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Review Article

RISE AND FALL IN SARS-COV-2 GLOBAL PANDEMIC STRAIN RATE–AN OVERVIEW

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ABSTRACT

After its discovery in Hubei in China in December 2019, the deadly rise of modern coronavirus (COVID-19 or 2019-nCoV) has spread globally. SARS-CoV-2 disease COVID-19 has quickly spread worldwide, posing a serious threat to health and the economy. As of 25th January 2021, more than 100 million confirmed cases of 2,165,581 deaths have been reported by WHO and Worldometer. Many of the cases reported are caused by infection from human to human and are the carriers of this lethal coronavirus. Due to its calamitous nature, the whole world was under lockdown restricting all sorts of movements and means of transportation in hampering the countries economic balance. Presently, the world's endeavor to create and develop a safe and effective COVID-19 vaccine is bearing the fruit. A handful of vaccines now have been authorized around the globe and many more remain in the development phase. In addition, social isolation and knowledge of hygiene (facial masks and sanitizers) are potential methods of controlling the further dissemination of global pandemics COVID-19. This research article presents a brief overview of the catastrophic effect caused by COVID-19 disease globally and particularly in different states of India. Additionally, the article also discusses the recent variant of SARS-CoV-2 and its vulnerable impact. Furthermore, the article investigates the currently available vaccines and those in their development phase for the treatment of COVID-19 disease. This investigatory literature may provide comprehensive details on COVID-19 disease from its inception to grow and later fall in its strain rate.

Keywords: Coronavirus, COVID-19, 2019-nCoV, SARS-CoV-2, Wuhan, Vaccines

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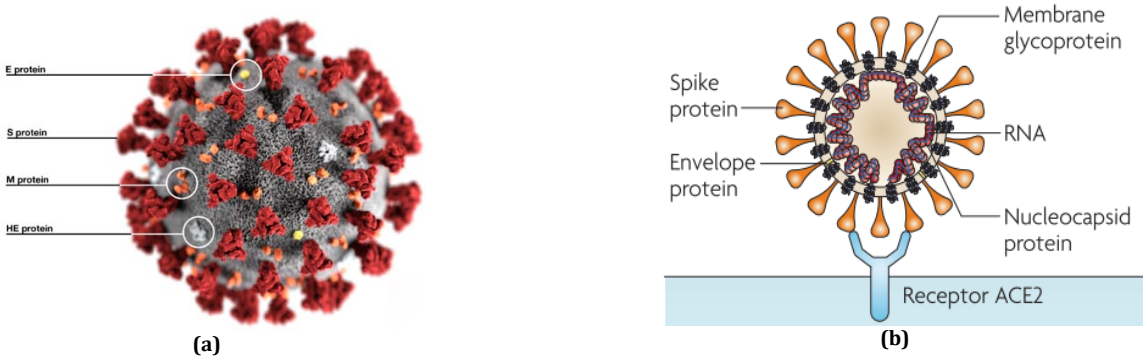
INTRODUCTION

The world is now in a state of crisis [1]. The latest coronavirus epidemic has easily reached the world population, which came into being in Wuhan, Hubei Province of China, on 31st December 2019 [2]. Coronaviruses (CoVs) are extremely large viruses with a single strand RNA genome encompassing a membrane shell [3]. The word 'coronavirus,' in electron microscopy, refers to the appearance of CoV virions in which viral membrane is tucked with projections of glycoprotein spikes(S), which give the appearance of the like corona (Crown in Latin) [4, 5]. Some virally encoded proteins that make up the surface portion of the virus include E (envelope protein), M (membrane protein), and HE (haemagglutinin-esterase protein) (fig. 1) [5, 6]. In many avian hosts [7, 8], as well as in different mammals, CoVs have been reported, including camels, bats, masked palm civets, mice, dogs, and cats. Novel mammalian coronaviruses are now regularly identified[10]. For eg, HKU2-related bat coronavirus caused acute pig diarrhea syndrome fatal in 2018 [11]. CoVs affect upper breathing, respiratory, hepatic, and central nervous system disorders [12]. In 1965, the first human coronavirus (HCoVs) was isolated from the nasal release of common cold patients named B814 [13]. There are seven multiple CoVs believed to infect humans. The following are HCoV-229E (229E), HCoV-OC43 (OC43), Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV), HCoV-NL63 (NL63), HCoV-HKU1 (HKU1), Middle East Respiratory Syndrome Coronavirus (MERS-CoV), and SARS-CoV-2 [13, 14]. Four of which are 229E, OC43, NL63, and HKU1, responsible for causing mild diseases, and the rest three SARS-CoV, MERS-CoV and SARS-CoV-2 can be even lethal [15, 16]. The novel beta coronavirus agent SARS-CoV, was found in the Guangdong province of China in 2002–2003 to be a serious acute respiratory disease outbreak [18]. Between 2002 and 2003 there were more than 8000 human infections and 774 deaths in 37 countries [19]. MERS-CoV is a pathogen accountable in 2012 for the continuing emergence of extreme respiratory diseases located in the Middle East, Saudi Arabia [20]. There have been 2494 laboratory-based infection deaths since September 2012 and 858, including 38 in South Korea after single infection [21]. However, the lower air system triggers viral pneumonia, both SARS-CoV and MERS-CoV [10].



(a) (b)

Fig. 1: (a) Schematic structure of CoVs [6], (b) Cross-sectional view of CoVs structure with a viral receptor on the host cell surface [7]

On 09th January 2020, the Chinese Centre for Disease Control and Prevention (CCDC) announced the latest human zoonotic coronavirus, SARS-CoV-2 [22]. SARS-CoV-2 does the same thing as SARS-CoV and MERS-CoV but also affects the immune tract, the respiratory system, the kidney, the liver and the center nerves [15]. The Huanan South China Seafood Industry was connected to the initial contaminated cases. Their first case was recorded in China in December 2019 and many scientists suspect that a pandemic is leading the planet to a halt [23]. In China 62 confirmed cases were reviewed by 17th January [24]. Total patients in Wuhan are contaminated until 198 on 19th January. On 20th January, the confirmed cases of 2019-nCoV increased to 282. Four countries, including China (278), Thailand (2 cases), Japan (1 case), and the Republic of Korea have registered these cases (1 case) [25]. The cases have been brought to Thailand, Japan and the Republic of Korea from Wuhan City, China. 258 cases were recorded from the province of Hubei alone, 14 from the province of Guangdong, 05 from the municipality of Beijing and 01 from Shanghai municipality, among 278 confirmed in China [25]. Of the 278 confirmed cases, 51 are seriously ill, 12 are critically ill and 06 death from the city of Wuhan were reported. On 24th January, the total confirmed cases of 2019-nCoV cases expanded to 846 globally [26]. 830 cases of China and 375 cases of Hubei Province have been reported. 177 cases of serious illness and 25 deaths have been recorded from 830 cases. The detailed situation report of COVID-19 disease from 21st January 2020 to 25th January 2021 has been discussed in section SARS-CoV-2: A situation report. The chronology of 2019 novel Coronavirus events as monitored by the Wuhan Municipal Health Commission was illustrated in fig. 2 [27].

Additionally, fig. 3 is the World Health Organization (WHO) timeline for the 2019-nCoV since 31st December 2019 [28]. The WHO declares it a global public health emergency on 30th January 2020 and labeled it as a 2019 novel Coronavirus (2019-nCoV) [29]. 2019-nCoV isolated from one patient and ultimately tested and expected as a causative agent in 16 other patients [30]. The International Committee of Taxonomy of Viruses (ICTV) has designated 2019-nCoV as SARS-CoV-2 [31]. Based on these reports, snakes [32] or pangolins [33] may be the intermediary carriers but the true source of COVID-19 is still unknown according to the WHO (fig. 4) [33, 34]. On 11th February 2020, the WHO officially named Coronavirus Disease-2019 (COVID-19) [36]. WHO later announced the COVID-19 outbreak as a pandemic on 11th March 2020 [36, 37]. This infectious disease produces a pandemic climate that results in a growing number of cases of death, intense pressure on health care systems worldwide, and unparalleled movement, transit, industry, and educational constraints [39]. COVID-19 pandemic is a rapidly moving topic of research, which entraps the whole world gripping into a lockdown phase at the cost of millions of lives and restricting all means of travel synchronously. If COVID-19 spreads are not efficiently managed, the effects on global health services may pose considerable challenges and far-reaching consequences for the global economy [40].

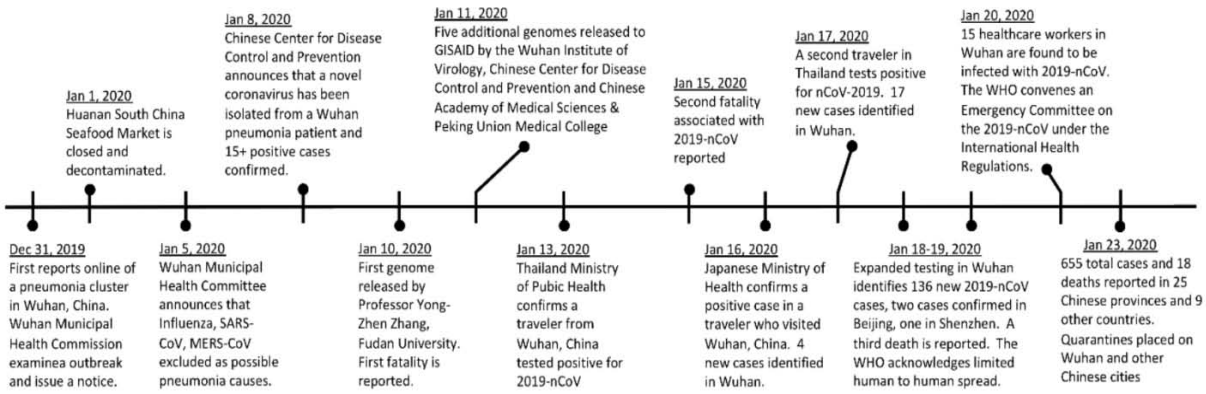


Fig. 2: 2019-nCoV events as monitored by the Wuhan Municipal Health Commission [27]

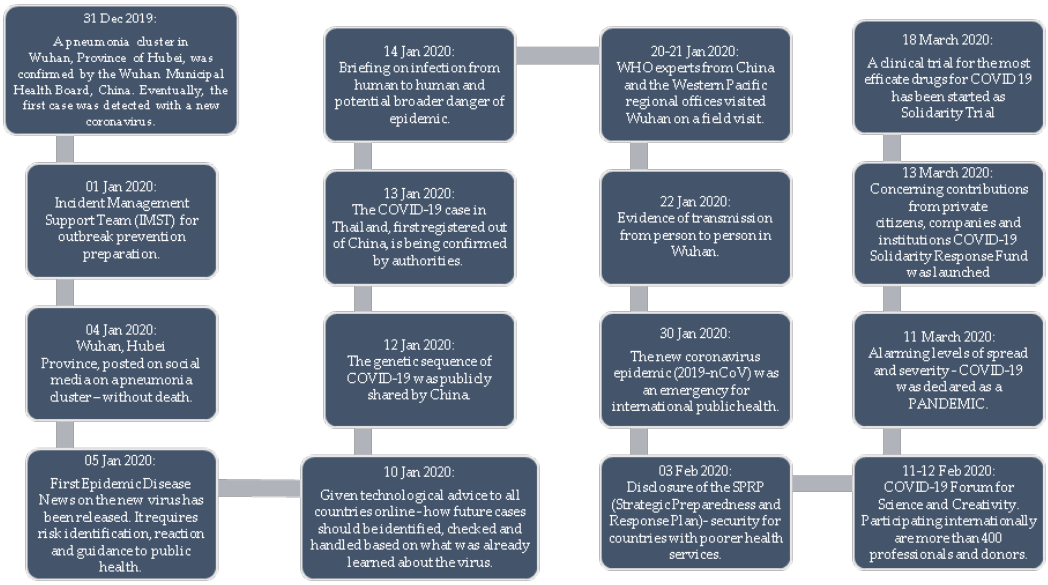


Fig. 3: WHO timeline for COVID-19 [28]

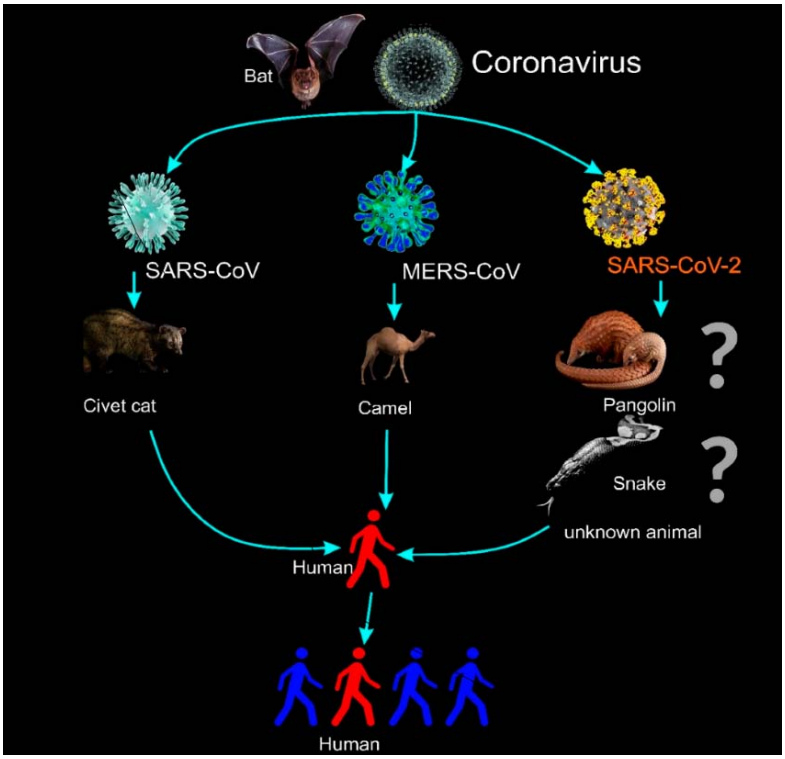


Fig. 4: Coronaviruses transmission from Animal to Human. However, SARS-CoV-2 or 2019-nCoV source is still unknown [35]

Vulnerable impact on population

The first 2019-nCoV sequence was made available online one day after the announcement was made on behalf of Dr. Yong-Zhen Zhang and scientists at the Fudan University in Shanghai [42]. The GSAID archive had five more 2019-nCoV sequences from institutes in China deposited on 11th January 2019 [26, 42]. With minimal patient records, robust declarations on communities that could be more vulnerable to 2019-nCoV are sometimes difficult to produce. However, the severity of disease arising from SARS-CoV and MERS-CoV was highly associated with the underlying circumstances of host age, sexuality, and overall health condition [44]. The new pathogen had ~80%, ~50%, and the genome of SARS-CoV, MERS-CoV, and bat CoV (RatG13), respectively, were found to have a similarity of ~96% [44, 45]. 2019-nCoV severe disease was associated with elderly patients (>60 y old) that caused death [47]. The patient's underlying health conditions frequently play a vital role in its ultimate vulnerability. The 2019-nCoV had a severe vulnerable impact on patients suffering from health conditions such as hypertension, diabetes, and heart or kidney problems [48]. Similarly, the MERS-CoV outbreak was responsible for most of the deaths to the patient suffering health illness such as smoking, hypertension, diabetes, cardiovascular, and other chronicle disease [49]. Taking into consideration signs that can differ in some patients, while others have a fever, cough, tiredness, and other symptoms. The signs may be identical to fever or cold patients [50]. The human-to-human transmission happens in droplets, touches, and fomites during earlier outbreaks of SARS-CoV and MERS-CoV and suggests a comparable 2019-nCoV transmittal mode (WHO Situation Report-4) [51]. Direct touch and droplet diffusion are the most probable means of transmission [52]. A new study of 2019-nCoV aerosols and surface persistence has shown that aerosols (<5 μm) have viruses for at least 3 h and maybe more robust on plastic and stainless steel than on copper and carton board [52, 53].

The United States' WHO and CDC [55] have reported that infectious persons with transmitting confirmations (fig. 4) are being spread from three-person cases outside China, mostly in the United States [47], Germany [56], and Vietnam [57]. The COVID-19 epidemic has expanded worldwide to 218 countries and territories (fig. 5) and has affected more than 101,441,979 people worldwide, claiming more than 2,184,283 death by 28th January 2021 [58]. Fig. 5 represents COVID-19 cases per 01 million populations reported in the last 07 d globally from 28th December 2020 to 03rd January 2021[59]. China's death toll has surpassed the 2002–2003 SARS outbreaks and increased to 4,632 by 24th April 2020 (WHO Situation Report-48) [60]. Therefore, SARS-CoV-2 is likewise more infectious and deadly than SARS-CoV [61]. At least 50 million people are locked up in China to slow down the propagation of COVID-19 [62]. Italy also took the same action on 8th March 2020 with 16 million residents in the northern part of the country under lockdown [63]. Since several mild and asymptomatic cases were not detected, the overall number of confirmed COVID-19 infections is underestimated [64]. Asymptomatic cases were estimated at 17.9 percent in the case report of the international transport cruise ship Diamond Princess in Japanese territorial waters (fig. 6) [65]. Asymptomatic patients are as contagious as symptomatic people and are hence able to further transmit the illness [66].

The U. S. Food and Drug Administration (FDA) has approved COVID-19 therapies and/or vaccines [67]. COVID-19 patients express signs that are unspecific and cannot be detected correctly. Guan *et al.* [68] recorded that 44% of 1,099 COVID-19 Chinese patients had a fever at the hospital and 89% developed a fever in the hospital. Patients had contaminants (68%), exhaustion (38%), development of sputum (34%), and shortness of respiration (19%). Many of these signs can be linked with other breathing infections. At present, diagnostic methods are important in the containment of COVID-19, which makes it possible to enforce restrictions restricting delivery, separation, and contact by case detection [50]. Currently, the main approach for testing and diagnosing COVID-19 disease is nucleic acid [69] and computed tomography (CT) testing [70]. As seen in fig. 7, the current workflow for diagnosis for COVID-19 [50].

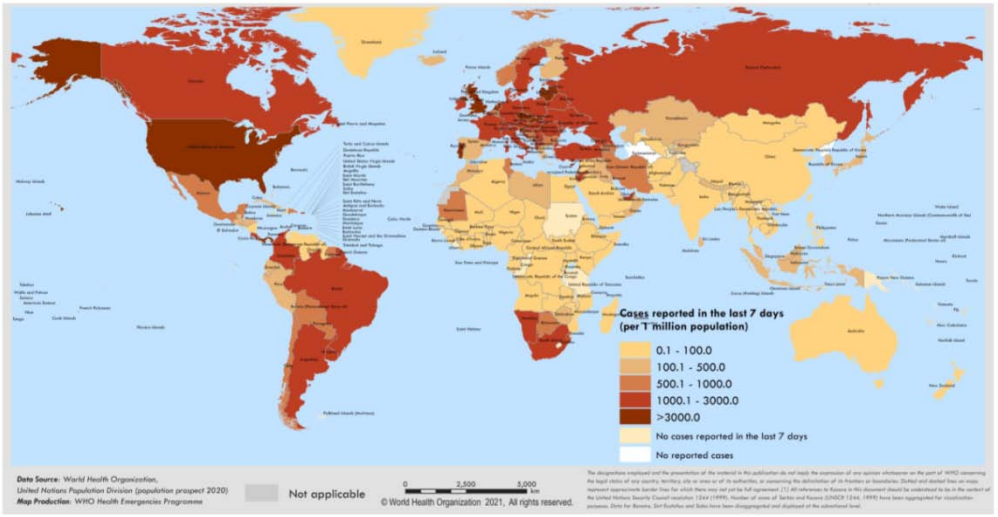


Fig. 5: World map showing the global distribution of COVID-19 confirmed cases per 01 million population from 28 December 2020 to 03 January 2021 [71]

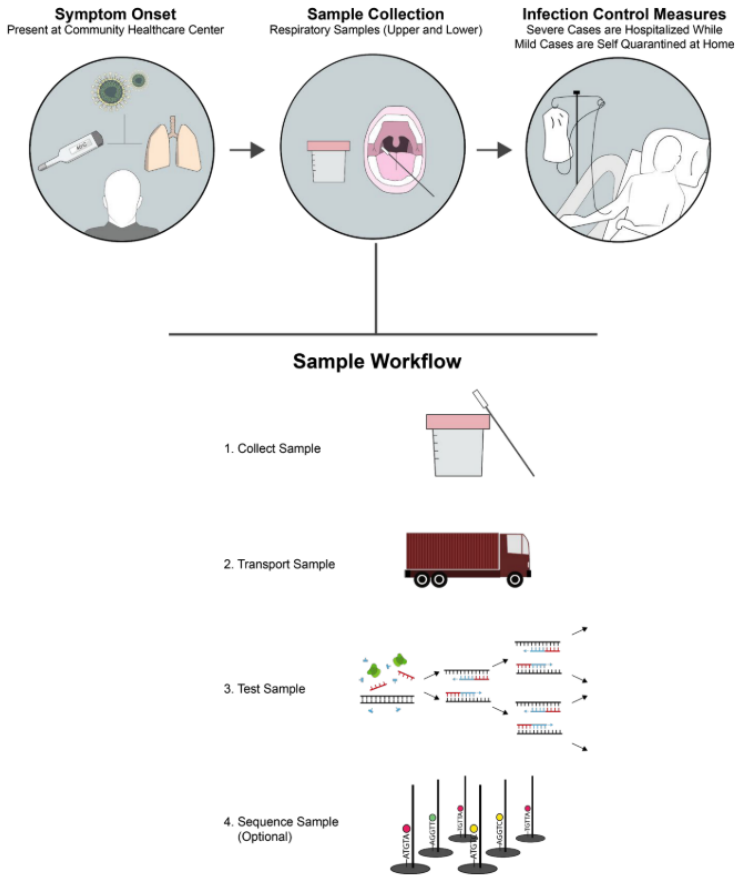


Fig. 6: COVID-19 diagnostic workflow [50]

Contagiousness of the SARS-COV-2 or 2019-nCoV

Three parameters that assess the extent of risk associated with this new coronavirus:

a) Rate of transmission (R_o)-Proportion of newly infected persons from a single case

The attack or transmission rate of a virus is suggested by its number (as quickly as the epidemic is spreading). The transmission rate (R_o) measures the average number of individuals in whom the virus is transferred from some infected person [72]. An outbreak with a R_0 less than 1 (R_0<1) is gradually considered as disappeared. For the common flu, R_o was expected to be 1.3 and for SARS to be 2.0 [73]. Depending on preliminary studies the estimated value of R_0 was between 1.5 and 3.5 [74–76]. On 23rd Jan. 2020, WHO's estimated the range of R_0 in lying between 1.4 and 2.5 [77] Other studies have also estimated the range of R_0 ranging from 3.6 to 4.0 and 2.24 to 3.58 [78].

b) Case fatality rate (CFR)-The percentage of death cases

CFR signifies the percentage of cases that actually die due to infection [79]. At the WHO press conference conducted on 29th January 2020, 2019-nCoV CFR was initially calculated at about 2% [80]. However, it was mentioned that it was too premature to be added a number to the mortality rate statistic without realizing how many were contaminated [80]. Wang *et al*. [14] gave a 3 percent early estimate for the total CFR. Dr. Tedros Adhanom Ghebreyesus, WHO Director-General, released on 3rd March 2020 that, "Globally, about 3.4% of reported COVID-19 cases have died**.** By comparison, seasonal flu generally kills far fewer than 1% of those infected" [81]. However, the influenza pandemic of 1918 is projected to be less than five percent lethal (CFR<5%) yet to have major consequences because of widespread dissemination, and complacency is unfounded. Surveillance was raised not only in China but also globally as the disease turns into a pandemic [82]. On 20th Feb 2020, a total of 55,924 laboratory cases were confirmed. Out of which 2114 people were died raising the CFR rate to 3.8%. For zone, the CFR is averaged 5.8% in Wuhan versus 0.7% in other Chinese regions, respectively. In the earlier stages of the epidemic in the general CFR of China (17.3 percent of cases with symptoms during 1-10 January) have been decreased to 0.7 percent in the course of the duration after 1 February for patients with symptom initiation [83]. As stated by the NHC, China in a press conference on 4th Feb. 2020, the nationwide mortality rate was 2.1% of confirmed cases [84]. The mortality rate was calculated using the formula:

Mortality or CFR Rate = cumulative current total deaths/current confirmed cases

There were 4.9% and 3.1% of mortality in Wuhan and Hubei Province. NHC has further stated that, from death analysis, more than 80 % of people with an age of 60 y are elderly and more than 75% have medical disorders such as coronary heart diseases and tumor diseases and more than 80% are old, with over 75% underlying health issues [82]. Elderly individuals with basic diseases had a greater clinical risk, whether or not they were infected by a coronavirus. For so long as they were, suffering from pneumonia, and the rate of fatality was also very high, and the rate of death of pneumonia has been not high due to infection. "Everyone must be explained at this point," the office of the NHC concluded [84]. According to epidemiologists, the fatality rate can be altered with the mutation of this virus [82]. At the moment the fatality rate is tested by the proportion of dividing the number of documented deaths by the confirmed cases. However, the result is not the actual case fatality rate. Moreover, the case fatality rate cannot currently be precisely estimated [79]. SARS-CoV originated in Beijing, China (November 2002-July 2003) has spread to 29 countries and caused 774 deaths of 8,096 infected persons (9.6 percent death rate). Given the SARS infection in China, on 29th January 2020, when Chinese officials confirmed 5,974 cases, Wuhan 2019-nCoV surpassed SARS (table 1). One day later on 30th January 2020, only the 8,096 reports that became the latest SARS outbreaks of 2003 became outpaced by fresh coronavirus infections worldwide. Of the 2,494 persons infected, MERS-CoV (in 2012) killed 858 people (34.4 percent fatality rates) [73].

Table 1: CFR of 2019-nCoV in comparison to others

Virus	CFR	References
2019-nCoV	3.4% (estimated)	[79]
SARS	9.6%	[82]
MERS	34%	[82]
Swine Flu	0.02%	[82]

c) COVID-19 incubation period (IbP)

It is calculated that the IbP (a period from exposure to symptoms development) for the virus ranges from 2 to 14 d based on the following sources:

- The WHO recorded a time of incubation of COVID-19 between 2 and 10 d (WHO Situation Report-7)[85]
- Initially, the Chinese National Health Commission predicted an incubation period of 10 to 14 d [84].
- Incubation periods for COVID-19 disease are estimated between 2 and 14 d by the United States Centres for the Control and Prevention of Diseases (CDC). People with symptoms such as cough, breathing difficulties, fever, chills, muscle aches, sore throat, loss of taste or scent may suffer COVID-19 [86].
- DXY. cn, China's leading online medical and healthcare group, recorded a "3-7 d up to 14 d" incubation duration [87].

The virus is spreading during the incubation period, but the patient presents no signs (asymptomatic transmission). It is very critical that health officials recognize the incubation time, monitor and potentially deter the transmission of the virus, and establish a more robust Quaranto scheme for individuals suspected of having the virus [88]. Backer et. al. results were reviewed on 88 cases of documented travel background (to and from) Wuhan, identified as contaminated by COVID-19 from 20th to 28th January. The overall incubation time was expected to be 6.4 d. The IbP varies from 2.1 to 11.1 d. The 11.1-day limit should, however, be deemed conservative [89]. The period of incubation varies considerably between patients. Hubei Province Local Government reported on 22nd February 2020 a case with an IbP of 27 d [90]. Furthermore, in a report documented by JAMA released on 21st February 2020, five cases with an incubation time of 19 d were reported [91]. Moreover, in a study on 09th February 2020, a 24-day incubation cycle was firstly observed [49]. WHO has said that this could represent a second exposure and not a longer duration of incubation. The average incubation time observed as showed in table 2 is focused on various case studies [88]. The incubation time for common influenza (seasonal flu) typically is about 2 d relative to other viruses. table 3 indicates the period of incubation for other coronaviruses [88].

Table 2: Mean incubation period

Mean incubation period (days)	Time duration (days)	References
3.0	0-24 (on the basis 1324 cases)	[88]
5.2	4.1-7.0 (on the basis 425 cases)	[88]
6.4	2.1 to 11.1 (based on travelers from Wuhan)	[88]

Table 3: Incubation period of 2019-nCoV in comparison to others

Virus	IbP	References
2019-nCoV	2-24 d or 0-24 d	[88]
SARS	2–7 d (as long as 10 d)	[88]
MERS	5 d (as long as 2-14 d)	[88]
Swine Flu	1-4 d (as long as 7 d)	[88]
Seasonal Flu	2 d (as long as 1-4 d)	[88]

SARS-CoV-2: A situation report

Concerning WHO, a situation report on COVID-19 disease has been considered in this section from 21st January to 01st May 2020. On 04th April 2020, the worldwide confirmed cases climb above 1 million and death over 50,000 (WHO Situation Report-75) [92]. 13 d later, the sum of cases reported has universally crossed more than 2 million cases on 17th April 2020 (WHO Situation Report-88) [93]. The social and religious meetings of Ramadan are specifically influenced by physical distancing steps, such as shutting mosques, tracking public activities, and other constraints on the move. Therefore, on 15th April 2020, WHO released a guideline on "Safe Practices in Ramadan" in the context of COVID-19 [94]. Its fundamental aim is to illustrate the guidance on public health in social and religious activities and meetings during Ramadan holy month that can be used in various national contexts [94]. Later on within 12 d, the total number of reported cases has globally surpassed the 3 million mark on 29th April 2020 (WHO Situation Report-100) [95]. For 10 d interval, the total number of confirmed

cases has globally exceeded 4 million marks as reported by Worldometer on 09th May 2020 [96]. Presently, the worldwide infection hits more than 100million as stated by the Worldometer report on 25th January 2021 [97]. For the first 1million cases to be recorded it took three months but has taken just four days for the global tally to grow that much again. This describes the severity of the pandemic community spread of COVID-19 disease and the necessity of required awareness to reduce its spread rate. Till 28th January 2021, the outbreak of COVID-19 disease has so far affected with 218 countries and territories across the globe and 02 international conveyances [98]. According to WHO, the number of cases globally is around triple that of severe influenza illness recorded annually. The details of the cases are given in table 4. As reported by Worldometer on 28th January 2021 at 05:57 GMT, COVID-19 disease has globally infected 101,441,979 people, claimed over 2,184,283 lives and recovered 73,325,790 cases (table 4) [58]. Fig. 7 illustrates the list of the top 70 countries reported cases (reported/active) and death due to COVID-19 disease as of 25th January 2021. Table 5 provides a weekly epidemiological update on COVID-19 laboratory-confirmed cases and deaths founded on evidence from the situation report from the WHO, from 28th December to 03rd January 2021 [59].

Table 4: COVID-19 disease case details and condition status on 28th January 2021 at 10:22 GMT

Total confirmed cases (Globally)	Cases type	Case status	Condition status		References
101,441,979	Active Cases	25,928,938 (Currently infected patients)	25,821,571 (99.6%)	Mild Condition	[58]
			110,335 (0.4%)	Serious or critical	[58]
	Closed Cases	75,513,041 (Cases which had an outcome)	73,325,790 (97%)	Recovered/Discharged	[58]
			2,184,283 (3%)	Deaths	[58]

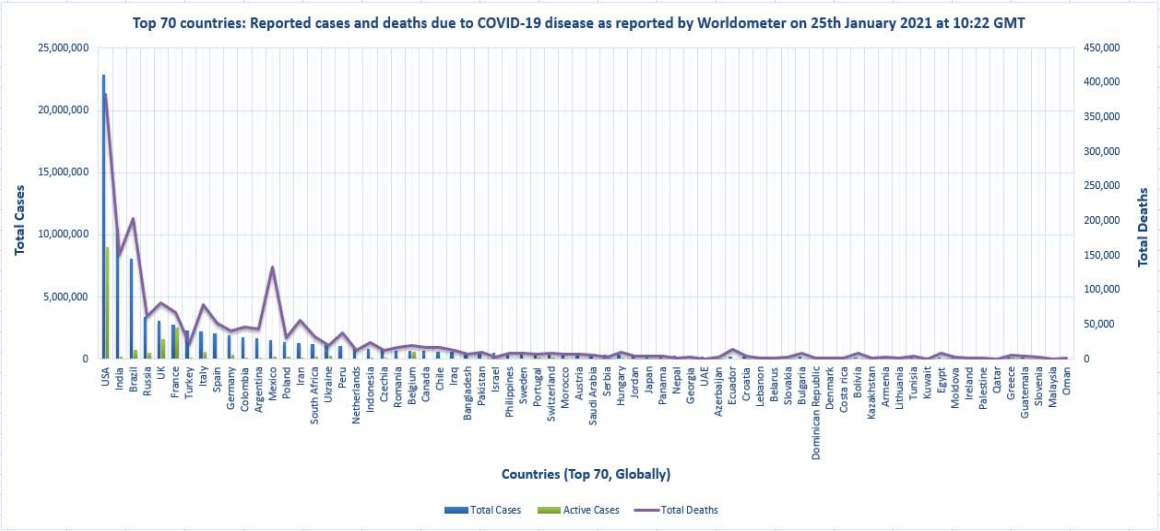


Fig. 7: Globally reported cases and deaths in top 70 countries, due to COVID-19 disease as reported by Worldometer on 25th January 2021

Table 5: Laboratory-confirmed COVID-19 case and death, epidemiological report 28th December to 3rd January 2021

Location	New cases	Cumulative cases	New deaths	Cumulative deaths	Type of transmission	References
Africa	130007	1961234	3293	43592		[59]
South Africa	93978	1088889	2654	29175	COM	[59]
Nigeria	5587	89163	55	1302	COM	[59]
Mauritania	3393	14364	122	347	COM	[59]
Namibia	3256	24654	26	213	COM	[59]
Ethiopia	2636	125049	43	1944	COM	[59]
Algeria	2302	100159	47	2769	COM	[59]
Uganda	2149	35712	29	274	COM	[59]
Democratic Republic of the Congo	1568	17848	25	591	COM	[59]
Zambia	1559	21230	10	392	COM	[59]
Zimbabwe	1528	14491	36	377	COM	[59]
Eswatini	1344	9711	64	227	COM	[59]
Botswana	1183	14805	4	42	COM	[59]
Senegal	988	19511	29	416	COM	[59]
Kenya	835	96678	30	1685	COM	[59]
Mozambique	806	18968	9	168	COM	[59]
Ghana	778	55064	2	335	COM	[59]
Rwanda	750	8567	26	98	CLU	[59]
Burkina Faso	685	6940	9	86	COM	[59]
Mali	652	7226	27	276	COM	[59]

Cameroon	571	26848	0	448	COM	[59]
Angola	459	17608	8	407	COM	[59]
Niger	405	3208	13	102	COM	[59]
Malawi	368	6711	4	192	COM	[59]
Eritrea	328	1320	2	3	SPR	[59]
South Sudan	250	3558	1	63	COM	[59]
Cabo Verde	185	11883	1	113	COM	[59]
Chad	183	2169	1	104	COM	[59]
Comoros	149	864	6	13	COM	[59]
Guinea	138	13784	1	81	COM	[59]
Madagascar	134	17767	2	262	COM	[59]
Togo	128	3683	0	68	COM	[59]
Gabon	74	9571	0	64	COM	[59]
Seychelles	73	284	0	0	SPR	[59]
Benin	46	3251	0	44	COM	[59]
Equatorial Guinea	41	5277	1	86	COM	[59]
Burundi	29	833	0	2	COM	[59]
Central African Republic	15	4963	0	63	COM	[59]
Sierra Leone	11	2560	0	76	COM	[59]
Gambia	10	3802	1	124	COM	[59]
Sao Tome and Principe	10	1024	0	17	COM	[59]
Mauritius	3	527	0	10	CLU	[59]
Congo	0	6200	0	100	COM	[59]
Guinea-Bissau	0	2447	0	45	COM	[59]
Lesotho	0	2577	0	50	COM	[59]
Liberia	0	1800	0	83	COM	[59]
United Republic of Tanzania	0	509	0	21	COM	[59]
Territories						
Reunion	128	9037	0	42	CLU	[59]
Mayotte	123	5890	1	55	CLU	[59]
America	1935621	36337439	32283	872486		
USA	1325424	19974413	17239	345253	COM	[59]
Brazil	252018	7700578	4923	195411	COM	[59]
Colombia	80173	1654880	1805	43495	COM	[59]
Mexico	64942	1437185	4670	126507	COM	[59]
Argentina	55040	1629594	897	43319	COM	[59]
Canada	50966	587639	959	15679	COM	[59]
Panama	23073	249733	308	4064	COM	[59]
Chile	17508	615902	320	16724	COM	[59]
Peru	11653	1017199	356	37724	COM	[59]
Bolivia	8465	162055	103	9186	COM	[59]
Dominican Republic	7025	172965	12	2416	COM	[59]
Costa Rica	5259	169321	82	2185	COM	[59]
Ecuador	5239	214513	63	14059	COM	[59]
Paraguay	4461	108349	108	2262	COM	[59]
Honduras	4315	122974	99	3160	COM	[59]
Uruguay	3905	19753	50	193	COM	[59]
Guatemala	3145	138316	64	4827	COM	[59]
Venezuela	1959	113562	18	1028	COM	[59]
El Salvador	1623	46242	54	1351	COM	[59]
Cuba	1187	12225	5	146	CLU	[59]
Suriname	391	6277	4	123	CLU	[59]
Belize	317	10807	21	249	COM	[59]
Jamaica	247	12931	9	303	COM	[59]
Haiti	231	10077	1	236	COM	[59]
Bahamas	83	7871	1	170	CLU	[59]
Guyana	62	6351	2	164	CLU	[59]
Trinidad and Tobago	61	7158	2	127	COM	[59]
Barbados	48	395	0	7	CLU	[59]
Saint Lucia	48	353	0	5	SPR	[59]
Nicaragua	39	4829	1	165	COM	[59]
Grenada	18	134	0	0	SPR	[59]
Saint Vincent	14	122	0	0	SPR	[59]
Antigua and Barbuda	4	159	0	54	SPR	[59]
Saint Kitts and Nevis	3	33	0	0	SPR	[59]
Dominica	0	96	0	0	CLU	[59]
Territories						
Puerto Rico	5489	77932	94	1526	COM	[59]
French Guiana	500	13273	0	71	COM	[59]
Aruba	214	5442	2	49	COM	[59]
Curacao	179	4230	2	14	COM	[59]
Sint Maarten	64	1434	1	27	COM	[59]
Turks and Caicos Islands	64	908	0	6	CLU	[59]
United States Virgin Islands	57	2036	0	23	COM	[59]

Bermuda	43	604	1	10	CLU	[59]
Cayman Islands	20	338	0	2	SPR	[59]
Martinique	19	6091	1	43	COM	[59]
Saint Martin	9	995	0	12	COM	[59]
Bonaire, Saint Eustatius and Saba	7	189	0	3	NA	[59]
Anguilla	3	15	0	0	SPR	[59]
Saint Barthélemy British	1	190	0	0	SPR	[59]
British Virgin Islands	0	93	0	1	CLU	[59]
Falkland Islands	0	29	0	0	No Cases	[59]
Guadeloupe	0	8620	0	155	COM	[59]
Montserrat	0	13	0	1	No Cases	[59]
Saint Pierre and Miquelon	0	16	0	0	SPR	[59]
Eastern Mediterranean	154695	4977852	3057	122061		
Iran	42511	1237474	864	55438	COM	[59]
Lebanon	16936	186408	97	1476	COM	[59]
Pakistan	14880	484362	442	025	CLU	[59]
Tunisia	11749	141373	339	4765	COM	[59]
Morocco	11579	442141	248	7452	CLU	[59]
United Arab Emirates	10749	211641	19	674	COM	[59]
Jordan	10312	296668	148	3877	COM	[59]
Egypt	9563	140878	389	7741	CLU	[59]
Iraq	6254	597033	62	12829	COM	[59]
Libya	3091	100744	72	1487	COM	[59]
Bahrain	1666	93184	1	352	CLU	[59]
Kuwait	1625	151074	8	937	COM	[59]
Qatar	1337	144240	1	245	COM	[59]
Saudi Arabia	913	362979	63	6239	SPR	[59]
Afghanistan	861	52079	63	2221	CLU	[59]
Syrian Arab Republic	684	11616	54	723	COM	[59]
Oman	577	128867	8	1499	COM	[59]
Djibouti	36	5841	0	61	CLU	[59]
Somalia	24	4714	3	130	SPR	[59]
Yemen	9	2105	4	611	SPR	[59]
Sudan	0	23316	0	1468	NA	[59]
Territories						
Occupied Palestinian territory	9339	157879	172	1578	COM	[59]
Europe	1553332	26885471	32898	588770		
The United Kingdom	343784	2599793	4165	74570	COM	[59]
Russian Federation	186539	3236787	3728	58506	CLU	[59]
Germany	124808	1765666	4494	34272	CLU	[59]
Italy	102442	2141201	3365	74985	CLU	[59]
Turkey	98662	1417697	1671	21295	COM	[59]
France	91595	2599127	2346	64543	COM	[59]
Czechia	69882	740481	916	11960	COM	[59]
Poland	60763	1318562	2001	29119	COM	[59]
Netherlands	59975	813725	600	11565	COM	[59]
Ukraine	48104	1074093	1080	18854	COM	[59]
Portugal	30874	423870	489	7045	CLU	[59]
Israel	28963	425582	132	3338	COM	[59]
Romania	23635	637395	811	15919	COM	[59]
Sweden	22117	437379	68	8727	COM	[59]
Slovakia	19940	187463	544	2317	CLU	[59]
Switzerland	18879	450075	419	7049	COM	[59]
Serbia	18537	341904	305	3288	COM	[59]
Spain	16852	1893502	168	50442	COM	[59]
Denmark	16374	167541	192	1345	COM	[59]
Lithuania	16039	146637	390	1644	COM	[59]
Austria	14604	362963	462	6214	COM	[59]
Belarus	13203	198125	66	1442	COM	[59]
Hungary	11935	327995	837	9884	COM	[59]
Ireland	11532	96926	52	2252	COM	[59]
Slovenia	10894	125086	359	2889	CLU	[59]
Belgium	10458	650009	436	19693	COM	[59]
Croatia	8028	212958	401	4072	COM	[59]
Georgia	7564	229169	226	2603	COM	[59]
Azerbaijan	6270	219462	249	2703	CLU	[59]
Latvia	6110	41929	153	668	CLU	[59]
Kazakhstan	5661	203563	96	2845	CLU	[59]
Bulgaria	5496	202880	521	7644	CLU	[59]
Republic of Moldova	4698	145694	137	3020	COM	[59]
Greece	4595	139709	368	4921	COM	[59]
Cyprus	4054	23445	18	129	CLU	[59]
Estonia	3739	29131	40	244	CLU	[59]
Norway	3346	48278	15	436	CLU	[59]

Albania	3236	58991	47	1190	CLU	[59]
Bosnia and Herzegovina	3015	112345	177	4100	COM	[59]
Armenia	2880	160027	87	2850	COM	[59]
Armenia	2439	49339	23	690	CLU	[59]
North Macedonia	2364	83789	95	2522	COM	[59]
Finland	2023	36107	37	561	COM	[59]
Luxembourg	1062	46838	33	503	COM	[59]
Kyrgyzstan	932	81305	11	1359	CLU	[59]
Malta	756	12997	14	220	CLU	[59]
Uzbekistan	487	77238	1	614	CLU	[59]
Andorra	360	8166	1	84	COM	[59]
Liechtenstein	223	2221	7	33	SPR	[59]
San Marino	199	2463	4	61	COM	[59]
Monaco	101	901	1	4	SPR	[59]
Iceland	71	5754	1	29	COM	[59]
Holy See	0	26	0	0	SPR	[59]
Tajikistan	0	13182	0	89	PND	[59]
Territories						
Kosovo	1326	51688	35	1330	COM	[59]
Gibraltar	678	2212	1	7	CLU	[59]
Jersey	177	2760	3	44	COM	[59]
Faroe Islands	43	614	0	0	SPR	[59]
Isle of Man	6	380	0	25	No Cases	[59]
Guernsey	2	299	0	13	COM	[59]
Greenland	0	27	0	0	No Cases	[59]
South-East Asia	208592	12051014	3756	184493		
India	136115	10323965	1813	149435	CLU	[59]
Indonesia	51636	758473	1561	22555	COM	[59]
Bangladesh	7085	515184	171	7599	COM	[59]
Myanmar	4336	125616	132	2711	CLU	[59]
Sri Lanka	3991	44371	24	211	CLU	[59]
Nepal	3738	261438	51	1870	CLU	[59]
Thailand	1359	7379	4	64	CLU	[59]
Maldives	216	13834	0	48	CLU	[59]
Bhutan	113	710	0	0	CLU	[59]
Timore-Leste	3	44	0	0	SPR	[59]
Western Pacific	52979	1112724	730	20288		
Japan	23642	240954	335	3548	CLU	[59]
Malaysia	13473	117373	32	483	CLU	[59]
Philippines	7911	476916	186	9523	COM	[59]
Republic of Korea	6378	63244	154	962	CLU	[59]
China	570	96894	14	4791	CLU	[59]
Australia	166	28462	1	909	SPR	[59]
Mongolia	160	1242	0	0	CLU	[59]
Singapore	143	58662	0	29	SPR	[59]
Vietnam	42	1482	0	35	CLU	[59]
New Zealand	37	1825	0	25	CLU	[59]
Cambodia	17	381	0	0	SPR	[59]
Brunei Darussalam	5	157	0	3	No Cases	[59]
Fiji	3	49	0	2	SPR	[59]
Lao People's Democratic Republic	0	41	0	0	SPR	[59]
Papua New Guinea	0	780	0	9	COM	[59]
Solomon Islands	0	17	0	0	No Cases	[59]
Territories						
French Polynesia	376	16926	6	114	SPR	[59]
Guam	54	7148	2	123	CLU	[59]
New Caledonia	2	40	0	0	SPR	[59]
Marshall Islands	0	4	0	0	No Cases	[59]
Northern Mariana Islands	0	122	0	2	PND	[59]
Vanuatu	0	1	0	0	No Cases	[59]
Wallis and Futuna	0	4	0	0	SPR	[59]
Grand Total	4035226	83326479	76017	1831703	_	

Note:

Abbreviated: COM: Community; CLU: Clusters; SPR: Sporadic; PND: Pending; N. A: Not Applicable

The different degrees of transmission classification [99] are categorized as follows:

- Cases Sporadic in Nature: One or two instances either imported or observed locally.
- Cases Clusters in Nature: Cases of experience, grouped over time, geographical location, and/or general exposure.
- Community transmission in Nature: The history of broader local transmission outbreaks decided by empirical causes, including a large number of cases that cannot be correlated with transmission chains, a large number of cases resulting from the surveillance of labs, and/or numerous unrelated clusters across different areas of the country/territory/area.

- Cases awaiting or pending in Nature: Transmission designation not referred by the WHO.

SARS-CoV-2 in India: A state-wise analysis

India is a large nation with 3,287,240 square kilometers, a geographical area of nearly 1.3 billion inhabitants. The majority of Indian States are very large in geographic and urban areas so the transmission of the disease must be treated separately in each state where the conditions are quite different (table 8) [100]. A student returning from Wuhan on 30th January 2020 detected the first case of COVID 19. In different countries in the world, the number of cases has since steadily increased. More than 10 million infections are confirmed and are now propagated in India from 22nd January 2021 [101]. The first infection date and history of travel in each Indian state for the infected person presented in fig. 8. Indeed, for the first time, a traveler from one or more contaminated COVID-19 countries has been observed in every union and territory except Assam, Tripura, Nagaland, Meghalaya, and Arunachal Pradesh [102]. All 22nd March 2020, on international flights to India by the Indian government imposed a total ban. Fig. 8 justifies government policy to suspend transcontinental flight in contrast [103]. Table 6 displays the Indian Government's effective preventive steps for preventing the growth rate of COVID-19 [100].

Table 6: Significant protective steps to monitor the dissemination of COVID-19 by the Indian Government [100]

Dates	Preventive measures adopted by Indian government	References
25th January to 13th March 2020	Health Screening at Airports and Border crossings.	[100]
26th February to 20th March 2020	Quarantine policies are introduced: step by step for travelers from various countries	[100]
26th February to 13th March 2020	Restrictions to Visa	[100]
05th March 2020	Limitation to Public Gathering (Museums and religious places)	[100]
11th March 2020	Border Checks	[100]
13th March 2020 to 15th March 2020	Border closure	[100]
16th March 2020	Limitation to Public Gathering	[100]
18th March 2020	Travel Restrictions	[100]
20th March 2020	Coronavirus disease testing	[100]
22nd March 2020	Flight Suspension	[100]
	Passenger Train Services canceled till 31st March 2020	[100]
24th March 2020	Flight Suspension (Domestic Airlines)	[100]
25th March 2020	21-day complete lockdown in the whole country	[100]
	Passenger Train Services canceled till 14th April 2020	[100]
25th March 2020	Increase of Quarantine and Isolation facilities	[100]
14th April 2020	Lockdown Extended nationwide until 03rd May 2020	[100]
01st May 2020	Lockdown Extended nationwide until 17th May 2020	[100]

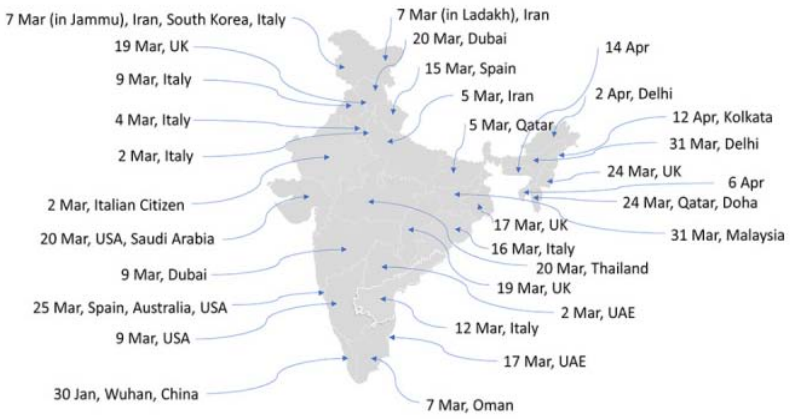


Fig. 8: The arrival of the first case in each State of India [100]

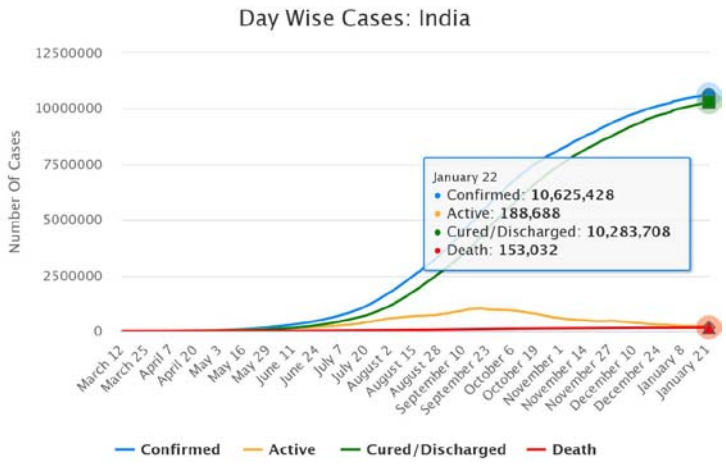


Fig. 9: Day wise different cases in India, 22nd January 2021 [101]

Presently, as COVID-19 statistics on 22nd January 2021, Maharashtra, Karnataka, Andhra Pradesh, Kerala, Tamil Nadu, Delhi, Uttar Pradesh, West Bengal, Odisha, and Rajasthan are among the top 10 states holding the most number of confirmed cases. The growth rate seems to have dropped in Kerala, as reported by the first COVID-19 event [104]. Table 7 presents the state-wise status of COVID-19 cases in India until 22nd January 2021[101]. Considering the top 10 most affected states in India among the 36 based on confirmed cases, active cases, cured cases, and death are presented in table 8. Fig. 9 illustrates the day-wise different types of cases in India and fig. 10 represents state-wise data of COVID-19 disease.

Table 7: Status of COVID-19 disease in India–state-wise data until 22 January 2021[101]

S. No.	State	Confirmed cases	Active cases	Cured/discharged cases	Deaths	References
1	Andaman and Nicobar Islands	4991	25	4904	62	[101]
2	Andhra Pradesh	886557	1522	877893	7142	[101]
3	Arunachal Pradesh	16816	38	16722	56	[101]
4	Assam	216940	2568	213295	1077	[101]
5	Bihar	258414	2923	254023	1468	[101]
6	Chandigarh	20639	146	20162	331	[101]
7	Chhattisgarh	295509	5638	286277	3594	[101]
8	Dadra and Nagar Haveli and Daman and Diu	3393	10	3381	2	[101]
9	Delhi	633276	2120	620374	10782	[101]
10	Goa	52712	865	51090	757	[101]
11	Gujarat	257813	5491	247950	4372	[101]
12	Haryana	266819	1679	262140	3000	[101]
13	Himachal Pradesh	57121	556	55595	970	[101]
14	Jammu and Kashmir	123764	1111	120729	1924	[101]
15	Jharkhand	118079	1032	115989	1058	[101]
16	Karnataka	934252	7573	914492	12187	[101]
17	Kerala	870529	69998	796986	3545	[101]
18	Ladakh	9673	73	9471	129	[101]
19	Lakshadweep	48	48	0	0	[101]
20	Madhya Pradesh	252767	4599	244392	3776	[101]
21	Maharashtra	2000878	46836	1903408	50634	[101]
22	Manipur	28938	220	28351	367	[101]
23	Meghalaya	13721	129	13446	146	[101]
24	Mizoram	4349	64	4276	9	[101]
25	Nagaland	12070	107	11875	88	[101]
26	Odisha	333866	1418	330545	1903	[101]
27	Puducherry	38772	299	37830	643	[101]
28	Punjab	171316	2343	163438	5535	[101]
29	Rajasthan	316081	3934	309391	2756	[101]
30	Sikkim	6062	148	5783	131	[101]
31	Tamil Nadu	833011	5196	815516	12299	[101]
32	Telangana	292835	3781	287468	1586	[101]
33	Tripura	33342	40	32911	391	[101]
34	Uttar Pradesh	597823	7717	581509	8597	[101]
35	Uttarakhand	95354	1876	91852	1626	[101]
36	West Bengal	566898	6565	550244	10089	[101]
India		10625428	188688	10283708	153032	

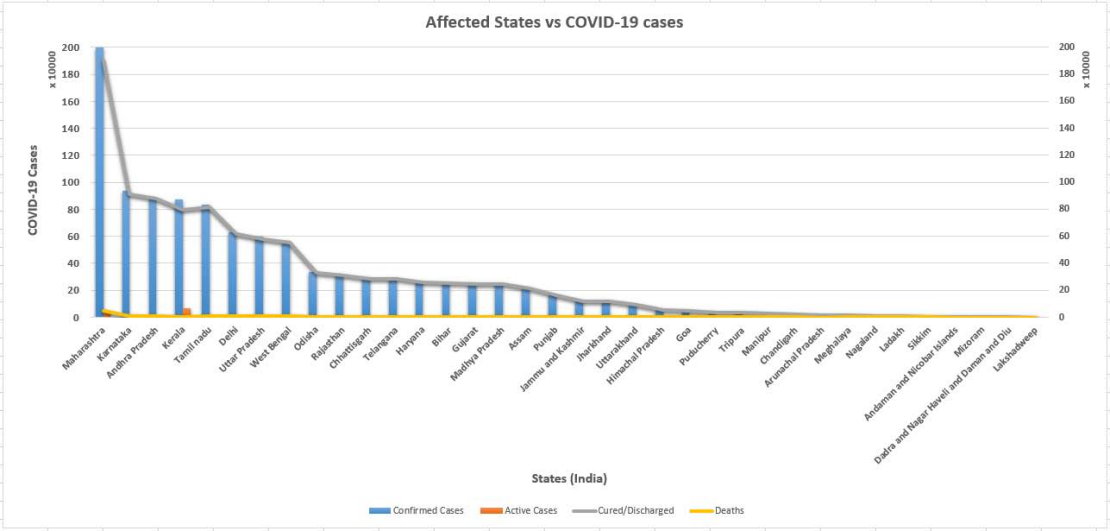


Fig. 10: Total cases of COVID-19 in various Indian states, 22 January 2021

Table 8: Top 10 most affected states in India until 22 January 2021

S. No.	Confirmed cases	Active cases	Cured cases	Deaths
1	Maharashtra	Kerala	Maharashtra	Maharashtra
2	Karnataka	Maharashtra	Karnataka	Tamil Nadu
3	Andhra Pradesh	Uttar Pradesh	Andhra Pradesh	Karnataka
4	Kerala	Karnataka	Tamil Nadu	Delhi
5	Tamil Nadu	West Bengal	Kerala	West Bengal
6	Delhi	Chhattisgarh	Delhi	Uttar Pradesh
7	Uttar Pradesh	Gujarat	Uttar Pradesh	Andhra Pradesh
8	West Bengal	Tamil Nadu	West Bengal	Punjab
9	Odisha	Madhya Pradesh	Odisha	Gujarat
10	Rajasthan	Rajasthan	Rajasthan	Madhya Pradesh

Variants of SARS-CoV-2: A Recent Update

The WHO Epidemiological report-COVID-19 published on 03rd January 2021, stated for the different variants of SARS-CoV-2, the virus that causes COVID-19, has again raised interest in and concern about the impact of the viral changes. In the last months, two distinct variants of SARS-CoV-2 have been reported to WHO as unusual public health events from the United Kingdom of Great Britain and Northern Ireland, referred to as VOC 202012/01, and the Republic of South Africa named 501Y. V2[59]. Preliminary epidemiological, modeling, phylogenetic, and clinical conclusions indicate that SARS-CoV-2 VOC 202012/01 rises in transmissibility and preliminary results also indicate no improvements in the seriousness of the disease (as calculated by hospital duration and 28d case fatality) or reinfection of variant cases in contrast to other circulating SARS-CoV-2 viruses in the United Kingdom[105]. To date, outside of the United Kingdom, 40 countries across five of the six WHO regions have reported cases of VOC 202012/01, while outside of South Africa six countries, in two of the six WHO regions have reported cases of 501Y. V2 [106]. Further epidemiological and virological investigations have been undertaken by the authorities in both countries to further determine the transmissibility of new variants such as seriousness, risk of reinfection, and antibody reaction, and their likely effect on countermeasures including diagnosis, treatment, and vaccine [107].

The decrease observed in the last week in new death has been reversed with deaths rising by 3% to 76,000 (fig. 11) [59]. The Region of the Americas accounted for 47% of all new cases and 42% of all new deaths globally in the past week. New cases and deaths remained high in the European Region, which accounted for 38% and 43% respectively, showing a slight decrease in new cases and a slight increase in new death. Recent cases and deaths continue to decline in the South-East Asia and Eastern Mediterranean regions. In African Region, while both new cases and deaths remain low in absolute numbers, for the fourth week in a row, the Region is reporting the largest percentage increase globally in weekly reported case numbers and there was a further 13% increase in new cases and 28% increase in new deaths. At the beginning of the year 2021, COVID-19 vaccination campaigns have been initiated worldwide. The current epidemiological situation with near-record numbers of new cases and deaths makes it imperative to go on adhere to safety measures to prevent further transmission and loss of life. Five countries which reported the highest amount of cases were the USA (with 1,325,424 cases, just under a third of global cases), the UK of Great Britain and Northern Ireland (3,43,784 cases, with a rapid increase of 36%), Brazil (2,52,018 cases, an 11% decrease), the Russian Federation (1,86,539 cases, a 7% decrease) and India (1,36,115 cases, a 13% decrease).

Case distribution: Graphical Analysis

(a) Total confirmed cases (Globally)

The graph describes the rise in 2019-ncoV confirmed cases globally from 21st January 2020 (282 cases) to 25th January 2021 (100,283,922) [97] (fig. 12). The rise in confirmed cases begins after 16th February 2020 and there has got a spike since 20th March 2020. Since then the total confirmed 2019-ncoV cases globally have been consistently increasing in a rapid form. The milestone for the worldwide-confirmed cases is given in table 9. Country-wise case distribution outside china and worldwide has been shown in fig. 13 and 14 (as reported by worldmeter, 17th January 2021) [95, 106].

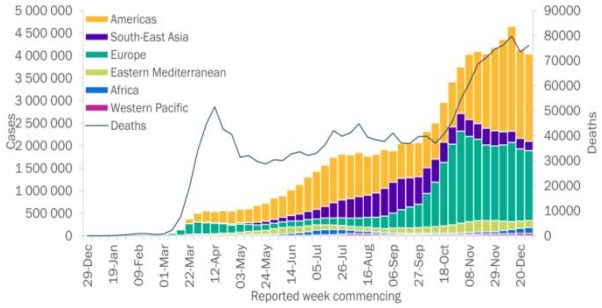


Fig. 11: Covid-19 global cases and deaths, reported weekly by who [59]

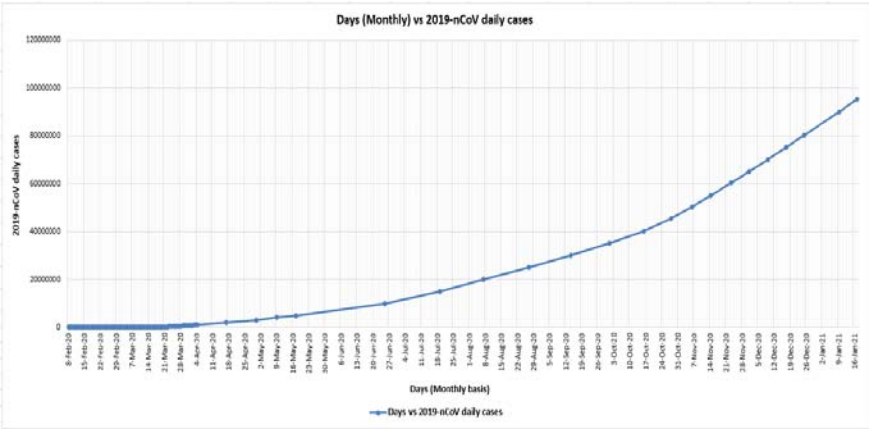


Fig. 12: 2019-nCoV confirmed cases globally, 17th January 2021

Table 9: Milestone for 2019-nCoV Global Cases

Dates	Milestone (Global Cases)
04th April 2020	Exceeded 1 million (1051697 cases)
17th April 2020	Exceeded 2 million (2074529 cases)
29th April 2020	Exceeded 3 million (3018681 cases)
09th May 2020	Exceeded 4 million (4098288 cases)
17th May 2020	Exceeded 5 million (5010291 cases)
25th June 2020	Exceeded 10 million (10024554 cases)
19th July 2020	Exceeded 15 million (15051517 cases)
07th August 2020	Exceeded 20 million (20014171 cases)
27th August 2020	Exceeded 25 million (25209843 cases)
14th September 2020	Exceeded 30 million (30143022 cases)
01st October 2020	Exceeded 35 million (35208481 cases)
16th October 2020	Exceeded 40 million (40270868 cases)
28th October 2020	Exceeded 45 million (45510562 cases)
06th November 2020	Exceeded 50 million (50421101 cases)
14th November 2020	Exceeded 55 million (55170426 cases)
23rd November 2020	Exceeded 60 million (60412853 cases)
01st December 2020	Exceeded 65 million (65070502 cases)
09th December 2020	Exceeded 70 million (70107969 cases)
17th December 2020	Exceeded 75 million (75330456 cases)
25th December 2020	Exceeded 80 million (80339800 cases)
02nd January 2021	Exceeded 85 million (85075159 cases)
09th January 2021	Exceeded 90 million (90102438 cases)
17th January 2021	Exceeded 95 million (95520875 cases)
25th January 2021	Exceeded 100 million (100283922 cases)

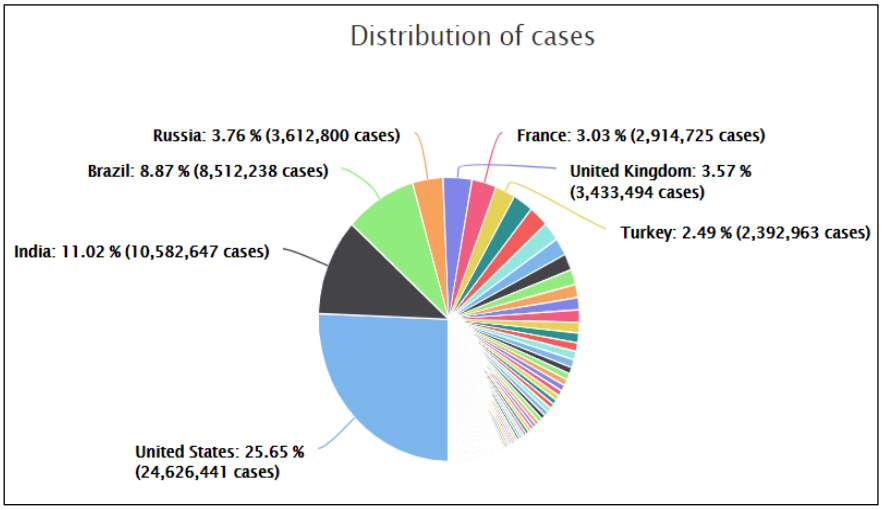


Fig. 13: Country-wise 2019-nCoV cases distribution (Outside china), 17th January 2021 [109]

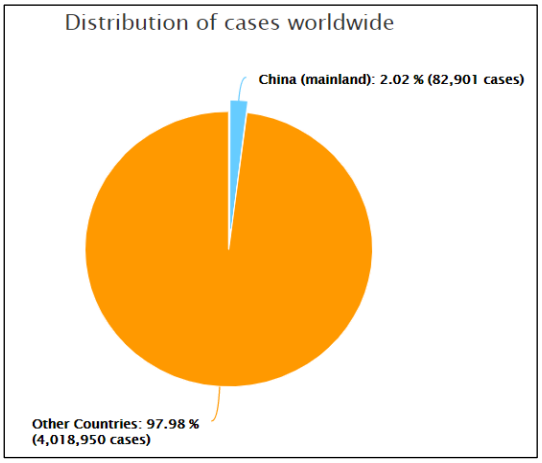


Fig. 14: Country-wise 2019-nCoV cases distribution (Worldwide) [108]

(b) Total death cases (globally)

Fig. 15 describes the total confirmed death cases globally due to the 2019-nCoV pandemic. Total lives are claimed by this deadly novel coronavirus from 23rd January 2020 until 17th January 2021 and were recorded as 2,149,311. The maximum rate of change in aggregate death was observed during its starting period on 24th January 2020 with an aggregate of 64%. After 07th April 2020, the rate change in absolute death was decreased gradually (<10%) and later on 24th April 2020 onwards almost consistent ranging from 1% to 3%.

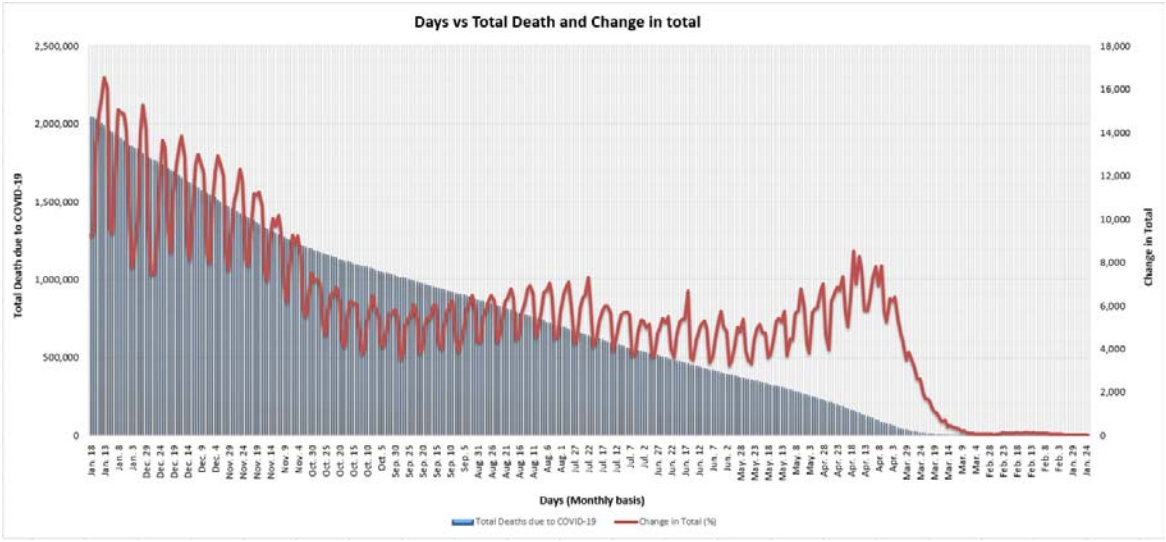


Fig. 15: 2019-nCoV total death globally and change in total (%), 17th January 2021

(c) Country affected due to COVID-19 (Top 60's)

Fig. 16 refers to the top 60 countries in the world which are most severely affected by 2019-nCoV. It reflects the cumulative number of cases and deaths in each country during the pandemic. The world's most powerful country has been harshly affected having the highest number of COVID-19 cases (25,862,957) and death (431,407) respectively as reported by Worldometer on 25th January 2021 [97]. The second-highest number of confirmed cases was reported in India (10,677,710) and the death toll in Brazil (217,712). The worst death toll and cases reported in different countries of Europe, Asia, North America, South America, Africa, and Oceania continents are shown in table 10. In China, from where the outbreak story was started, reported 89,115 cases and 4,635 death. Among the Asian countries, India lies in the second position next to the USA with total cases of 10,677,710 and 153,624 deaths.

Table 10: Most severely affected countries in different continents, 25th January 2021

Continents	Country most severely affected	
	Total cases	Total deaths
Europe	Russia (3738690), UK (3669657)	UK (98,531), Italy (85,881)
Asia	India (10677710), Turkey (2,435,247)	India (1,53624), Iran (57,481)
North America	USA (25,862,957), Mexico (1,763,219)	USA (431407), Mexico(149614)
South America	Brazil (8,872,964), Colombia (2,027,746)	Brazil (217,712), Colombia (51,747)
Africa	South Africa (1,417,537), Egypt (162,486)	South Africa (41,117), Egypt (9,012)
Oceania	Australia (28,777), French Polynesia (17,912)	Australia (909), French Polynesia (129)

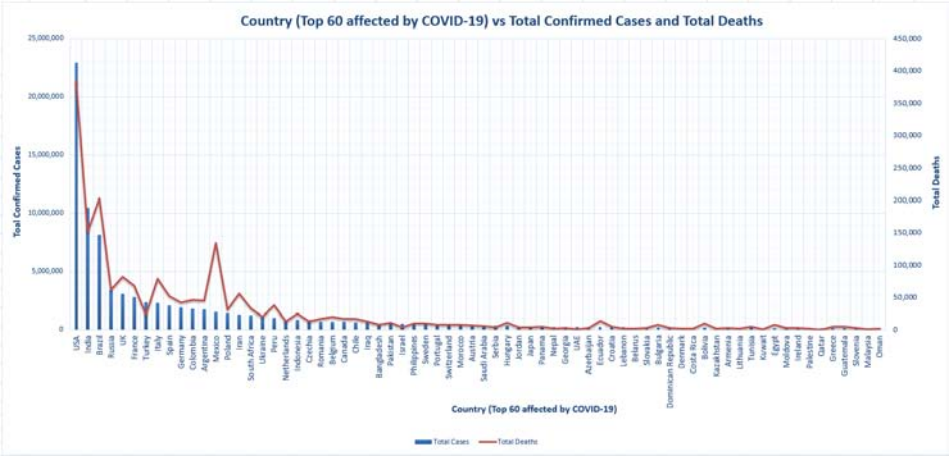


Fig. 16: 2019-nCoV total cases and deaths country wise (arranged in descending order), 17th January 2021

(d) Daily Cases Growth Factor (Globally)

A growth factor is the factor of growth in which the quantity multiplies over time [110]. It expresses as:

Growth Factor = New Cases (Present Day)/New Cases (Previous Day)

A growth factor above 1 implies a rise, whereas between 0 and 1 is a symbol of the decrease and the number gradually becomes zero, whereas a growth factor above 1 continuously may be an indicator of exponential growth. For example, a quantity growing by 7% every period (daily) has a growth factor of 1.07[108]. Fig. 17 represents the growth factor curve for daily new cases worldwide from 24th January 2020 to 25th January 2021[111]. The observed peaks in the growth factor curves represent the hikes in daily-confirmed cases of COVID-19. The maximum rise in everyday cases growth factor was observed on 12th February 2020 with a peak value of 6.95 and a second maximum on 27th January 2020 with a peak value of 2.27. On 25th January 2021, the daily cases have been recorded as less than 1, i.e., 0.93, which signifies the sign of decline in the rate of daily new cases. However, it has to be noted that the maximum rise in daily cases growth factor was observed during the starting period of the pandemic.

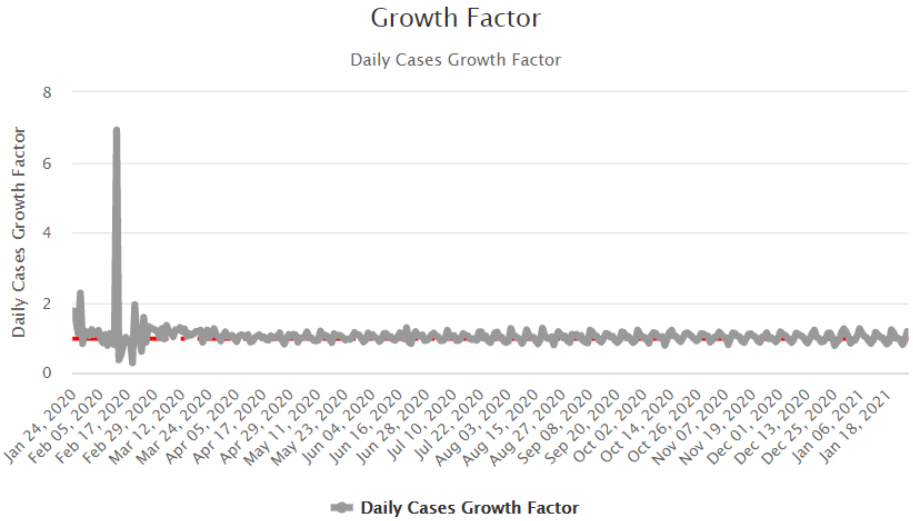


Fig. 17: 2019-nCoV worldwide daily cases growth factor, 25 January 2021 [111]

COVID-19 vaccination: An Overview

The worldwide endeavor to set up a safe and effective COVID-19 vaccine is bearing fruit. WHO started work on COVID-19 vaccine research and development in February 2020, after consultation with multiple scientists and health experts [112]. The COVID-19 Vaccines Global Access (COVAX) facility was established by WHO in collaboration with the ACT-Accelerator vaccine partners the Coalition for Epidemic Preparedness Innovations (CEPI) and Gavi, the Vaccine Alliance [113]. The motive behind the establishment of COVAX is to bring the nation together, regardless of their income level, to ensure the procurement and equitable distribution of COVID-19 vaccines. Since the vaccine resources remain scarce, therefore, immunization programs have to prioritize certain age groups over others before expanding their distribution to all population groups [114]. The prioritized groups include:

(i) Frontline Workers in Health and social care settings

(ii) People having age ≥ 65

(iii) People having age<65, having underlying health conditions leading to the death risk.

As determined by the WHO Strategic Advisory Group of Experts the immunization will be carried out for prioritized groups in different phases as described in table 11.

Table 11: Phases of immunization [113]

Phases	Description	References
Phase I	Doses will be made available to participating countries simultaneously until they cover approximately 20% of the population. In most countries, the firstly prioritized group includes the frontline workers in health and social care settings.	[113]
Phase II	The pace at which countries will receive additional dosage would be analyzed by risk assessment at any given time. Consideration will be based on threat, vulnerability (health care system and population). Special consideration to those countries that may suddenly face a major outbreak of the disease throughout the allocation process.	[113]
Humanitarian Buffer	In addition to the vaccine allocation in Phase I and II, some doses of vaccines will be reserved as part of the humanitarian buffer.	[113]
	A small buffer of up to 5% of the total number of available dosages will be considered as a buffer for the vulnerable population which may include Refugees, Migrants, Detainees, Asylum seekers, and workers involved in these settings.	[113]

The major WHO vaccinations and immunization consulting group are the Strategic Expert Advisory Group (SAGE). The production, development, and distribution of vaccines are taken care of by SAGE providing independent experts advice and recommendations towards safe and equitable distribution of the approved vaccines [114, 115]. A handful of vaccines now have been authorized around the globe, and many more remain in progress. Table 12 presents the details of vaccines that have achieved authorization and approval for vaccination. Table 13 is the list of vaccines in Phase 1-3 clinical trials [112].

Table 12: List of approved/authorized vaccines

Name	Vaccine type	Primary developer	Origin country	Approval	References
Comirnaty (BNT162b2)	mRNA-based vaccine	Pfizer, BioNTech; Fosun Pharma	Multinational	United Kingdom, Bahrain, Canada, Mexico, US, Singapore, Costa Rica, Ecuador, Jordan, Panama, Chile, Oman, Saudi Arabia, Argentina, Switzerland, Kuwait, EU, Philippines, Pakistan, Colombia, Iraq, Israel, Qatar, Singapore, United Arab Emirates, Faroe Islands, Greenland, Iceland, Malaysia, Norway, Serbia	[112]
Moderna COVID-19 Vaccine (mRNA-1273)	mRNA-based vaccine	Moderna, BARDA, NIAID	US	Canada, Israel, Saudi Arabia, Switzerland, United Kingdom, United States, EU, Faroe Islands, Greenland, Iceland, Norway	[112]
CoronaVac	Inactivated vaccine	Sinovac	China	China, Bolivia, Turkey, Indonesia, Brazil	[112]
COVID-19 Vaccine AstraZeneca (AZD1222)	Adenovirus vaccine	BARDA, OWS	UK	UK, Argentina, El Salvador, Dominican Republic, India, Bangladesh, Mexico, Nepal, Pakistan, Brazil, Saudi Arabia, Iraq, Hungary, Thailand	[112]
Sputnik V	Non-replicating viral vector	Gamaleya Research Institute, Acellena Contract Drug Research and Development	Russia	Russia, Belarus, Argentina, Guinea, Bolivia, Algeria, Palestine, Venezuela, Paraguay, Turkmenistan, Hungary, UAE, Serbia	[112]
BBIBP-CorV	Inactivated vaccine	Beijing Institute of Biological Products; China National Pharmaceutical Group (Sinopharm)	China	China, Bahrain, United Arab Emirates, Egypt, Jordan, Iraq, Pakistan, Serbia	[112]
EpiVacCorona	Peptide vaccine	Federal Budgetary Research Institution State Research Center of Virology and Biotechnology	Russia	Russia	[112]
Covaxin	Inactivated vaccine	Bharat Biotech, ICMR	India	India	[112]

Table 13: List of approved/authorized vaccines in trial phase II and III

Candidate	Mechanism	Sponsor	Trial phase	Institution	References
JNJ-78436735 (formerly Ad26. COV2. S)	Non-replicating viral vector	Johnson and Johnson	Phase III	Johnson and Johnson	[112]
NVX-CoV2373	Nanoparticle vaccine	Novavax	Phase III	Novavax	[112]
Convidicea (Ad5-nCoV)	Recombinant vaccine (adenovirus type 5 vector)	CanSino Biologics	Phase III	Tongji Hospital; Wuhan, China	[112]
Bacillus Calmette-Guerin (BCG) vaccine	Live-attenuated vaccine	University of Melbourne and Murdoch Children's Research Institute; Radboud University Medical Center; Faustman Lab at Massachusetts General Hospital	Phase II/III	University of Melbourne and Murdoch Children's Research Institute; Radboud University Medical Center; Faustman Lab at Massachusetts General Hospital	[112]
INO-4800	DNA vaccine (plasmid)	Inovio Pharmaceuticals	Phase II/III	Center for Pharmaceutical Research, Kansas City. Mo.; University of Pennsylvania, Philadelphia	[112]
VIR-7831	Plant-based adjuvant vaccine	Medicago; GSK; Dynavax	Phase II/III	Medicago	[112]
CVnCoV	mRNA-based vaccine	CureVac	Phase II/III	CureVac	[112]
ZyCoV-D	DNA vaccine (plasmid)	Zydus Cadila	Phase II	Zydus Cadila	[112]
BNT162	mRNA-based vaccine	Pfizer, BioNTech	Phase I/II/III	Multiple study sites in Europe, North America and China	[112]
IIBR-100	Recombinant vesicular stomatitis virus (rVSV) vaccine		Phase I/II	Hadassah Medical Center; Sheba Medical Center Hospital	[112]

CONCLUSION

The growing number of cases involving 2019-nCoV and the global distribution of the disease raises questions about the future mechanism of the disease. The 2019-nCoV epidemic has prompted numerous nations to take unprecedented steps to curb the dissemination of the virus in the public health system. Such as India implemented nationwide lockdown-Phase I on 24th March 2020 for 21days which needed to be further extended to phase II from 15th April 2020 to 03rd May 2020 and then to phase III commenced from 04th May till 17th May 2020. Similarly, execution of Movement Control Order (MCO) in Malaysia from 18th March 2020 to 09th June

2020. To prevent further disease spread, travel controls were introduced followed by the suspension of transport by airports, train stops, and roads. However, COVID-19 has already crossed the outbreak of SARS by the number of affected cases and death tolls. Taking account of the financial effect, global production was anticipated to grow modestly by 2.5% in 2020 before the COVID-19 outbreak according to the World Economic Situation and Prospects for 2020. However, after the COVID-19 global pandemic, World Economic Forecasting Model, has estimated the worst scenario for global growth in 2020, i.e., the global output would contract by almost 1% with an economical effect of much larger than $360 billion [39].

Besides, details of epidemiological properties, including animal resource recognition and risk factor, are vital to the prevention of COVID-19 outbreaks [115]. The middle hosts with the disease are important not only to diagnose the existing epidemic but also to avoid a potential outbreak. Education programs should be put in place to encourage public precautions, including regular hand washes, cough labels, and the use of personal wearing facial masks and hand sanitizers during public visits. Public safety initiatives should be deployed in this area. Active screening must be carried out for new cases and carefully monitoring their interactions [114]. To improve detection efficiency, hospitals and clinics should be armed with diagnostic kits. Beyond supportive care, the chase for COVID-19 vaccination is equally vital. Although no registered COVID-19 treatment or vaccine is available at this time. Many clinical trials have already been initiated and many on their way for testing [117]. For example, Oxford University has begun the Phase-1 Human Clinical Trial of its vaccine ChAdOx1 nCoV-19 against COVID-19 on 23rd April 2020 [118]. On 02nd April 2020, the University of Pittsburgh School of Medicine also announces the clinical trial of the developed vaccine, PittCoVacc (Pittsburgh Coronavirus Vaccine) against the COVID-19 pandemic [119]. Similarly, Novavax, Inc., a clinical stage biotechnology company, announced the first in a human trial of their vaccine NVX-CoV2373 in mid-May [120]. Recent work on Bacillus Calmette-Guerin (BCG-CORONA) vaccine to fight against COVID-19 disease has been carried out in conjunction with the University of Melbourne's Murdoch Children's Research Institute (Australia), the Radboud University Medical Center in The Netherlands and Massachusetts General Hospital (The United States) Faustman Lab. BCG was already developed vaccine against tuberculosis. However research studies have shown its potential in preventing acute respiratory tract infections. Based on this hypothesis, the efficacy BCG vaccination is under study to evaluate its potential for protection against the severity of COVID-19 infection [119, 120].

Currently, Zhang and Liu [123] proposed that the status of COVID-19 affected patients to be reviewed before monitoring general therapies for their nutritional presence (Vitamins A, B, C, D, E, Selenium, Zinc, and Iron) as it could lead to the treatment of COVID-19 in the emergency medical assistance. Even the possible antidote to this new coronavirus can be regarded as unique antivirals, which were highly successful in treating SARS-CoV and MERS-CoV [124]. The development of the SARS vaccine has already attracted the attention of many scientists for the treatment of COVID-19 illness. SARS-CoV is identical to the avian infectious bronchitis virus (A-IBV) and both belong to the same family [125]. Bijlenga *et al.* [126] proposed using the IBV (strains H) avian live virus vaccine in 2005 for the treatment of SARS. Therefore, the IBV vaccine approach may also be effectively considered as a treatment against COVID-19 infection. However, preliminary tests on animals should be taken into consideration before the startup. In comparison, passive immunotherapy can be called Convalescent Plasma [127]. This therapy is frequently adopted where no special vaccines or medicines are accessible for new pathogens infected with viruses, as with the latest pandemic scenario. Arabi *et al.* [128] tested the efficacy and therapeutic safety of the convalescent plasma treatment in chronically ill patients with MERS. Depending on their results, convalescent plasma had an immunotherapy capacity to treat an infection of MERS-CoV. In the treatment of SARS-CoV patients, convalescent plasma retrieved from SARS patients was also stated clinically helpful [129, 130]. Prominently, WHO has also suggested the use of convalescent plasma or serum when vaccines or antiviral drugs are not available for an emerging virus such as a 2019-nCoV [123]. Lastly, as children are often infected by SARS-CoV, the RNA-virus vaccine program helps them in treatment against this infection. Vaccines associated with RNA viruses include measles, polio, Japan's encephalitis virus, influenza virus and vaccine associated with rabies [131]. Therefore, RNA-virus vaccines may be considered as a promising alternative towards COVID-19 treatment and prevent transmission between people by immunizing health workers and non-infected people.

As a concluding remark, as there are many unknowns yet to be explored with SARS-CoV-2 and the whole world is currently engaged in a challenging battle with an unseen enemy-COVID-19, the time to act is now. As stated in table 12 and 13 about the approved vaccines and vaccines under clinical trials, which shows that the whole world has united in the combat against COVID-19 and come up with a united effort to defeat and win this combat making the world as free, happier, healthier and livable place as it was before COVID-19.

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AUTHORS CONTRIBUTIONS

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CONFLICTS OF INTERESTS

The authors declare that they have no conflict of interest.

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