suffers from a sore throat, body aches, and fever should take over-the-counter medicine. Also, the WHO advised the person infected with the SARS virus do not use any other antibiotics that cause some other diseases along with SARS. Also, they are advised to hospitalise to improve their immunity (Principi and Esposito, 2020).

Initially, in the state stage of a pandemic situation, WHO approved that hydroxychloroquine and chloroquine be used to threaten COVID-19 positive patients (Beigel et al., 2020). But in the later days of the FDA study, the drug was ineffective for the COVID-19 patients. People hospitalized with SARS symptoms are given the medication remdesivir (Veklury), which was the first to be approved by the Food and Drug Administration for the treatment of COVID-19 patients. Moreover, this remdesivir recovered SARS virus patients within 11 days, which is higher than placebo treatment (15 days). Also, the FDA has approved



the plasma treatment to build immunity for COVID-19 patients (Nearly 6,000 Covid patients cured through Siddha medicine in Tamil Nadu).

Furthermore, during the early stages of COVID-19, the traditional Siddha system of medicine has proven to be extremely effective in the treatment of COVID-19 patients. In all, nearly 6,000 positive cases were cured by Siddha medicine in Tamil Nadu (Siddha research papers throw light on efficacy of 'Kabasura kudineer' in managing COVID-19). The Tamil Nadu state government preferred the Kabasura drink for positive patients, medical professionals and visitors to improve their health. Kabasura kudineer contains the combination of a few dry herbals like kadukkai, clove, mulli root, pappali, ajwain, ginger, cirukancori root, and other herbs (Kabasura Kudineer). This combined herbal drink does not have any side effects, although it is always preferable to get the opinion of an ayurvedic physician before using it. When combined with homoeopathic medicine, this mixture is safe (Coronavirus: Siddha treatment has 100% success rate, claims Tamil Nadu minister). The Tamil Nadu government reported a 100 % recovery rate among positive cases. Also, in the Siddha medicinal treatments the COVID positive cases are very well complemented (Siddha research papers throw light on efficacy of 'Kabasura kudineer' in managing COVID-19).

#### Positive approaches of lockdown

Lockdown has a significant influence on air quality around the world, including in India. A recent study discovered a link between COVID-19 instances and climatic conditions. The traffic-related limitations resulted in a more than 50 % reduction in PM<sub>2.5</sub> and NO<sub>2</sub> concentrations over Delhi-NCR. The COVID-19 pandemic's nationwide lockdown had a substantial impact on the air quality index. A quantitative assessment of air quality indicators is required to comprehend the influence of lockdown on anthropogenic emission sources and how to reframe mitigation measures in India. The primary goal of this study was to investigate changes in ambient air quality across India during lockdown and subsequent unlock phases (Mishra et al., 2022).

#### Conclusion

In conclusion, COVID-19 is a serious infectious disease which causes a huge disaster worldwide. In this work, we discussed how India is facing the COVID-19 situation and a case study of COVID-19 positive cases. Also, discussed the problems being faced by the Indian people in the lockdown for the pandemic situation. The implementation of social distancing is the way to suppress and mitigate the spread of COVID-19. As a result, the new and emerging treatments are imperative to reducing the death toll among those who are affected by the SARS virus in India and also in other countries. The governments implemented the lockdown during the COVID-19 situation to reduce the positive cases. But, the lockdown situation changed the lifespan, economic and unemployment for the people. The only positive thing that happened during the lockdown period is that air pollution was decreased and air quality was increased.

#### CRedit authorship contribution statement

V. Uma Shankar: Writing – review & editing, Data curation, Formal analysis. P. Senthil Kumar: Conceptualization, Validation, Supervision. K. Nirmala: Data curation, Formal analysis.

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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