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Review Article

COVID-19: A Brief Retrospect

R Rajendran[1], S B Anusree[2], M S Sasi[3], D Sheela Devi[4], S N Sharma[5], Nupur lal[6]

[1]Former Joint Director, [2]Research Assistant, National Centre for Disease Control, Ministry of Health and Family Welfare, Government of India, Thiruvananthapuram, Kerala, India.
[3]Assistant Director, Directorate of Health Services, Government of Kerala, India.
[4]Former Associate Professor, MMNSS College, Kottiyam, Kollam, Kerala, India.
[5]Former Senior Consultant, National Centre for Disease Control, Ministry of Health and Family welfare, Government of India, Delhi, India.
[6]Professor, Department of Zoology, YBN University, Ranchi, Jharkhand, India.
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Corresponding Author:
R Rajendran, National Centre for Disease Control, Ministry of Health and Family Welfare, Government of India, Thiruvananthapuram, Kerala, India.
E-mail Id:
rajendran061@gmail.com
Orcid Id:
https://orcid.org/0000-0003-2080-9723
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A B S T R A C T

A country like India, having a population of 1.3 billion with diverse topographies, conglomerate climatic conditions, vast ethnic diversities and high population density; was subjected to a litmus test when the first case of new Coronavirus disease (COVID-19) was diagnosed on January 30, 2020, in Kerala in a medical student who returned from China. The Government of Kerala (Gok), following the guidance of the Ministry of Health and Family Welfare Govt. of India, swiftly enhanced its health and hygiene department. They implemented strict containment, isolation and other preventive measures to halt the rapid spread of the disease in the community. The Govt. of Kerala could manage the COVID-19 pandemic using the five major components-trace, quarantine, test, isolate and treat. Kerala's success in restraining COVID-19 relies on the stable setting up of a successfully fabricated infrastructure to support social and human development including a well-equipped public healthcare delivery system. The grass-root empowerment in all realms of life articulated with decentralised governance helped the state prompt and immediate measures to contain the disease. The Govt. of Kerala has taken several welfare measures to extend care and support to the downtrodden, especially during the lockdown period. The lessons and experiences from Kerala state highlight the importance of a robust and dedicated public health system with active community participation for the guidance and control of the COVID-19 pandemic. Kerala's COVID-19 response serves as a yardstick for effective public health infrastructure utilisation.

Keywords: COVID-19, Route Map, Community Transmission, Vaccination Status, Public Health Infrastructure, Case Fatality Rate

Introduction

In late 2019, a cluster of mysterious pneumonia cases surfaced in Wuhan, China. Many of the initial patients had visited a local seafood market known for selling a variety of wild animals. The first known cases of the disease were reported on December 1, 2019, in a person who had not visited the Huanan seafood market. The disease outbreak was officially announced by the Wuhan health authority

on December 31, 2019.[1] Dr Zhong Nanshan of China's National Health Commission (NHC) has announced that the novel coronavirus is contagious. The Chinese scientists successfully isolated the virus on January 7, 2020, and genetic analysis confirmed it as a new strain.[2]

On January 12, the World Health Organization (WHO) designated the coronavirus as the 2019 novel coronavirus (2019-nCoV). However, they officially renamed the disease coronavirus disease 2019 (COVID-19) on February 11, 2020.[3] The Coronavirus Study Group (CSG) of the International Committee on Taxonomy of viruses (ICTV) set forth the name SARS-CoV-2, but COVID-19 remains to be officially confirmed. This is the seventh human-infecting coronavirus discovered. On January 22, novel CoV was proclaimed to have originated from wild bats and belonged to Group 2 of beta-coronavirus (β-CoV) that contains Severe Acute Respiratory Syndrome Associated Coronavirus (SARS-CoV). Similar to SARS CoV and MERS CoV, there is enough evidence that SARS CoV-2 also originated from bats, although the likelihood of transmission from other animals such as pangolins has also been reported.[4]

COVID-19 Outbreaks - Early Phase

By mid-November 2019, a few cases of 'flu' like illness of unknown origin were reported in Wuhan, Hubei province of China. A 55-year-old person from Hubei province was reported to be the first person infected with the new coronavirus, according to the South China Morning Post on November 17, 2019. Since November 17, 2019, one to five new coronavirus cases were reported each day and by December 15, 2019, the total number of infections stood at 27. However, by December 20, 2019, the number of new coronavirus cases rose to 60. The initial cases were attributed to the Huanan seafood market and hence the virus was thought to be of zoonotic origin. Among the infected individuals reported in Wuhan on December 1, 2019, a person who did not have exposed to the seafood market also contracted the disease. The researchers were motivated to investigate the origin of the causative agent of the ongoing disease outbreak.

In the initial phase of the disease outbreak, Wuhan health authorities did not take any serious steps either in investigating or controlling the disease. They thought it was a mild flu or cold. This lapse of local health officials at the beginning of the disease outbreak allowed the virus to spread to all the provinces of China and later the rest of the world. On December 27, 2019, a physician named Zhang Jixian of Hubei Provincial Hospital of Integrated Chinese and Western Medicine, informed Chinese health authorities that the illness might be caused by a novel coronavirus. Hence Dr Zhang Jixian is considered the first doctor to report the novel coronavirus before its outbreak.[5] By December 31, the number of confirmed cases rose to 266 and on January 1, 2020, the cases jumped to 381. However, on December 31, 2019, Dr Li Wenliang, a 29-year-old ophthalmologist from Wuhan Central Hospital (WCH), while examining the medical report of a patient with similar symptoms, realised that the disease may be due to a new coronavirus strain very much related to SARS. He conveyed the message to fellow doctors through social media. Instead of encouraging him for his foresightedness, he was warned by Wuhan police for "spreading rumours". Unfortunately, Dr Li died from a novel coronavirus on February 7, 2020. It appears that the haughtiness of local health and police authorities of Wuhan is responsible for the current crisis. Dr Zhang and Dr Li are worth remembering for their keen sense of observation and social commitment. The ongoing pandemic is a classic example to illustrate how simple negligence can cause highly dangerous devastation in the world.

"Patient zero" has not been identified among the initial nine cases reported in mid-November 2019, which included four men and five women. All patients were aged 39-79, but the number of residents from Wuhan, the epicentre of the new coronavirus, is not known. There may have been unreported cases prior to those documented in the official government data. The initial fatality of the novel coronavirus was a 61-year-old man who regularly visited the Huanan seafood market. The Chinese health commission officially confirmed the death on January 11, 2020.[6]

On January 13, 2020, Thailand reported the first case of novel coronavirus, and subsequently by January 20, 2020, 282 confirmed cases had been reported from four countries including China (278 cases), the Republic of Korea (1 case), Japan (1 case), and Thailand (2 cases). Among the 278 cases confirmed in China, 258 cases (92.81%) were reported from Hubei Province, 14 from Guangdong Province (5.03%), 05 from Beijing Municipality (1.80%) and 01 from Shanghai Municipality (0.36%). Six deaths were also reported in China during this time[1]. The situation report of the new coronavirus dated January 29, 2020, indicated that a total of 6065 confirmed cases were reported worldwide, of which 5997 (98.88%) were from China. Meanwhile, the disease has spread to 15 countries.[7] After a brief field-visit to China, WHO issued a statement that, even though the full extent of transmission is not known, there was evidence of human-to-human transmission in Wuhan. On January 30, 2020, the World Health Organization classified the novel coronavirus as a public health emergency of international concern (PHEIC).[8]

COVID-19: Global Scenario

Global situation report on novel coronavirus indicated that as of January 31, 2020, a total of 9720 confirmed cases and 213 deaths have been reported in China (Table 1). Outside China, 19 countries have reported 106 confirmed cases, most of them having a travel history with China.[9]

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Exactly after three months of this report, the confirmed COVID-19 cases rose to 8, 23,626 globally with 40598 deaths. It is interesting to note that in January 2020, the disease affected only 19 countries. However, on April 1, 2020, the disease spread over 206 countries/ territories. This clearly indicates the transmission potential of COVID-19 across the world.[10] As per this report, the number of confirmed cases in the United States of America (USA) was 1, 63,199 with 2,850 deaths. The details of the worst affected countries are given in Table 2.

The COVID-19 global situation report dated April 1, 2020 showed that among 100 patients, 22 are Americans, 12 are Italians, 12 are from Spain, 9 from China, 6 from France, 5 from Iran, 3 from Britain, etc. (Figure 1). Though the number of COVID-19-infected persons is higher in the USA, the case fatality rate (CFR) is only 1.75% which is lesser than the rest of the other worst-affected countries in the world. However, the CFR is very high in Italy (11.75%) followed by Spain (8.67%), Netherlands (8.25%), UK (7.11%), France (6.83%), Iran (6.50%), etc.

After six months of COVID-19 outbreak, 85,25,042 confirmed cases and 4,56,973 deaths (CFR- 5.36%) were reported globally.[11] Among the total cases, 41,63, 813 cases (48.84%) were from the Americas with 215903 deaths (Table 3).

Country/ territory-wise reported laboratory-confirmed COVID-19 cases indicated that the United States of America (USA) reported the highest number of cases followed by Brazil, the Russian Federation, India, etc. (Table 4).

Of the total 85,25,042 laboratory-confirmed COVID-19 cases reported all over the world, 55,83,802 (65.50%) cases were from the worst affected countries such as the USA, Brazil, Russia, India, UK, Spain, Peru, Italy, Chile and Iran. Similarly, of the total 4,56,973 deaths reported globally, 3,13,186 (68.53%) were from the aforementioned countries (Table 4).

India ranked fourth in terms of total COVID-19 cases worldwide, with a lower-case fatality rate of 3.38% compared to the global average of 5.36%. In the analysis of the ten COVID-19 worst-affected countries, the lowest CFR was noted in the Russian Federation (1.39%) and the highest in Italy (14.52%). The variation of disease manifestations and fatality among countries depends upon factors such as population characteristics (age and sex, genetic makeup of populations, lifestyle factors of hygiene, diet, etc., elderly care homes, density of populations), environmental and geographic factors (pollution, climate change, travel rate), health care policy (under-reporting, timely response of governments, national policy of BCG vaccination, diagnostic testing facilities, implementation of preventive measures, infrastructure and health care personnel) and virus-related factors (various strains of the virus).[12]

Country/ territory-wise COVID-19 cases and deaths, by WHO Region, as of April 28, 2024 indicated that a total of 77,54,01,794 confirmed cases and 70,47,316 deaths (CFR-0.90%) were reported globally.[13] The region-wise COVID-19 cases and deaths are given in Figure 2.

Table 1.Country-Wise Confirmed Novel Coronavirus Cases Reported as of January 31, 2020

Country	Cases
China	9720
Japan	14
Thailand	14
Singapore	13
South Korea	11
Australia	9
Malaysia	8
France	6
USA	6
Vietnam	5
Germany	5
UAE	4
Canada	3
Italy	2
Cambodia, Sri Lanka, Nepal, Philippines, Finland, India	1 each

Table 2.Situation Report of COVID-19 Worst Affected Countries in the World (as of April 1, 2020)

Countries/ Territories	Cases	Deaths	Case Fatality Rate (%)
United States of America	163199	2850	1.75
Italy	105792	12430	11.75
Spain	94417	8189	8.67
China	82631	3321	4.02
France	51477	3514	6.83
Iran	44606	2898	6.50
United Kingdom	25154	1789	7.11
Switzerland	16108	373	2.32
Belgium	12775	705	5.52
Netherlands	12595	1039	8.25

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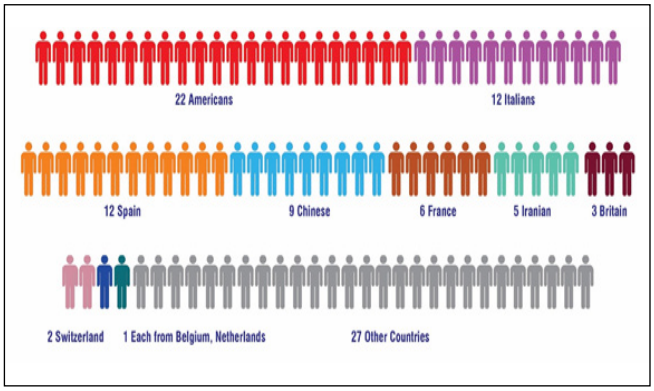

Figure 1.Schematic Representation of Number of Persons per 100 COVID-19 Affected Patients from Worst Affected Countries as of April 1, 2020

Table 3.Region-Wise COVID-19 Cases and Deaths as of June 20, 2020

Regions	Confirmed Cases	Deaths
Africa	208535	4750
Americas	4163813	215903
Eastern Mediterranean	878428	19560
Europe	2509750	192645
South-East Asia	560285	16814
Western Pacific	203490	7288
Globally	8525042	456973

Table 4.Situation Report of COVID-19 Worst Affected Countries in the World as of June 20, 2020

Country/ Territory	Confirmed Cases	Deaths	Case Fatality Rate (%)
United States of America	21,72,212	1,18,205	5.44
Brazil	9,78,142	47,748	4.88
Russian Federation	5,76,952	8,002	1.39
India	3,95,048	12,948	3.28
United Kingdom	3,01,819	42,461	14.07
Spain	2,45,575	28,315	11.53
Peru	2,44,388	7,461	3.05
Italy	2,38,011	34,561	14.52
Chile	2,31,393	4,093	1.77
Iran	2,00,262	9,392	4.69
Total of above 10 countries	55,83,802 (65.50%)	3,13,186 (68.53%)	5.61
World total	85,25,042	4,56,973	5.36

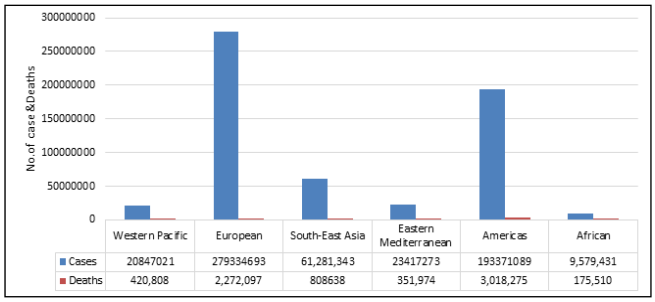

Figure 2.Region-Wise COVID-19 Cases and Deaths as of April 28, 2024

In four WHO regions, there was a decrease or no change in the number of new 28-day COVID-19 cases: the Americas (-75%), Western Pacific (-67%), Europe (-25%), and South-East Asia (-25). Nevertheless, there was a rise in confirmed COVID-19 cases in two WHO Regions; the African Region saw an increase of 18%, while the Eastern Mediterranean Region reported a 45% increase. It is important to mention that during the declining stage of the COVID-19 pandemic, there has been a significant decrease in the number of newly reported 28-day deaths in most WHO Regions, with decreases in Eastern Mediterranean (-78%), Americas (-46%), Western Pacific (-42%), Europe (-31%), and South-east Asia (-28%), but an increase in African Region (+75%). The largest drop in COVID-19 fatalities was seen in the Eastern Mediterranean Region (-78%), with the Americas following closely behind (-46%), then the Western Pacific (-42%). Just like the rise in new 28-day COVID-19 cases in the African Region, there was also a 75% decline in reported COVID-19 deaths.[13]

Examining the latest 28-day COVID-19 data by country, it shows that Russia had the most cases at 69,311 cases (down by 27%), then Australia with 18483 cases (-18%), New Zealand at 11180 cases (-86%), the UK reported 6586 cases (a 6% increase), and China with 5713 cases (-47%). However, none of the countries showed an increasing tendency in the newly reported COVId-19 deaths. The COVID-19 situation report of the 10 worst affected countries as of 13th August 2020 is given in Table 5.

A comparative analysis of the COVID-19 cases and deaths reported as of June 20, 2020 and April 13, 2024 clearly indicated that among the ten worst affected COVID-19 reporting countries, India was at the fourth position in June 2020 (Figure 3), while in April 2024, India's position was on second (Figure 4). In June 2020, the CFR ranged from 1.39% (Russia) to 14.52% (Italy). However, the CFR drastically declined in April 2024 and it ranged from 0.10% (South Korea) to 1.67% (Russia) (Figures 5 and 6). The decreased number of COVID-19 cases and decreased CFR in the fading

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phase of the pandemic could be attributed to several reasons. Among these, the notable ones are widespread roll out of testing, improved case management strategy with modified treatment protocols, service of highly experienced health professionals, increased public health awareness, community participation, the readiness of the people to co-operate with the public health system, coordinate effort from grass root level to higher authorities.[14]

Table 5.Situation Report of COVID-19 Worst Affected Countries in the World as of April 13, 2024

Country/ Territory	Confirmed Cases	Deaths	Case Fatality Rate (%)
United States of America	11,18,20,082	12,19,487	1.09
India	4,50,35,393	5,33,570	1.18
France	4,01,38,560	1,67,642	0.42
Germany	3,88,28,995	1,83,027	0.47
Brazil	3,87,43,918	1,79,908	0.46
South Korea	3,45,71,873	35,934	0.10
Japan	3,38,03,572	74,694	0.22
Italy	2,67,23,249	1,96,487	0.74
United Kingdom	2,49,10,387	2,32,112	0.93
Russian Federation	2,41,24,215	4,02,756	1.67
Total of above 10 countries	41,87,00,244 (59.41%)	32,25,617 (46.01%)	0.77
World total (as of April 13, 2024)	70,47,53,890	70,10,681	0.99%

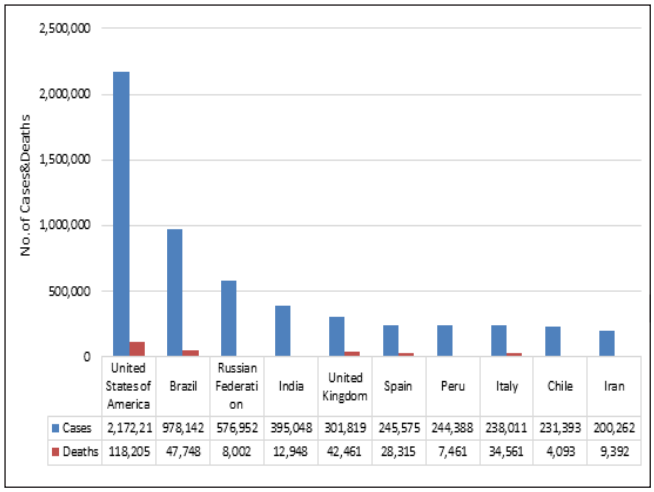

Figure 3.Country-Wise COVID-19 Cases and Deaths as of June 20, 2020

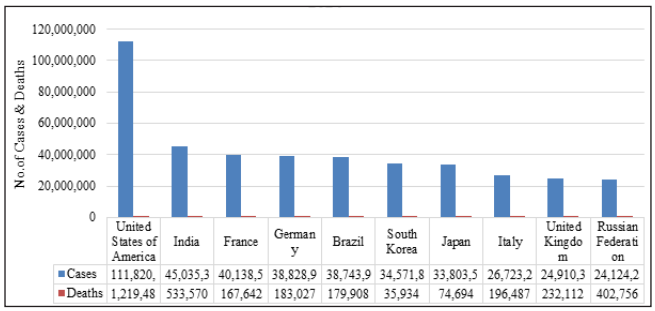

Figure 4.Country-Wise COVID-19 Cases and Deaths as of April 13, 2024

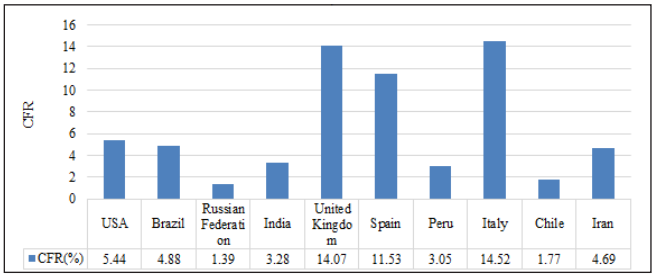

Figure 5.Country-wise Case Fatality Rate due to COVID-19 as of June 20, 2020

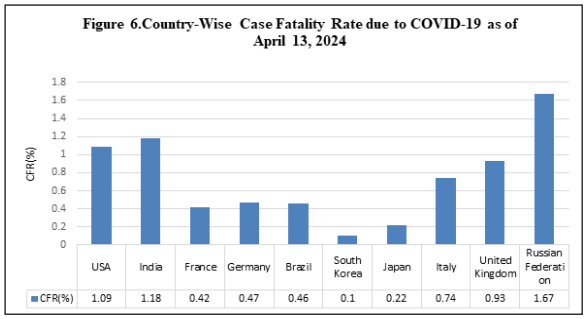

Figure 6.Country-Wise Case Fatality Rate due to COVID-19 as of April 13, 2024

COVID-19 Variants - A Cause of Concern in Disease Control

Since 2020, SARS-CoV-2, the virus that causes COVID-19 pandemic, has been spreading globally. Naturally, viruses do change and evolve as they spread between people over time. When these changes become notably different from a previously detected virus, these new virus types are termed as 'variants. The most significant of these variants are grouped in three ways – 1) variants under monitoring (VUM), 2) variants of interest (VOI) and 3) variants of concern (VOC). There are currently no SARS-CoV-2 variants meeting the criteria of variants Under Monitoring (VUM). Based on the March 2023 evaluation from the European Center for disease Prevention and Control (ECDC), BA.2, BA.4, and BA. 5 are no longer considered major global health risks and have been de-escalated from the Variants of Concern (VOC) status. However, ECDC will continue to monitor SARS-CoV-2 sub-lineages in circulation considering its relevance in the present epidemiological situation.

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Currently, none of the SARS-CoV-2 variants meet the criteria to be classified as Variants of Concern (VOCs).[15] The details of COVID-19 variants of interest (VOI) are given in Table 6.

Table 6.Details of COVID-19 Variants of Interest (VOI)

WHO Label	Lineage + Additional Mutations	Country First Detected	Spike Mutations of Interest
Omicron	XBB.1.5-like	USA	N460K
			S486 P
			F490S
Omicron	BA.2.86	n/a	1332V
			D339H
			R403 K
			V445H
			G446S
			N450D
			L452W
			N481K
			483del
			E484K
			F486P

COVID-19 Vaccine - A Boon to Mankind

As COVID-19 spread rampantly and resulted in exorbitant morbidity and mortality all over the world, confounded people began to run away from loss of life. The public health system of the whole world realised that it is only through an effective vaccine that the pandemic can be controlled. Vaccines function as a barrier, defending us against illnesses by enhancing our innate immune system. The outbreaks of severe acute respiratory syndrome (SARS) and Middle East Respiratory Syndrome (MERS) prompted the quick creation of vaccines to safeguard life on the planet. In 2020, the first COVID-19 vaccines were developed and made available to the public with the consent and approval of concerned authorities. In order to get optimum immunity, initially, COVID-19 vaccines were given in two doses. However, as the immunity from the vaccines has been found to subside over time, it necessitates booster doses of vaccine to maintain protection against COVID-19.[16] The COVID-19 vaccines are extensively assigned for their role in reducing the dissemination of the disease and thus reducing the morbidity and mortality caused by COVID-19. The recent COVID-19 vaccination report indicated that as of the first quarter (Q1) of 2024 (January to March), 9.8 million individuals received the COVID-19 vaccine across the global population.[17] Though various COVID-19 variants are circulating in different geographical regions of the World, the global public health system could provide vaccines to the needy and thus protect the lives of millions of people. The recent report showed that as of May 26, 2024, 77,55,53,735 COVID-19 cases and 70,50,356 deaths were reported from all over the world.[18]

COVID-19: Indian Scenario

The initial instance of the novel coronavirus (COVID-19) in India was documented on January 30, 2020, specifically in Kerala. A medical student, 20 years old, from Thrissur district, who has travelled to Wuhan, China, the origin of the COVID-19 outbreak, is being monitored[19] .The second case of COVID-19, from Alappuzha district, was confirmed on February 1, 2020, followed by the third case, from Kasaragod district, on February 3, 2020. All three of them are medical students who have travelled to Wuhan. The initial three confirmed cases of CVID-19 in India were documented in Kerala, without any cases being reported before March 1, 2020. A 45-year-old man in Delhi who had come back from Italy was diagnosed with COVID-19 on March 2, 2020. This marked the first confirmed COVID-19 case outside of Kerala, the state where the first three cases were identified.

Shortly after it was confirmed that the new coronavirus (COVID-19) had spread from China to neighbouring countries, India implemented measures to control the outbreak. To enhance readiness and response measures for controlling the transmission of COVID-19, the Ministry of Health and Family Welfare (MoH &FW), Government of India has boosted surveillance at entry points, health facilities, and within the community. This includes conducting contact tracing and monitoring following the identification of a positive case. India's strategy towards the disease involved a strong emphasis on monitoring the transmission, detecting cases early, providing medical care, averting infections, managing supply chains effectively, and keeping the public informed. The national and state health authorities consistently monitored these activities. The National Center for Disease Control (NCDC) in Delhi has activated the strategic Health Operations Center (SHOC) room to give guidance and oversee operations, while also launching a helpline to address public enquiries.

By January 31, 2020, India's Ministry of Health and Family Welfare (MoH 7FW) and Ministry of Civil Aviation (MoCA) had introduced in-flight announcements and health checks at 21 airports for travellers coming from China, emphasising symptoms such as fever and cough. MoHFW issued a travel advisory on January 17, 2020 requesting the public to refrain from travel to China. National Institute of Virology (NIV), Pune, equipped with international standards of competence and capability was assigned to test samples of nCoV. Within one month, 12 additional laboratories were

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also identified and authorised for accelerating COVID-19 testing.[20] As of February 5, 2020, 901 samples were tested of which only 3 were positive.

Following the reports of nCoV infection in different countries/ territories, thermal screening and quarantine were started in India. Screening centres were set up in 21 airports, as well as in 12 major and 65 non-major seaports and border crossings across the country. Consequently, a total of 3,97,146 passengers from 3,836 flights underwent screening.[21]

The analysis of the global situation of nCoV indicated that as of January 31, 2020, there were only 9,826 cases and 213 deaths globally. Of the total cases reported, 9720 (98.92%) were from China. Similarly, of the total 213 deaths, all are from China. Meanwhile, in India, only one confirmed case was reported. After 42 days, a drastic increase in the number of nCoV could be noted globally. The new coronavirus (COVID-19) spread in more than 122 countries/ territories across the world. Similarly, a rapid increase in the number of COVID-19 cases and deaths could also be noted in China.[22] However, the same was not reflected in India in terms of COVID-19 cases and deaths (Table 7). During this period, only 19 confirmed COVID-19 cases were reported from Kerala with no deaths. Even though Kerala was the first state to have a confirmed case of COVID-19, the implementation of strict preventive measures like social distancing, mask-wearing, and hand hygiene greatly decreased the spread of the virus. An attempt has been made to compare the COVID-19 situation (Table 8) to explain the transmission potential of the ongoing pandemic.

The Indian Government enacted a countrywide lockdown on March 24, 2020, which spanned 21 days in duration. This choice was made in order to protect its 1.38 billion inhabitants. The lockdown was extended to May 3, 2020 and further by two weeks until May 17, 2020.[23] The realisation that the lockdown was the best available option as a preventive measure against COVID-19, the National Disaster Management Authority (NDMA), and the lockdown was further extended till May 31, 2020. Spread of COVID-19 increased over a month due to the entry of several people with travel history to affected countries, and their close contacts tested positive. Amidst this, India's first death due to COVID-19 occurred on March 12, 2020, in the state of Karnataka. It is to be noted that as of March 12, 2020, among South-East Asian countries, India recorded 73 cases with nil deaths followed by Thailand-70 cases and one death; and Indonesia-34 cases with one death.[24]

As of May 4, 2022, the COVID-19 cases rose to 51,26,07,587 globally with 62,43,038 cases (CFR-1.22%). During this period, a total number of 5,78,82,589 COVID-19 cases and 7,86,439 deaths (CFR- 1.36%) were reported from the South-East Asia region.[25] However, in India the reported COVID-19 cases rose to 4,30,88,118 with 5,23,920 deaths (CFR-1.22%) which is the same as the global situation (Table 8). As of May 2, 2023, 68,72,25,609 confirmed COVID-19 cases and 68,66,733 deaths (CFR-0.99%) were reported globally.[26] In the meantime, 4,49,49,671 COVID-19 cases and 5,31,547 deaths were reported from India (CFR-1.18%). The recent report on the epidemiological situation of COVID-19 showed that as of May 26, 2024, a total of 77,55,53,735 COVID-19 cases and 70,50,356 deaths were reported globally.[27] During this period, from South-East Asian (SEA) countries, the confirmed COVID-19 cases and deaths were 6,12,92,047 and 8,08,713 respectively. The global and SEA region-level case fatality rate (CFR) was 0.99% and 1.32% respectively. The epidemiological data dated April 13, 2024 revealed that in India, a total of 4,50,35,393 confirmed COVID-19 cases and 5,33,570 deaths (CFR-1.18%) were reported.[28]

Table 7.Details of COVID-19 Based on Global Situation Update

Reported Date (as of)	Reported Countries	Global		China		India		Kerala	
		C	D	C	D	C	D	C	D
Jan 31, 2020	20	9,826	213	9,720	213	01	0	01	0
Feb 06, 2020	28	28,267	565	28,018	563	03	0	03	0
Feb 13, 2020	25	45,177	1,369	44,730	1,368	03	0	03	0
Feb 21, 2020	26	75,748	2,129	74,675	2,121	03	0	03	0
Feb 28, 2020	46	82,294	2,804	78,630	2,747	03	0	03	0
Mar 09, 2020	104	1,09,577	3,809	80,904	2,123	44	0	09	0
Mar 14, 2020	122	1,32,758	4,955	80,991	3,180	84	02	19	0

C: Cases; D: Deaths

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Table 8.COVID-19 Cases and Deaths Globally, in South-East Asia and India

Reported Date (as of)	Global		South-East Asia		India	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
Apr 05, 2020	1051635	56985	6528	267	3577	83
Sep 01, 2020	25118689	844312	4157798	76385	3691166	65081
Feb 01, 2021	102083344	2209195	12882712	198123	10746183	154274
Jul 07, 2021	183934913	3985022	35450108	500129	30619932	403281
Dec 01, 2021	261435768	5207634	44556142	706874	34587822	468980
May 04, 2022	512607587	6243038	57882589	786439	43088118	523920

C: Cases; D: Deaths

Table 9.Details of the First Reported Case of COVID-19 in India (State/ UT)

Name of State/ UT	First Reported Case	Details
Andaman and Nicobar Islands	March 26, 2020	A man who had recently travelled to Kolkata tested positive.
Andhra Pradesh	March 12, 2020	A man who returned from Italy to Nellore in early March tested positive.
Arunachal Pradesh	April 2, 2020	A 31-year-old man from Lohit district in Arunachal Pradesh, who had attended a congregation in Nizamuddin West, Delhi, has been diagnosed with COVID-19.
Assam	March 31, 2020	A 52-year-old patient has tested positive for COVID-19 and received treatment at Silchar Medical College.
Bihar	March 22, 2020	A 38-year-old man from Munger district, Bihar, who had travelled to Qatar, had become the first reported fatality related to COVID-19. He was also suffering from kidney disease.
Chandigarh	March 19, 2020	A 23-year-old woman who had travelled to London and had symptoms on March 16 has tested positive for COVID-19. She has been in quarantine at the Government Medical College hospital in Sector 32.
Chhattisgarh	March 19, 2020	A 24-year-old woman from Chhattisgarh was the first to be diagnosed with COVID-19 after returning from London on March 15. She was admitted to AIIMS on March 19.
Delhi	March 02, 2020	A 45-year-old resident of East Delhi, who had travelled to Italy, tested positive for COVID-19.
Goa	March 25, 2020	Three men, aged 25, 29, and 55, who recently travelled to Spain, Australia, and the United States, have tested positive.
Gujarat	March 19, 2020	Two imported COVID-19 cases have been reported positive for COVID-19 in Gujarat: a woman from Surat who returned from the USA and a man from Rajkot who returned from Saudi Arabia.
Haryana	March 04, 2020	A 26-year-old Gurugram resident, tested positive for COVID-19 after her travels to Malaysia and Indonesia.

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Himachal Pradesh	March 20, 2020	Two individuals, a 63-year-old woman who had travelled from Dubai and a 32-year-old man from Kangra district, have tested positive for COVID-19.
Jammu and Kashmir	March 09, 2020	A 63-year-old woman from Iran tested positive upon her return
Jharkhand	March 31, 2020	A Malaysian woman who had participated in the Tablighi Jamaat gathering in Nizamuddin tested positive for COVID-19. She and 17 other foreign nationals were rescued from a mosque in Ranchi on March 29 and subsequently kept in quarantine at Khelgaon.
Karnataka	March 09, 2020	A Dwell employee who travelled from Texas to Bangalore via New York City and Dubai on February 25 tested positive for coronavirus upon arrival on March 1.
Kerala	January 30, 2020 (First confirmed case in India)	First confirmed case reported in Kerala- A medical student, a native of Thrissur district, returned from Wuhan, China tested positive.
Ladakh	March 07, 2020	Two individuals have been tested positive for coronavirus after their travel to Iran and hospitalised at Sonam Norboo Memorial Hospital (SNMH) in Ladakh.
Lakshadweep	January 18 2021	A traveller who arrived in Lakshadweep from Kochi, Kerala, by ship on January 4th, was diagnosed with COVID-19 after showing symptoms.
Madhya Pradesh	March 21, 2020	Four people who recently returned from Dubai to India via Mumbai tested positive for COVID-19 in Jabalpur.
Maharashtra	March 09, 2020	The first confirmed case of coronavirus in Maharashtra was reported on 9 March 2020 in Pune, where a couple returned from Dubai tested positive.
Manipur	March 24, 2020 (This is the first case from North East region)	A 23-year-old woman with a travel history to the UK has tested positive.
Meghalaya	April 14, 2020	A doctor from a Shillong hospital was tested positive for COVID-19.
Mizoram	March 24, 2020 (This is the second case in North East region).	A resident of Aizawl, having returned from the Netherlands on March 16, developed symptoms and was placed in isolation at Zoram Medical College and tested positive for coronavirus.
Nagaland	April 12, 2020 (midnight)	The man came from Kolkata to Nagaland on March 24, 2020 and was advised to stay in self-quarantine for 14 days. He tested positive for coronavirus at Guwahati Medical College Hospital.
Odissa	March 16, 2020	The individual, who had returned from Italy and was under quarantine in New Delhi despite being asymptomatic, later travelled by train to Bhubaneswar. He tested positive for COVID-19 upon arrival and received treatment at Capital Hospital in Bhubaneswar.
Puducherry	March 17, 2020	Reported COVID-19 positive case in a 68- year-old woman. She was treated in Govt. General Hospital, Mahi.

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Punjab	March 09, 2020	A COVID-19 case has been reported in Hoshiarpur, Punjab. The infected individual had travelled back from Italy.
Rajasthan	March 02, 2020	A coronavirus infection was confirmed in an Italian tourist who had been in Delhi.
Tamil Nadu	March 07, 2020	A 45-year-old man from Kancheepuram, who had returned from Oman, tested positive and was treated at Rajiv Gandhi Government general Hospital.
Telangana	March 02, 2020	From a man who had a travel history with UAE.
Tripura	April 06, 2020	A 44-year-old woman who has a foreign travel history tested positive. The woman was from Udaipur town in Gomati district. She was given treatment in Agartala Govt. Medical College and GB Pant Hospital.
Uttar Pradesh	March 05, 2020	A middle-aged man in Ghaziabad with a travel history to Iran has tested positive for COVID-19.
Uttarakhand	March 15, 2020	A trainee officer of the Indian Forest Service (IFS), who returned from Spain, had tested positive for COVID-19.
West Bengal	March 17, 2020	An 18-year-old man who visited the UK tested positive for COVID-19.
Sikkim	May 23, 2020	A 25-year-old male student tested positive for COVID-19 after returning from Delhi to the state on May 17. He was quarantined at JNV Rayangla.

Between March 1 and 15, 2020, the first confirmed cases of COVID-19 were reported in thirteen Indian states and union territories, which include Andhra Pradesh, Arunachal Pradesh, Delhi, Jammu and Kashmir, Haryana, Karnataka, Ladakh, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, and Uttarakhand. In the remaining States (Andaman Nicobar, Assam, Bihar, Chhattisgarh, Chandigarh, Goa, Gujarat, Himachal Pradesh, Jharkhand, Madhya Pradesh, Manipur, Mizoram, Odessa, Pondicherry, West Bengal), first confirmed COVID-19 was reported during March 16–March 31, 2020. In Meghalaya, Nagaland and Tripura, COVID-19 was first reported between April 1 and April 15, 2020. However, in Sikkim, the first COVID-19 was reported only on May 23, 2020 (Table 9). It is interesting to note that it took four months since January 30, 2020, for the completion of the first appearance of COVID-19 in Indian states except Lakshadweep islands. In Lakshadweep, a confirmed case of COVID-19 was reported only on January 18, 2021. It is the last region of India to report its first case (Figure 7).

In India, COVID-19 cases slowly started increasing in the first week of March 2020. As per the COVID-19 communication dated March 22, 2020, India reported a total of 360 confirmed cases, including 319 Indian Nationals and 41 Foreign Nationals, from 23 states/ UTs [29](Table 10).[29] With the country witnessing a steady increase in daily new cases of COVID-19, and countries around the world proclaiming measures to restrain the spread of the pandemic, the Prime Minister of India motivated people to observe 'Janata Curfew', which translates to People's Curfew, from 7 am to 9 pm on March 20, 2020. This was mainly intended to convey solidarity and recognition for health workers who are directly or indirectly involved in disease control. Thirty nodal officers, appointed at the level of Joint Secretary, were entrusted to facilitate efficient and smooth communication between the central and state governments. Ministry of Health and Family Welfare, Govt. of India did regular evaluations regarding the availability of quarantine facilities, availability of testing kits, personal protective equipment (PPEs) and adequate isolation wards. Forty-two days after the observation of Janta Curfew, a total of 26917 COVID-19 cases and 826 deaths were reported from 32 states and UTs of India.[30]

The total number of confirmed COVID-19 cases and deaths recorded in India are given in Table 10. Data on COVID-19 cases and deaths in India showed a sharp spike towards the end of March 2020.[31] After six months from the date of the report of the first laboratory-confirmed COVID-19 case in India, the COVID-19 cases shot up to 508953 with 15685 deaths.[32] (CFR- 3.08%) By the end of the year, the number of COVID-19 cases reached 10207871 with 147901 deaths (CFR-1.45%) indicating a slight decrease in the case fatality rate.[33]

As of January 25, 2021, there were 1,06,67,736 COVID-19 cases and 1,53,470 deaths.[34] (CFR-1.44%) However, at the end of 2021, the COVID-19 cases rose to 3,47,99,691 (more than three times increase) than the reported cases in January 2021. Similarly, the number of deaths also showed a similar increase during the period (Table 11).[35]

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Figure 7.Details of First Reported COVID-19 Case in India (States/ UTs)

Table 10.COVID-19 Cases and Deaths Reported in India as of March 22, 2020

S.No	State	Total Cases	Deaths
1	Maharashtra	67	2
2	Kerala	52	0
3	Delhi	29	1
4	Uttar Pradesh	27	0
5	Karnataka	26	1
6	Rajasthan	24	0
7	Telangana	22	0
8	Haryana	21	0
9	Punjab	21	1
10	Gujrat	18	I
11	Ladakh	13	0
12	Andhra Pradesh	05	0
13	Chandigarh	05	0
14	Jammu & Kashmir	04	0
15	Madhya Pradesh	04	0
16	Tamil Nadu	07	0
17	West Bengal	04	0
18	Uttarakhand	03	0
19	Bihar	02	1
20	Himachal Pradesh	02	0
21	Odissa	02	0
22	Chandigarh	01	0
23	Puducherry	01	0
Total for 23 states/ UTs		360	7

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Table 11.Details of COVID-19 Cases and Deaths Recorded in India (January 2020 to December 2020)

Reported Date	Cases	Deaths	Remarks
Jan 31, 2020	01	0	India's first confirmed case of COVID-19 was reported in Kerala on January 30, 2020.
Feb 28, 2020	03	0	No new cases have been reported.
Mar 28, 2020	909	19	Reported from 27 states/ UTs.
Apr 26, 2020	26,917	826	Reported in 32 states/ UTs.
May 31, 2020	1,82,143	5,164	The ICMR advised states to carry out sero-surveys with IgG ELISA test to determine the exposure rate of the coronavirus among selected populations.
Jun 28, 2020	5,08,953	15,685	A new COVID-19 Diagnostic Training Center with advanced technology has been launched by the Government of India at the Jawaharlal Nehru Center for Advanced Scientific Research (JNCASR), Jakkur campus, Bangalore.
Jul 26, 2020	13,36,861	31,358	India has tested 16291331 samples to date with 442263 samples tested on 25th July alone.
Aug 24, 2020	31,06,348	57,542	Three promising COVID-19 vaccines are in the final stages of clinical trials.
Sep 28, 2020	59,92.532	94,503	Overall, India has conducted more than 69 million COVID-19 tests to date.
Oct 26, 2020	79,46,429	1,19,502	India tested 103462778 cumulative samples by 26 Oct 2020
Nov 30, 2020	94,31,691	1,37,139	Total operational laboratories – 1176 (Government) and 994 (Private) labs.
Dec 28, 2020	1,02,07,871	1,47,901	India's COVID-19 testing program has reached a total of 168 million samples.
Jan 25, 2021	1,06,67,736	1,53,470	Over 1.6 million healthcare workers have been vaccinated countrywide
Feb 22, 2021	1,10,16,434	1,56,463	Three variants of nCoV have been detected in the country. There are 187 cases of the UK variant, 4 cases of the South African variant, and 1 case of the Brazil variant.
Mar 29, 2021	1,20,39,644	1,61,843	India has administered over 60 million doses of the COVID-19 vaccine.
Apr 28, 2021	1,76,36,307	1,97,894	India has overtaken other countries in terms of daily COVID-19 cases, contributing roughly 50% to the worldwide total.
May 26, 2021	2,69,48,874	3,07,231	After noting a peak of 4,14,188 cases on May 7, 2021, daily COVID-19 cases have consistently decreased.
Jun 30, 2021	3,03,16,897	3,97,637	India accounts for 13% of all new COVID-19 cases worldwide.
Jul 28, 2021	3,14,40,951	4,21,382	As of July 27, 2021, India's total number of COVID-19 tests exceeded 448 million.
Aug 25, 2021	3,24,74,773	4,35,110	As of August 24, 2021, India could test more than 496 million samples.
Sep 29, 2021	3,36,97,581	4,47,373	India launched the countrywide Ayushman Bharat Digital Mission (ABDM).

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Oct 27, 2021	3,42,02,202	4,55,068	The southern states of Maharashtra, Kerala, Karnataka, Tamil Nadu, and Andhra Pradesh account for half of all COVID-19 cases.
Nov 24, 2021	3,45,26,480	4,66,147	Maharashtra and Kerala continued to be the states with the highest number of COVID-19 cases, with Maharashtra reporting over 6 million and Kerala exceeding 5 million.
Dec 29, 2021	3,47,99.691	4,80,290	Omicron cases reached a total of 653 in 21 states and UTs across India.

It has been reported that as of January 26, 2020, 68.41 million doses of vaccine were made available across the world.[36] The country-wise COVID-19 vaccination doses administered are given in Figure 8.

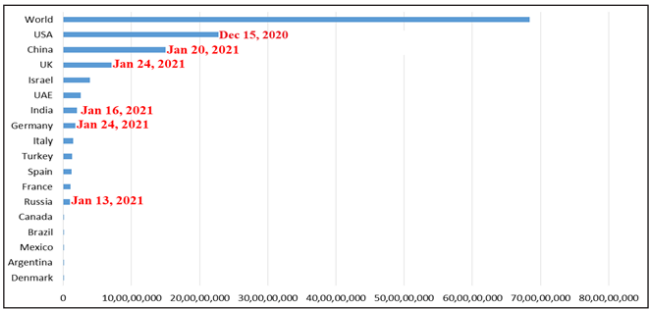

Figure 8.Country-Wise COVID-19 Vaccination Doses Administered

It is evident from the COVID-19 situation report that as of January 5, 2022, a total of 3,49,60,261 confirmed cases and 4,82,017 deaths were reported in India.[37] At the end of the year, the number of COVID-19 cases rose to 4,41,44,029 and the number of deaths increased by 5,30,702.[38]

The COVID-19 vaccines authorise to use in India are COVAXIN, Covishield, ZyCoV-D, Sputnik V, Biological E's novel COVID-19 vaccine, BBV154- Intranasal vaccine, COVOVAX, mRNA-based vaccine and (HGCO19). India started distribution of COVID-19 vaccines on January 16, 2020. As of March 4, 2023, India could distribute over 2.2 million doses all over the country.

The status of vaccination in India as of March 4, 2023 showed that the partially vaccinated and fully vaccinated constitute 94.61% and 87.81% respectively. The males are more vaccinated than females and Covishield is used by the majority compared with other vaccine brands and the age group of 18-44 received the vaccine more when compared to other age groups[39] (Figures 9–12).[39]

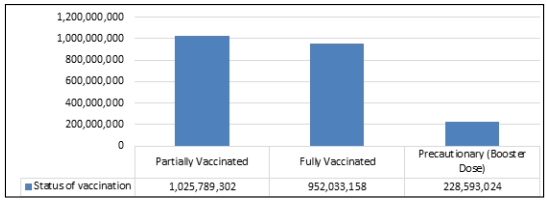

Figure 9.Total Doses Administered Across the Country as of March 4, 2023

The report of the COVID-19 situation in India as of January 31, 2023 indicates a total of 44150289 cases and 530740 deaths.[40] whereas at the end of the year, the COVID-19 cases rose to 44475602 with 533361 deaths.[41] The analysis of the data indicated that the case fatality rate was higher in Punjab (2.66%) followed by Nagaland (2.22%) whereas the lowest CFR was reported in Dadra and Nagar Haveli and Daman and Diu (0.03%) and in Mizoram (0.31%). However, the overall CFR remains in India at 1.19% indicating that the disease control strategy adopted by India is trustworthy (Table 12).

As of July 3, 2024, India reported 45040074 COVID-19 cases, which is the second-highest case record in the world, and 533619 deaths, which is the third-highest number in the world.[42] As per the recent report, the total vaccination in India as of June 19, 2024 is 2,20,68,94,861.[43] For the convenience of elucidating the ongoing incidents and experiences of the COVID-19 pandemic, the whole events are classified into five phases.

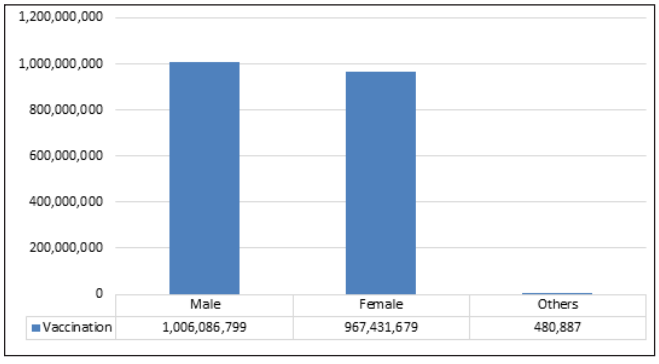

Figure 10.Vaccinations in India by Gender as of March 4, 2023

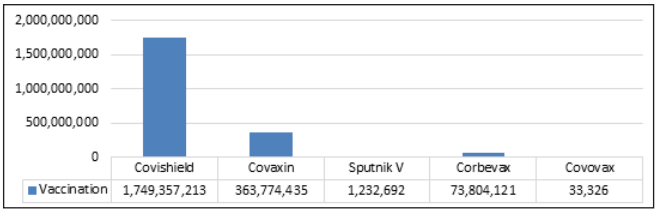

Figure 11.Vaccinations in India by Vaccine Brand as of March 4, 2023

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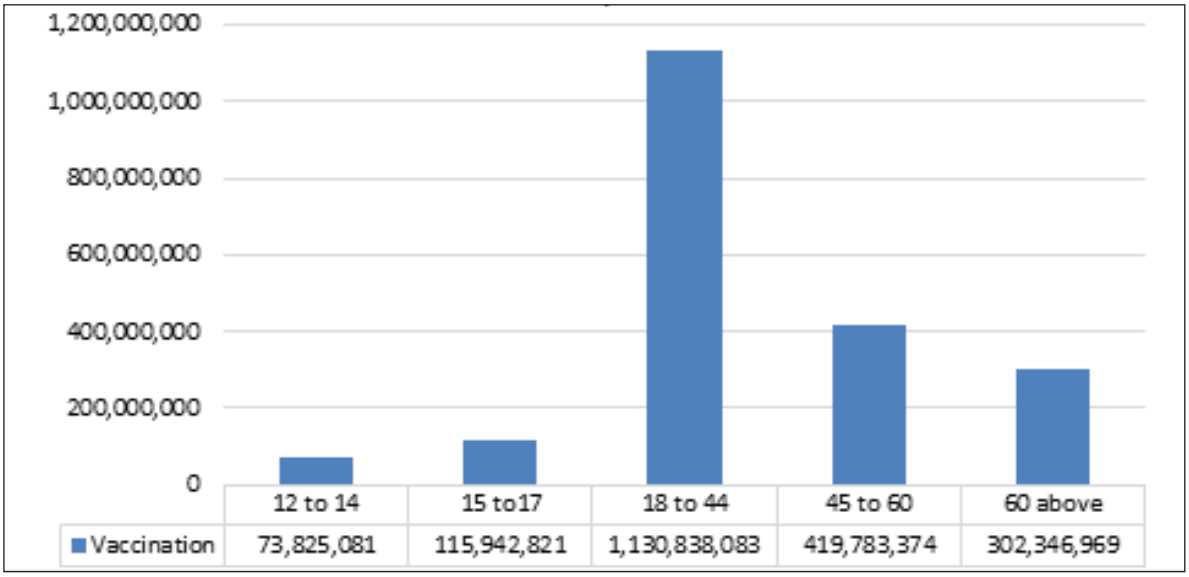

Figure 12.Vaccination in India by Different Age Groups as of March 4, 2024

Table 12.State-Wise COVID-19 Cases and Deaths in India as of December 31, 2023

S. No.	States/ UTs	Cases	Deaths	CFR (%)
1	Andaman and Nicobar Islands	10,637	129	1.21
2	Andhra Pradesh	2325966	14,733	0.63
3	Arunachal Pradesh	66,753	296	0.44
4	Assam	7,38,134	8,035	1.09
5	Bihar	8,42,957	12,315	1.46
6	Chandigarh	99,514	1,185	1.19
7	Chhattisgarh	11,73,513	14,191	1.21
8	Dadra and Nagar Haveli and Daman and Diu	11,588	04	0.03
9	Delhi	20,14,485	26,670	1.32
10	Goa	2,59,422	4,014	1.55
11	Gujarat	12,80,445	11,081	0.87
12	Haryana	10,68,205	10,779	1.01
13	Himachal Pradesh	3,18,700	4,246	1.33
14	Jammu and Kashmir	4,77,250	4,792	1.00
15	Jharkhand	4,38,515	5,337	1.22
16	Karnataka	40,49,073	40,372	0.99
17	Kerala	68,41,474	72,071	1.05
18	Ladakh	29,372	231	0.79
19	Lakshadweep	11,363	52	0.46
20	Madhya Pradesh	10,45,774	10,786	1.03
21	Maharashtra	80,23,525	1,48,567	0.19
22	Manipur	1,37,886	2,149	1.56
23	Meghalaya	95,362	1,628	1.71
24	Mizoram	2,38,828	734	0.31

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25	Nagaland	35,251	782	2.22
26	Odessa	13,39,179	9,215	0.69
27	Puducherry	1,75,632	1,982	1.13
28	Punjab	7,73,115	20,570	2.66
29	Rajasthan	13,16,746	9,737	0.74
30	Sikkim	44,431	501	1.13
31	Tamil Nadu	35,72,905	38,083	1.07
32	Telangana	8,40,429	4,111	0.49
33	Tripura	1,07,553	942	0.88
34	Uttarakhand	4,44,820	7,768	1.75
35	Uttar Pradesh	21,21,801	23,717	1.12
36	West Bengal	21,04, 999	21,556	1.02
Total		4,44,75,602	5,33,361	1.19

COVID-19: Kerala Scenario

Initial Cases – Phase-1 (January 30–March 7, 2020)

Kerala's first confirmed COVID-19 case was reported on January 30, 2020. The patient was a 20-year-old female medical student from Wuhan University, China, who had recently returned to Thrissur. This is the first confirmed COVID-19 case in India.[20] Coincidently, it was on that day, that the World Health Organization (WHO) declared COVID-19 a Public Health Emergency of International Concern (PHEIC) as per the advice of the International Health Regulations Emergency Committee (IHREC). Kerala confirmed two more COVID-19 cases on February 2 and 3, 2020 (Figure 13). These two patients were also medical students who had returned from Wuhan, China. In response to laboratory-confirmed COVID-19 cases, Kerala declared a state emergency.[44] The state calamity warning was rescinded after four days due to the absence of new COVID-19 cases.

The enriching knowledge and experience learned from the outbreak of Nipah in 2018 and 2019 in Kerala, provided valuable perception and realisation in how to tackle the emerging and re-emerging infectious agents.[45] The main emphasis in addressing confirmed COVID-19 cases in Kerala was on monitoring and examining all passengers arriving from China and their close contacts, followed by immediate tracing and isolation. The first Corona centre was established at the Government Medical College at Kochi. The trio of patients were released from the medical facility on February 20 following their successful recovery from their illnesses. None of them got infections from them. The analysis of the first reported COVID-19 cases in Kerala showed it took about two months to cover the entire Kerala (Figure 14 and Table 13).

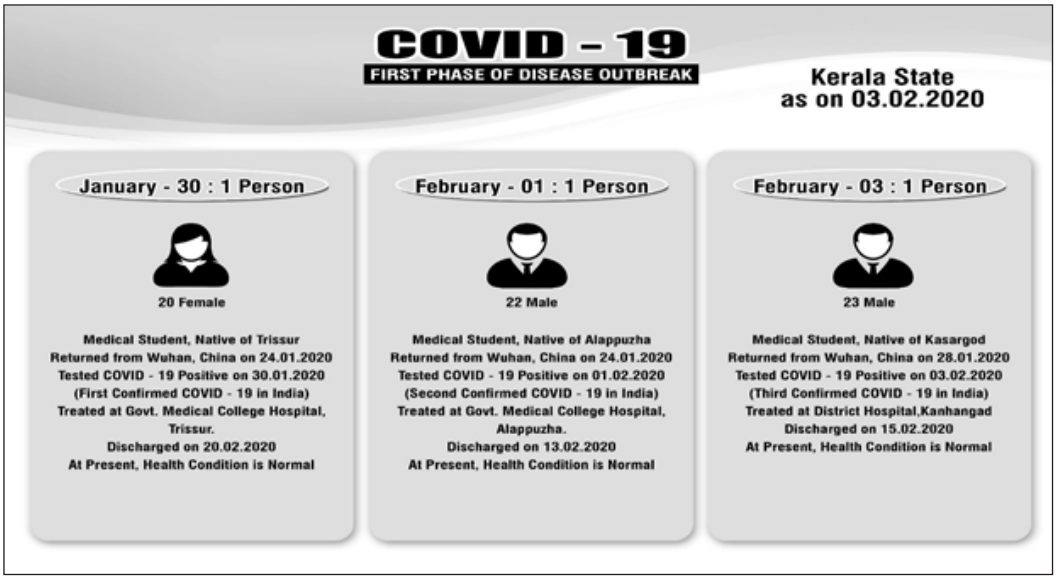

Figure 13.Details of First Reported COVID-19 Cases in Kerala (Also in India)

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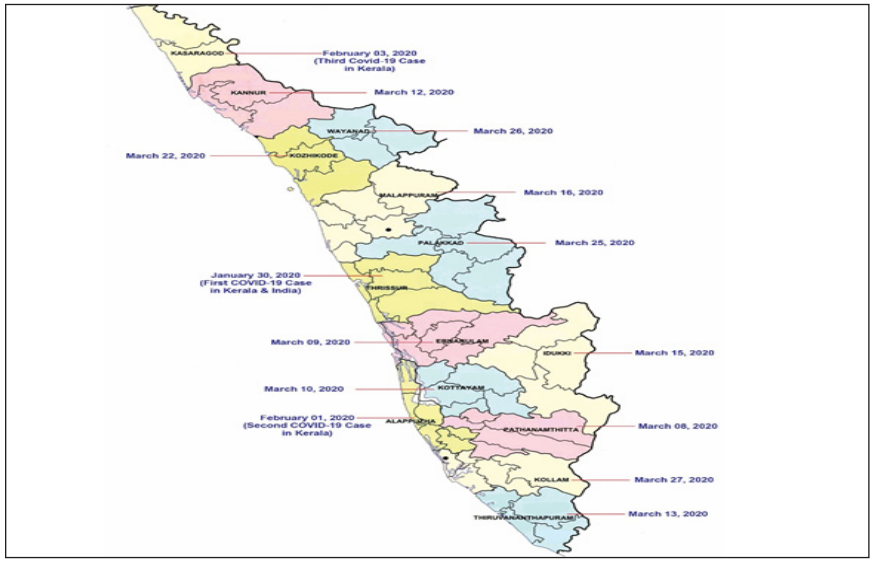

Figure 14.Date of First Reported COVID-19 in Kerala

Table 13.Details of First Reported COVID-19 in Different Districts of Kerala

District(s)	Date of First Case Reported	Details of the Case(s) Including Travel History	Details of Hospitalisation	Status
Thiruvananthapuram	March 13, 2020	03 cases. A 32-year-old man had returned from Dubai after visiting several countries, including Italy. Another 30-year-old man had returned from the UK. Both of them are from Kerala. The third man (57M) was an Italian tourist who had been under observation at the resort	Govt. Medical College Hospital, Thiruvananthapuram	Discharged
Kollam	March 27, 2020	01 case. A Keralite (49M) who arrived in Kerala from Dubai on March 18. He is a native of Prakkulam, Kollam district.	Govt. Medical College, Parippalli, Kollam	Discharged

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Alappuzha	February 01, 2020 (Second COVID-19 case in Kerala)	01 case. A second-year medical student (22M) in Wuhan, China, a native of Thamarakkulam, Alappuzha district. He started the journey from Wuhan to Kunming on January 23, 2020 by train. The same day continued the journey from Kunming Airport and reached Kolkata at 8.00 am by China East Flight. On January 24, 2020 he reached Cochin Airport from Kolkata by Indigo flight.	Reported at Thamarakkulam PHC on January 25, 2020; as there were no signs and symptoms, advised for home quarantine. On January 26, 2020, he visited Vallikkulam PHC. As he developed fever and diarrhoea on January 26, 2020, he was admitted to General Hospital, Alappuzha. His sample was found positive for COVID-19 on January 26, 2020 and was shifted to Govt. Medical College Hospital, Alappuzha on January 01, 2020.	Discharged on February 13, 2020
Pathanamthitta	March 08, 2020	03 cases. Father (55M), Mother (53F) and son (25M) returned to Kerala from Italy. Native of Ranni, Pathanamthitta. They started from Venice, Italy on February 28, 2020 to Doha by Qatar Airlines. From Doha, they proceeded to Cochin by Qatar Airlines on February 29, 2020.	Their samples were collected on March 06, 2020 and found positive on March 07, 2020. They are admitted to General Hospital, Pathanamthitta.	Discharged
Kottayam	March 10, 2020	02 cases. Daughter (40F) and son-in-law (42M) of the Italian returned couple. They brought them from the airport to their house. Native of Chengalam, Kottayam district.	Admitted in Govt. Medical College Hospital, Kottayam.	Discharged
Idukki	March 15, 2020	01 case. A visitor from the UK stayed in a resort at Moonnar under self-isolation protocols.	Treated at Govt. Medical College Hospital, Ernakulam.	Recovered on March 26. 2020 and discharged
Ernakulam	March 09, 2020	01 case. A 3-year-old male child and his parents returned from Italy and were taken to Govt. Medical College Hospital, Ernakulam	Treated at Govt. Medical College Hospital, Ernakulam.	Discharged
Thrissur	January 30, 2020 (First COVID-19 case in India)	01 case. A Medical student (20F) of Wuhan, China belonging to Thrissur district. Started the journey from Kunming Airport to Kolkata on January 23, 2020 by China East Flight. Preceded the journey from Kolkata on January 24, 2020 and reached Cochin at 18.30 hrs. He reached home by car along with his parents.	On January 25, 2020 visited Mathilakam PHC. As no signs and symptoms advised home quarantine. On 27, 01.2020 she developed a fever, cough and sore throat and contacted the District Surveillance Officer (DSO), Thrissur district. The district team admitted her to the isolation ward at Thrissur General Hospital. Blood and throat swab samples were sent to NIV, Pune on the same day. On January 01, 2020 result came as positive and shifted to Govt. Medical College Hospital, Thrissur.	She was strictly monitored and under symptomatic management and discharged on February 20, 2020 after her consecutive sample was found negative.

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Malappuram	March 16, 2020	02 cases. One is a native of Vandoor Vaniambalam, Malappuram District (60F) reached Calicut airport on February 25, 2020 by Jeddah Calicut Air India flight. A 10-member group of children/ grandchildren received her at the airport. By auto taxi, they went home. On the way, they visited four relatives' houses. The other native of Areekode, Chemrakattoor (60F) returned to Calicut Airport on March 12, 2020 in Jeddah Cochin by Air India flight.	Ist case: On February 25, she went to a nearby clinic due to tiredness. On March 11, she developed a fever, went to Wandoor Taluk Hospital and returned home after getting medicines. March 12 fever reduced. On March 12, fever increased and as per the direction of Taluk HQ hospital, Wandoor she was taken to the Govt. Medical College Hospital, Mancheri by ambulance. The sample was found positive on 16.03.2020. IInd case: On March 13, 2020 she went to Taluk Hospital, Areekode due to a fever. By ambulance taken to Medical College Hospital, Mancheri and kept in isolation. The sample was found positive on March 13, 2020.	-
Kozhikode	March 22, 2020	02 cases: Ist case: A lady (47 years) who arrived at Calicut airport on March 13, 2020 from Abu Dhabi. She reached home around 19.00 hrs. Since then, she has been in home quarantine. IInd case: A 27-year-old male reached Calicut airport from Dubai by flight. He was unwell so informed the health department. He was kept in observation at the Medical emigration desk from 21.50 hrs. to 01.15 hrs.	Ist case: On March 19, 2020, she was admitted at Beach Hospital, Calicut. IInd case: In the morning 01.15 hrs., the patient was taken in an ambulance and admitted to Govt. Medical College Hospital, Calicut at 2.00 AM.	-
Wayanad	March 26, 2020	01 case: A native of Tondarnad Grama Panchayath (48 M) returned from Dubai, and tested positive for COVID-19 on March 24, 2020. He returned to the country from Dubai through Abudabi by EY 254 flight. He reached Calicut airport and took a taxi to his home.	He was under treatment in Wayanad District Hospital Mananthavadi.	Discharged
Kannur	March 12, 2020	01 case: A native of Vayakkara Panchayath (45 M) reached Calicut airport on March 05, 2020 by Spice jet flight from Dubai.	On March 06, 2020 he developed fever and tiredness shown at Kankol Private. Hospital. On March 07, 2020 he went to Pariyaram Medical College, Kannur along with his wife. Returned home with the directions to have home quarantine. As his sample became positive on March 12, he was shifted to Medical College.	-

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Palakkad	March 25, 2020	02 cases: Ist case: A native of Kottopadam (51 M) reached Calicut airport on March 13 after Umrah on an Air India flight from Dubai. He went home in his car along with four family members. IInd case: A native of Karakkurissy of Mannarkkad (33 male) returned from Dubai.	-	-
Kasaragod	February 03, 2020 (Third case in Kerala)	01 case: Fifth-year medical student of Wuhan University, China, a native of Ajanur Panchayath (23 Male). He started the journey on January 25, 2020 from Guangzhou and reached Kolkata by Indigo flight. From Kolkata, he reached Bangalore on the same day by Indigo flight. On January 26, 2020 he preceded the journey and reached Cochin by Indigo flight. He arrived at Cochin Airport on January 26, then proceeded to Aluva railway station, boarded a train to Angamali, and checked into a hotel there. On January 27, from the hotel to Aluva Rly. Stn. By KSRTC bus. From Aluva to Kanhangad by train. Reached home from Kanhangad by car.	On January 28, he contacted the health department over the phone and as there were no signs and symptoms advised for home quarantine. On January 30, he developed a runny nose and reached the district hospital, Kanhangad and was admitted to the isolation ward. His blood and throat samples were sent to NIV, Pune on January 30 and found positive. He was strictly monitored.	Discharged on February 15, 2020 after consecutive samples were found negative.

Phase 2 (March 8–First Week of May 2020)

The family members who were infected with the coronavirus had recently travelled to Italy. A 55-year-old man, his 53-year-old wife, and their 26-year-old son came back to Kerala from Italy on February 29, 2020. On March 8, 2020, five family members were confirmed to have contracted the coronavirus. They started their journey from Venice, Italy on February 28, 2020 to Doha by Qatar Airlines, and from Doha to Kochi and reached Kochi on February 29, 2020. They ostensibly eluded their travel history and evaded the surveillance screening at the airport. They reached their homeland at Ayithala, Ranni, Pathanamthitta District. Meanwhile, the brother and sister-in-law of the Italian returned man, residing in the adjoining house were also found positive for COVID-19. The health department came to know that the family had visited several places during their one-week stay in Kerala. On March 9, 202O, COVID-19 was diagnosed in a three-year-old boy who had recently travelled to Italy with his parents. The family was quarantined at the Government Medical College in Ernakulam. Following this, the department issued a drastic alert[46,47]. Within two days, a detailed route map was prepared depicting the places of the family's visit. The route map was made public on March 10, 2020 and informed all the close contacts of the confirmed cases to report immediately to nearby health centres for testing. Subsequently, on March 10, 2020, six individuals who were in close contact with the Italian returned family were confirmed to have COVID-19 infection. Four of these cases were admitted at Govt. Medical College, Kottayam and General Hospital, Pathanamthitta. Meanwhile, the parents of the three-year-old child, who were at Medical College, Ernakulam also found positive for COVID-19. A 45-year-old male, native of Kannur district, who landed in Kozhikode airport from Dubai on March 5, 2020 was found positive for COVID-19 on March 12, 2020. On the same day, a 21-year-old man, a native of Thrissur district, who had returned from Italy along with the Pathanamthitta family, was also found positive for COVID-19 (Figure 15). Altogether 12 COVID-19 cases were reported related to Italian returned family.[48] This is the beginning of the COVID-19 cluster in Kerala.

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The range of creating route maps to monitor the travel history of COVID-19-positive individuals was broadened to encompass the rest of the districts in the state. The government of Kerala issued a heightened alert on March 8, 2020, after five additional cases tested positive for COVID-19 in the state. To address the continuing pandemic, 21 major hospitals in the state set up isolation wards each with 40 beds. 215 health workers were sent out to offer psycho-social support to families facing severe distress and anxiety because of fears of COVID-19 infection, with 3,646 tele-counselling services set up by March 4, 2020.[49]

Moreover, the Kerala government established three COVID-19 testing facilities in Alappuzha (National Institute of Virology, field station), Thiruvananthapuram (Govt. Medical College) in addition to one in Kozhikode (Govt. Medical College). The Kerala Government, along with Kerala Startup Mission (KSM) and the Information & Public Relations Department (I&PRD), introduced the mobile app "Gok Direct" to simplify the exchange and gathering of COVID-19 information.

On March 15, 2020, Govt. of Kerala brought out a new initiative a mass hand-washing campaign called "Break the Chain". The movement aims to educate individuals on the importance of personal hygiene as a protection against contracting the infection.[50] It has been observed that day by day, the COVID-19 cases are increasing in the state and as of March 22, 2020, confirmed COVID-19 cases rose to 67. Following this, on 23 March, Govt. of Kerala announced a statewide lockdown till 31 March 2020 to prevent the further spread of COVID-19.[51] This was one day before the nationwide lockdown declared by the central government (Figure 16)[52]. On March 26, 2020, the Government of Kerala arranged adequate amenities for providing food and shelter to the most vulnerable groups including the guest labourers. During the lockdown period, guest and daily wage labourers lost jobs and some of them were expelled from their rented homes. Meanwhile, the Government of Kerala took very bold and compassionate steps to protect guest labourers by providing food and shelter. They have arranged 1,255 community kitchens across 14 districts which served 2.5–2.8 lakh of food packets per day.[53] Community kitchens are operated in association with civil society, non-government organisations, religious institutions, local governments and volunteer groups. In addition to this, in April 2020, it was decided to distribute food kits to all ration card holders.[54]

While other Indian states were struggling with a surge in COVID-19 cases during the second week of May 2020, Kerala's curve remained relatively flat (Figure 17).

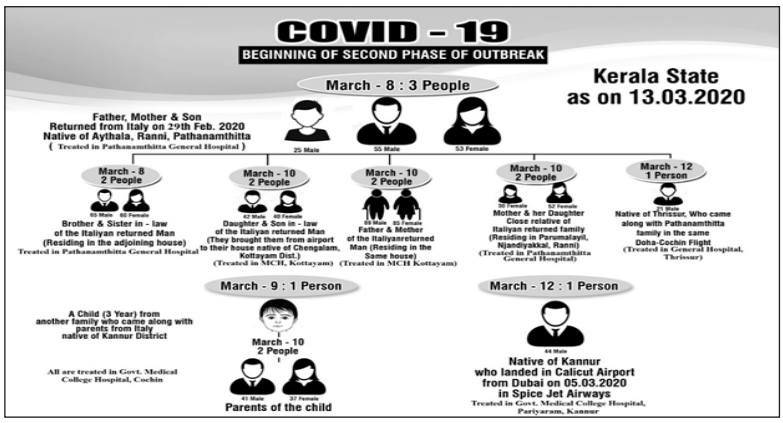

Figure 15.Schematic Representation of the Beginning of the Second Phase of COVID-19 in Kerala

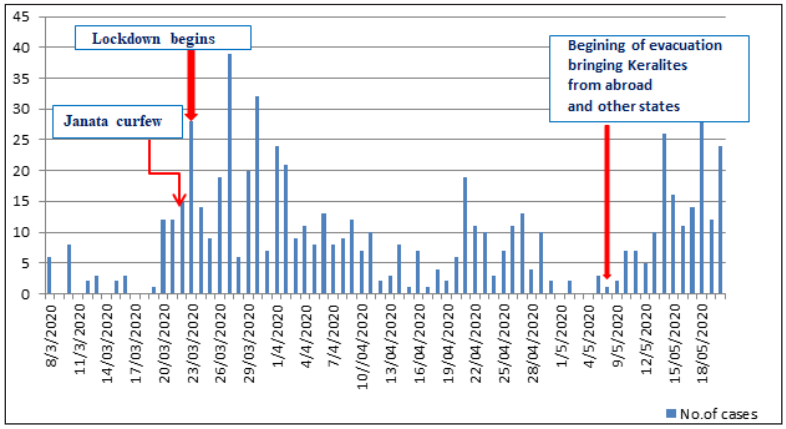

Figure 16.Timeline of Major Events during the First Wave of COVID-19 Pandemic in Kerala

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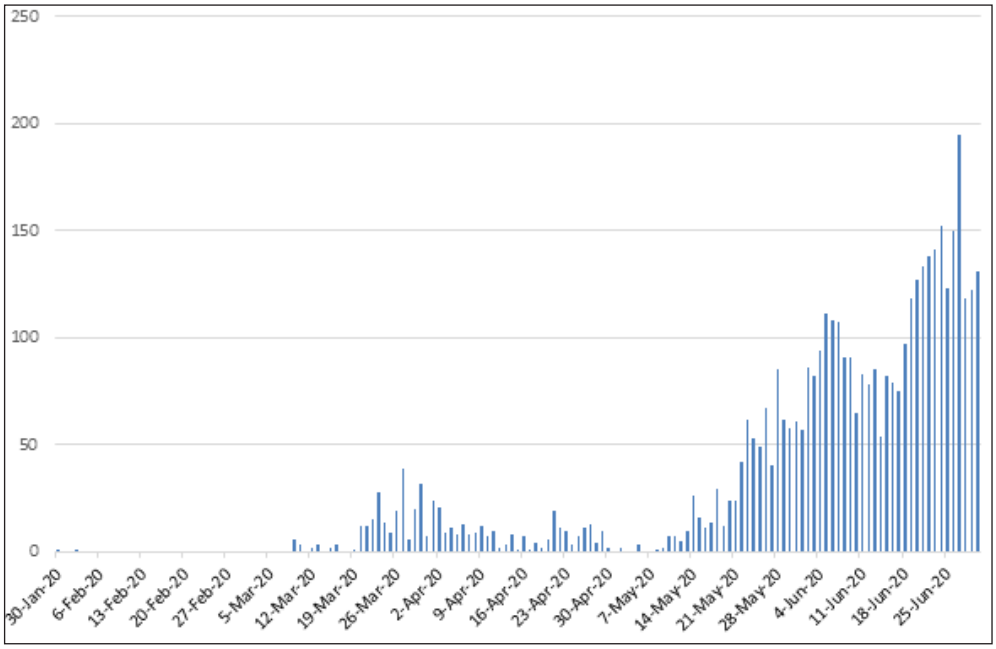

Figure 17.Number of COVID-19 Positive Cases Reported in Kerala from January 3 to June 2020

The COVID-19 state-wise status report indicates that, as of May 11, 2020, a total of 67152 cases and 2206 deaths were reported in India. Among the states, Maharashtra recorded the highest number of COVID-19 cases (22,171 cases, 832 deaths) and is followed by Gujarat (8,194 cases, 493 deaths) and Delhi (6,923 cases, 73 deaths) whereas; only 512 COVID-19 positive cases and 4 deaths were reported from Kerala.[55] Four months since the country's first positive case of COVID-19 was reported in Kerala, the state with a population of 3.51 crores, has reported only 512 cases of COVID-19 as of May 11, 2020 and 4 deaths with CFR, 0.78% and an impressive recovery rate of 95.5%. The state used innovational approaches and its experience and expertise in disaster management strategy turned out to be useful for quick distribution of resources and provide a timely and comprehensive response in association with key stakeholders. The key to controlling the spread of the disease was the state government's successful implementation of active surveillance and monitoring, capacity building of frontline health workers, effective risk communication, strong civic management, and addressing the psychosocial needs of the at-risk population. Timely release of technical guidelines on contact tracing, quarantine, isolation, hospitalisation, and comprehensive capacity development for all cadres of health and affiliated departments played a vital role in managing the situation.[56,57]

Phase 3 (May 20–July 2020)

The low number of COVID-19 cases in the second phase is mainly due to the lockdown and break-the-chain campaign. Kerala received international acclaim for its commendable actions during the pandemic-induced lockdown. The state not only implemented successful disease control measures but also offered caring assistance to vulnerable groups, including providing food, shelter, and psychosocial support to alleviate their hardships. This opened the way for the dawn of the Kerala model of COVID-19 pandemic management. This proclamation did not last long. In the event of relaxation of the lockdown, naturally, all the people will come out of their shelters and pave for the rapid spread of the disease. We have learnt a lesson from this pandemic that public health or any administrative system can't insist that people are in restricted conditions for quite a long time. As the pandemic progresses, essentially the people will get infection once they are out of their dwellings. The same has happened in Kerala in mid-May 2020 (Figure 18). Amidst this, with the arrival of expatriates, the COVID-19 infection rate started to increase. By May 20, 2020, one in every hundred non-resident Keralites (NRKs) had tested positive for COVID-19. In mid-July, a large local group of COVID-19-positive cases was identified in two coastal villages, Poonthura and Pulluvila in Thiruvananthapuram district.[58] On July 17, 2020, the state government announced that community transmission had taken place in these villages. On the same day, Kerala reported the highest single-day surge with 791 COVID-19 cases. Thiruvananthapuram reported 246 cases followed by Ernakulam with 115 cases, and Pathanamthitta with 87 cases.[59] The district-wise details of COVID-19-positive cases (import/ contact) reported in Kerala as of May 3, 2020 are given in Table 14.

COVID-19 passenger screening at Ports of Entry (PoE) and other areas indicated that a total of 5,53,547 people were screened as of July 17, 2020 (Table 15).

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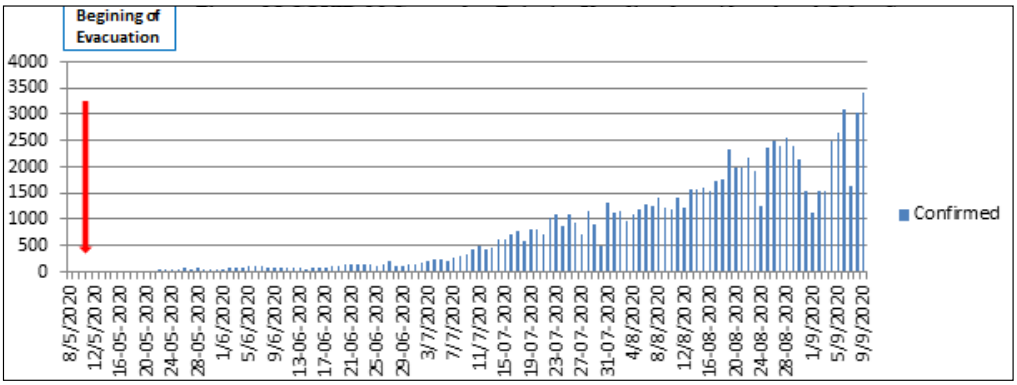

Figure 18.COVID-19 Cases after Bringing Keralites from Abroad and Other States

Table 14.Details of COVID-19-Positive Cases as of May 3, 2020

District	January	February	March		April		Till May 3, 2020		Total
	Import	Import	Import	Contact	Import	Contact	Import	Contact	
TVM	-	-	7	3	5	2	-	-	17
KLM	-	-	2	1	8	9	-	-	20
PTA	-	-	6	6	5	-	-	-	17
ALP	-	1	1	-	3	-	-	-	05
KTM	-	-	-	3	6	11	-	-	20
IDK	-	-	2	3	10	9	-	-	24
EKM	-	-	11	3	1	3	-	-	18
TSR	1	-	6	1	2	3	-	-	13
PKD	-	-	5	-	6	2	-	-	13
MPM	-	-	11	-	12	2	-	-	25
KKD	-	-	6	-	12	6	-	-	24
WYD	-	-	3	-	-	-	1	-	04
KNR	-	-	50	-	43	27	-	1	121
KSD	-	1	77	31	30	39	-	-	178
Total	01	02	187	51	143	113	01	01	499

TVM- Thiruvananthapuram, KLM- Kollam, PTA- Pathanamthitta, ALP- Alappuzha, KTM-Kottayam, IDK- Idukki, EKM- Ernakulam, TST-Thrissur, PKD- Palakkad, MPM- Malappuram, KKD- Kozhikode, WYD- Wayanad, KNR- Kannur, KSD- Kasaragod

Table 15.Details of Passengers Screened at Air/ Sea Ports, Check Post, Railway as of July 17, 2020

Travel	Total Passengers	Home Quarantined	Institution Quarantined	Passengers in Isolation
Airport	2,59,603	1,86,110	28593	2872
Seaport	1,621	514	1,101	06
Check post	2,39,847	2,31,949	7,745	153
Railway	52,476	50,224	1,669	115
Total	5,53,547	4,68,797	39,108	3,146

Phase 4 (August–October 2020)

In late August 2020, lockdown restrictions were considerably reduced due to Onam and Eid festivals in Kerala. In September 2020, Kerala started reporting a greater number of COVID-19 cases. For instance, on September 2, 2020, a total of 1,547 COVID-19 cases were reported from Kerala, whereas, on September 30, 2020, the reported number of COVID-19 cases rose to 8,830. The COVID-19 situation report of Kerala clearly indicated that a total of 51,772 cases and 213 deaths were reported from the state during September

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2020 and in October, the cases rose to 2,36,999 with 742 deaths indicating how fast the COVID-19 is spreading in the state. The first wave of COVID-19 infections in India peaked in September 2020, and started to decline by October. However, in Kerala, the peak occurred a month later, with cases exceeding 2 lakhs in October (Figure 19).[60]

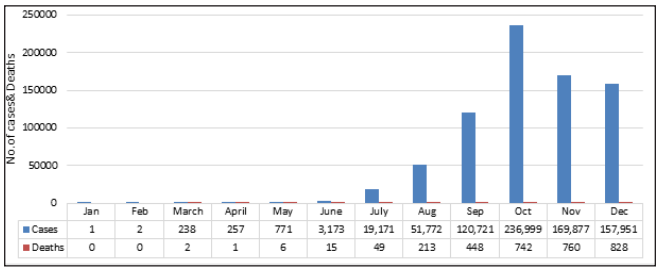

Figure 19.COVID-19 Cases and Deaths, January 30 to December 31, 2020

Phase 5

In November 2020, the number of COVID-19 cases decreased (Figure 19). Elections to local bodies (Panchayaths, Municipalities and Corporations) in Kerala were held December 8–14, 2020 and results were announced on December 16. During the election time, COVID-19 protocols were largely flouted and this led to a minor increase in cases in December 2020 and January 2021. After a rise from 28,000 active cases in mid-December to 70,000 in late January, the number of active cases started to drop, reaching approximately 25,000 in mid-March 2021 and continuing to decline. The overall Case fatality rate is only 0.40% indicating the efficiency of the state in providing exceptional care and first-rate treatment to the infected individuals.

Phase 6

A second wave of COVID-19 infections flared up in India since the last week of March 2021. India was the first nation to surpass 400,000 COVID-19 cases in a day, with 498,323 new cases and 3,464 deaths on April 30, 2021.[61] The second wave of COVID-19 in India coincided with election events in Kerala, resenting more difficulties for the state. Till then, not even half of the population in Kerala was vaccinated because of the shortage of vaccines and people's concern over the consequences. Amidst this, the Kerala Assembly elections were held on April 6, 2021. In spite of the repeated warnings of the Election Commission, the political parties, and electoral candidates could not adhere to the COVID-19 protocol. Politicians and the public ignored COVID-19 safety measures by continuing election campaigns and rallies without pause, showing no regard for social distancing or wearing masks. This led to a sudden increase in COVID-19 cases throughout the state. Kerala recorded its highest single-day surge with 43,529 new cases on May 12, 2021.[62] Kerala declared the second lockdown on May 6, 2021, which will be in effect from May 8 to May 16 in order to curb the widespread transmission of the illness. Subsequently, the lockdown was prolonged until May 30, and then further extended to June 9, 2021 with some easing of restrictions. Given the success of the lockdown, it was extended until June 16, 2021. After the conclusion of the state-wide lockdown on June 16, 2021, a tiered system was put in place, relying on Test Positivity Rates (TPRs). Local bodies with TPR exceeding 30% were kept under triple lock-down, whereas, local bodies with TPR between 8–20% were given significant relaxations. Local bodies with below 8% TPR were allowed the advantage of near-normal life.

The Gok relaxed the lockdown regulations from July 18–20, 2021 due to the Bakrid celebration on July 21. This leads to a surge in COVID-19 cases in the last week of July 2021. During July 27 and 28, 2021, Kerala reported 22,129 and 22,056 new cases respectively, accounting for more than 50% of daily new COVID-19 cases in India in those days.[63]

On August 4, 2021, the TPR-based system of the Local Self Government bodies was changed to a ward-level case density-based system. This envisioned carrying out triple lockdowns in areas with over ten cases per thousand individuals. Lockdown rules were significantly eased during the Onam festival, resulting in a sharp increase in COVID cases throughout the state. During September 2021, more than 60% of India's daily new COVID-19 cases were reported in Kerala, with a positivity rate of 20%. The number of COVID-19 cases has started decreasing since October 2021 onwards (Figure 20). The overall case fatality rate due to COVID-19 in 2020 and 2021 is below 1%.

In January 2022, Kerala reported 1,25,744 COVID-19 cases and 6,601 deaths. The number of COVID-19 cases and deaths in February 2022 was 1,08,396 and 10,938 respectively. After January and February 2022, the cases and deaths started decreasing. As of September 9, 2022, Kerala reported 67,67,856 COVID-19 cases and 70,913 deaths (CFR-1.04%). During this period, an impressive recovery rate of 98.8% 9 (No. recovered- 66,86,948) was also reported. Month-wise COVID-19 cases and deaths reported in Kerala in 2021 are given in Figure 20.

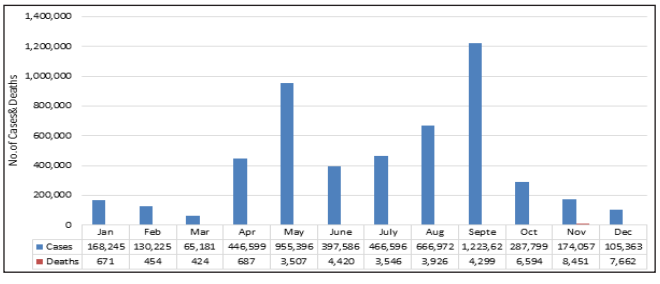

Figure 20.Month-Wise COVID-19 Cases and Deaths in 2021

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By the last week of November, the adult vaccination had crossed 95%. A rapid increase in COVID-19 cases occurred in early 2022, caused by the Omicron variant. On January 16, 2021, the vaccination drive started in India. Though initially, Govt. of Kerala struggled to procure the vaccines, later the government successfully implemented a vaccination drive in the state (Table 16).

In Kerala, a total of 84,086 COVID-19 cases were reported in 2023 and the district-wise details are given in Table 17. In 2023, a total of 84,086 COVID-19 cases were reported in Kerala. New COVID sub-variant JN.1 was detected in Thiruvananthapuram on December 8, 2023. Kerala reported 302 new COVID cases on December 16, 2023 with four deaths.

COVID-19 in Kerala: Issues, Challenges, Lessons and Future Concern

Kerala detected India's first COVID-19 case on January 30, 2020, signalling the nation's brush with the new coronavirus. Coincidently, it was on the same day, that WHO declared COVID-19 a public health emergency of international concern[20,58]. While India deals with the COVID-19 outbreak, Kerala has stood out as an example in handling the situation. Kerala has been so successful in its initial exercises to control the disease that many call it the 'Kerala model' for dealing with the COVID-19 situation[64,65]. Even with a large population and many tourists, Kerala's effective handling of the COVID-19 pandemic is impressive.

Table 16.Details Regarding Vaccination Coverage in Kerala as of July 19, 2022

Category	1st Dose	2nd Dose	Fully vaccinated (%)	Precaution Dose	Precaution Dose (%)
HCW	555807	510752	92	245036	48
FLW	571923	536946	94	184337	35
12-14 years	7,26,445	3,88,579	38	-	-
15-17 years	13,06,436	9,13,107	60	-	-
18-44 years	1,29,54,189	1,08,99,549	81	129335	01
45-59 years	69,44,030	62,97,759	87	149005	02
> 60 years	59,66,031	54,56,766	92	16,18,133	30

HCW- Health Care workers, FLW- Frontline Workers

Table 17.District-Wise COVID-19 Cases Reported in Kerala in 2023

District	No. of COVID Cases
Thiruvananthapuram	13727
Kollam	7537
Pathanamthitta	6770
Alappuzha	3725
Kottayam	11377
Ernakulam	21522
Idukki	3496
Thrissur	4948
Palakkad	2017
Malappuram	1560
Kozhikode	3384
Wayanad	1567
Kannur	1206
Kasaragod	1250
Total	84086

Kerala, widely regarded as a benchmark state in India, is known for its remarkable social metrics, outperforming numerous other states in the country in different areas. Both the health and education sectors have been given priority by the state. Throughout history, Kerala has dedicated significant resources to enhance its public health infrastructure. Kerala implemented a people's planning programme in the 1990s. Hence, at the grassroots level, the administrative capacity is entrusted to local self-government (LSG) bodies. Hence expenditure of the fund and implementation of the program is restricted to LSGs. The state's social organisation encourages the participation of the community and solicits cooperation from the public. The government is very keen on improving the infrastructure and providing logistics to the government-run primary health care system and education system which set out a strong support for persistent development.[66] Kerala effectively controlled the COVID-19 pandemic by utilising its social cohesion, governance, and public health system demonstrated during the Nipah virus outbreak, along with innovative social, communication, and technological strategies.[67,68]

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Kerala state is inhabited by a population of 33.38 million people, contributing to a high population density of 859 people per sq km area as compared to the national average of 312 per sq km.[69] Kerala's closely packed population accelerated the rapid spread of COVID-19, leading to increased morbidity and mortality.[70,71] Amid the other persistent vulnerabilities of a high proportion of old age populations, high prevalence of non-communicable diseases (NCDs), and large inflow of expatriates, the state could show exemplary performance in minimising the COVID-19 cases in the initial phase.[72,73] In addition to this, in the initial phase, the state could maintain a low fatality rate of less than 1%. However, the case fatality rates during this time remain at 7% and 4% at global and national levels, respectively.[74]

The main reasons for curbing the spread of the disease were systematic surveillance, efficient and prompt contact tracing, vigorous testing, good quality isolation and quarantine, uninterrupted treatment strategy, community involvement, proactive care and support of elderly and people with co-morbidity, social mobilisation, inter-sectoral co-ordination, excellent teamwork from grass root level to higher authorities, and impressive governance.[75,76]

The diligent work of Accredited Social Health Activists (ASHA) workers, police officers, and volunteers at the grassroots level played a key role in controlling the spread of the disease. The initiative of public-private partnership was a boon to the local residents, especially during lockdown periods. Their service was immensely helpful to those who were bedridden or needed urgent medical care and support. The limitations in the state's healthcare infrastructure were adroitly overcome by integrating the available resources with social capital.[77]The effective utilisation of existing resources and providing goods and services to the needy is a great lesson that we learnt from the ongoing pandemic.

The research carried out in Kerala highlighted the importance of human resources and service delivery in ensuring stability during public health emergencies in developing countries with limited resources.[71] The success of Kerala in controlling the COVID-19 pandemic is due to various factors, such as significant investments in the social sector, informative public awareness campaigns, and widespread compliance with health guidelines.[78]

One of the major impacts of the COVID-19 pandemic is decreased physical activity due to 'work at home" practice. The increased weight is yet another issue. Hence public health system should address all these issues and promote healthy practices in the community.[79] A recent study on the persistence of symptoms after COVID-19 infection in Kerala indicated fatigue, joint pain and shortness of breath are the most common symptoms.[80] Post-COVID illnesses are increasing in Kerala and elsewhere and it is a challenge and concern to the existing medical system. The ongoing pandemic is not only a threat to the physical health of the affected individuals but also affects the mental health and psychosocial consequences. The aftermath has been experienced by the general public as a whole, but undeniably more intensely by individuals who belong to marginalised and deprived sections of society. Sometimes, the impact can lead to detrimental and long-term repercussions as well as mental health issues[81]. The need for mental health care and psychosocial support therefore becomes highly relevant in such a situation. Learning from the lessons of the COVID-19 pandemic, it is now time to invest in establishing facilities and the latest technology-based services for the future. The global community should come together to offer consistent care and support to those impacted by this worldwide disaster. The dedication shown by people all over the globe during the pandemic should be maintained in the period after COVID-19.

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