Coronavirus Disease 2019 (COVID-19) pandemic, lessons to be learned!

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ABSTRACT

Coronavirus Disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been reported as a worldwide emergency. Due to the extensiveness of spread and death, it has been declared as a pandemic. This review focused on the current pandemic situation and understanding the prevention and control strategies of COVID-19. Data presented here was by April 3, 2020. A total of 1,016,399 cases of COVID-19 with 53,238 deaths was reported from 204 countries and territories including two international conveyances over the world. After China, most of the new cases were from Europe, particularly Italy acting as the source of importation to many of the other countries around the world. China has obtained success by ascribing control strategies against COVID-19. The implementation of China’s strategy, as well as the development of a vaccine, may control the pandemic of COVID-19. Further robust studies are required for a clear understanding of transmission parameters, prevention, and control strategies of SARS-CoV-2. This review paper describes the nature of COVID-19 and the possible ways for the effective controlling of the COVID-19 or similar viral diseases that may come in the future.

Introduction

Under the Coronaviridae family, coronavirus possesses enveloped, single-stranded Gram-positive RNA genome which has been detected in avian hosts and mammals, including bats, camels, civets, dog, and cats [1–3]. Among previously known several coronaviruses, most are mild pathogenic to humans [1], but Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) and the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) caused severe human infection [4]. In Guangdong, Southern China, a betacoronavirus: SARS-CoV arose in November 2002 [5] and caused 774 deaths in 37 countries with more than 8,000 human infections [6]; and MERS-CoV first emerged in Saudi Arabia in 2012 [7] with 2,494 human cases constituting 858 deaths, besides, 38 deaths were recorded in South Korea through a single introduction [8,9]. Several patients with pneumonia-like respiratory illness were recognized in late December 2019 in Wuhan, Hubei (a province of China) [4,6]. Epidemiologically, they were connected with Human wet market where multifarious non-aquatic birds and rabbits were sold [6]. Although doctors couldn’t trace the cause at the beginning, a novel human infecting coronavirus was identified as the etiology in the first week of January 2020 [4,10–15] using next-generation sequencing [10,16]. WHO named the virus provisionally as 2019 novel coronavirus (2019-nCoV) [17], followed by renaming as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) based on the rule of international committee on taxonomy of viruses (ICTV) [18,19]. Before that, the virus was recognized as a sister to SARS-CoV [19]. The name SARS-CoV-2 was approved by ICTV based on the similarities of genetic characteristics with the previous coronavirus that caused the outbreak of SARS, 2003 [18]. Finally, based on severity, spread, transmissibility, prevention, and treatment, WHO named the disease as Coronavirus Disease 2019 (COVID-19) in the international classification of diseases [15,18].

Due to the importation of COVID-19 from epidemic states and countries to different states and countries, the disease spread, transmissibility, prevention, and treatment, WHO named the disease as Coronavirus Disease 2019 (COVID-19) in the international classification of diseases [15,18].

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has spread throughout China and all over the world in a short time, though the outbreak was recognized in Wuhan [19–26]. Because of fast-spreading, COVID-19 has affected 204 countries and territories including two international conveyances [27]. WHO declared the COVID-19 disease as a global pandemic by observing the enormous number of cases and colossal deaths with the concatenate of social operations and huge economic losses throughout the world [27,28]. Furthermore, WHO also declared that Europe has become the new epicenter of COVID-19 on March 13, 2020, due to the deadly run through the European countries [29]. An implausible number of deaths has made the coronavirus pandemic as death toll over the world.

Human-to-human transmission among a cluster of people including doctors and healthcare workers is augmenting the piquancy of COVID-19 with the mild-to-severe sign-symptoms [14,23]. Although the extensiveness of spread and death rate has differed among SARS, MERS, and COVID-19 outbreak, the sign and symptoms with transmission patterns are similar [30]. Several studies found the similarities in the transmission pattern by droplet and contact (direct and indirect) transmission among the SARS-like viruses [31–33]. The transmission of viruses is under the influence of many factors, such as environmental temperature, humidity, and population density [11,12]. However, no effective medications and vaccines are developed against SARS-CoV-2 though different research groups over the world are trying to develop vaccines and antiviral drugs [34]. Thereafter, every nation is providing their best endeavors to alleviate the extensiveness of COVID-19.

As a strategy to prevent and control the intensification of COVID-19, China started to take an extreme level of strategies such as extreme lockdown, transmission route blocking, and susceptible population protection, followed by other nations are trying to follow China’s strategies [35,36]. However, the present review focused on the current outbreak situation of COVID-19 and described the prevention and control strategies.

Selection criteria

The current review included peer-review articles focusing on human coronaviruses, including SARS, MERS, and COVID-19 virus with their epidemiology, transmission dynamics, and current situation of the outbreak, and prevention and control measures. We also extracted the information from relevant websites for current situation reports of the outbreak. No language limit was for information acquisition. There was a strong focus on the most recent published data.

Information sources and search strategy

The present review was conducted using PubMed, Scopus, Google Scholar, Research Gate, Web of Sciences, Elsevier, Nature, WHO, and Worldometer. The keywords used here were: “COVID-19,” “SARS,” “MERS,” “SARS-CoV-2,” “Coronavirus,” “2019 nCoV,” “Pandemic,” “Wuhan coronavirus,” “First New Case,” “Prevention,” “Control,” and “China’s Control Strategies” or a combination among these. The searches were between March 29, 2020, and April 3, 2020, by individual researchers, and then all the collected data were coordinated.

Data incorporation

The searched articles were screened initially by title and abstract in context to the interest of the study. To find out the current scenario of COVID-19 outbreak, prevention, and control strategies across the globe, the total number of confirmed cases, death cases, and recovery cases [27,37] were documented in Supplementary Table 1. To analyze the first imported case in countries, importation sources [27,37] were listed in Supplementary Table 2.

Epidemiology

There were so many lessons for China during and after the SARS outbreak in the Southern part of the country in 2002. As a part of continuous research, in March 2019, research studies from China warned about the possible future SARS-like outbreak in China from bat [38]. Wild animals including bats, snakes, and others were sold in a seafood market at Huanan in Wuhan, primarily was declared as the source of infection but environmental specimens from the market were found to carry SARS-CoV-2 [39]. But the animal association is not confirmed yet. Initially, snake was thought to be a potential reservoir but researchers rejected the option [40]. The whole-genome sequence of SARS-CoV-2 and other available Betacorona virus revealed a close relation with BatCov RaTG13 with 96% similarity [11,41–44]. In the beginning, confirmed patients had a history of working in the market [45]. Human-to-human transmission through droplets and fomites was noticed in many patients having no association with the market. Besides, the infection to healthcare workers strongly indicated the high human-to-human transmission through droplets and fomites and direct contact [46–48]. The other provinces of China were infected through the importation of cases from Hubei province. Initially, some countries reported imported cases, later on, local transmission. Finally, importation among the countries and to new countries continued sharply, leads the outbreak towards pandemic. From the outset, newly infected countries reported their first case was imported from China as expected, thereafter, most of the countries announced their first patient traveled from Europe particularly, Italy (Supplementary Table 2). Besides, the neighboring country was also the source of importation in some cases (Supplementary Table 2). Europe has been declared as the epicenter of the pandemic.
by WHO [29], data of Supplementary Table 2 suggested the same.

**Current case reports**

A total of 1,016,399 cases of COVID-19 with 213,133 (80%) recovered and 53,238 (20%) deaths have been reported from 204 countries and territories along with two international conveyances all over the world by April 3, 2020 (Supplementary Fig. 1) [49]. USA reported the highest 245,373 number of cases, whereas Italy (115,242), Spain (112,065), Germany (84,794), China (81,620), France (France), Iran (50,468), and UK (33,718) were mostly affected [37]. The active cases are 750,028 where 712,373 (95%) were mild and 37,655 (5%) were serious or critical cases. The critical cases were mostly in France (6,399) followed by Spain (6,092), USA (5,421), Italy (4,053), Iran (3,956), and Germany (3,936). Although critical cases were high in China, the numbers are decreasing in the prospected way but increasing outside China particularly, in the USA and most European countries [37]. The numbers of new cases were always more than the recovery number. Since China has managed to prevent the spread of the virus and was discharging a large number of recoveries every day, the daily recovery number increased over the new cases. However, the number of confirmed cases is augmenting day by day. This is due to the huge number of new patients in the USA, European countries, Iran [37]. Overall, the number of confirmed cases was reported more in Europe than in other regions of the world (Supplementary Fig. 2) [50].

**Viability, incubation period, and symptoms**

Although viruses need a living host to survive and replicate, SARS-CoV-2 remains viable outside the living body and persist on different environmental conditions for several hours to days (Table 1). This virus remains more viable on stainless steel and plastic compared to aerosols, copper, and cardboard [51]. That’s why the way of transportation, food products, food containers, house doors, elevator buttons, cellphone screens, glass windows, hospital beds, etc. can act as the source of indirect contact transmission of SARS-CoV-2 [52].

Although COVID-19 produces signs and symptoms in the infected individuals within 1–14 days, the average period is 5–6 days. Within this average time, fever and mild respiratory symptoms may be developed in affected individuals [43].

The WHO-China Joint Mission has reported on signs and symptoms of COVID-19 and they revealed that the disease can cause non-specific symptoms, including asymptomatic to severe pneumonia, followed by death [53]. The joint mission indicated that the signs and symptoms can vary according to their laboratory findings collected from 55,924 confirmed cases by 20 February 2020 [53]. The signs and symptoms with their occurrence are shown in Figure 1.

**Mortality**

Among total cases, the mortality of COVID-19 was 5.2% (total death/total confirmed cases) quite lower than SARS (9.6%) and far away from MERS (34%) and Ebola (65.7%) [30,37,54]. The highest deaths were in Italy (13,915) followed by Spain (10,348), USA (6,095), France (5,387), China (3,322), Iran (3,160) and UK (2,921) (Supplementary Fig. 3) [55]. Daily new deaths are increasing in these countries except Chine (Supplementary Fig. 4) [37,55]. There are fluctuations of death based on age, country, and date. In context to sex, male death (2.8%) was higher than female (1.7%) among all cases and males were infected more than female [56]. The SARS study also revealed similar findings in relation to sex [57]. This may be due to the presence of gene for angiotensin I converting enzyme-2 (ACE-2) receptor and the host receptor for SARS found on the X chromosome and more tendency of males to smoke which results in lung damage [58–60]. Patients suffering from cardiovascular disease, diabetes, chronic respiratory disease, hypertension, cancer and elderly immunosuppressed people [61], are the most susceptible to critical cases of COVID-19 and death (Table 2) [56]. Only 0.9% of death was not associated with any pre-existing medical conditions [56].

**Is there any effect of temperature and humidity on COVID-19 transmission?**

There is speculation that climatic factors, such as temperature and humidity can affect the transmission of SARS-like viruses. Recent several studies indicated the effectiveness of temperature and humidity on SARS-CoV-2 though the data were collected during the pre-stage outbreak [62–64]. In the progression of pandemic, the outbreak is occurring in a few countries having high temperature, such as India, Malaysia, and Brazil, etc. On the other hand, some

| Environmental conditions | Viability time | Median half-life | References |
|--------------------------|---------------|-----------------|------------|
| Aerosol                  | Up to 3–4 h   | 1.1–1.2 h       | [51,52]    |
| Plastic                  | Up to 72 h    | 6.8 h           |            |
| Stainless steel          | Up to 72 h    | 5.6 h           |            |
| Copper                   | Up to 4 h     | 0.8 h           |            |
| Cardboard                | Up to 24 h    | 3.5 h           |            |
| Glass                    | Up to 96 h    | –               |            |
countries, such as Japan and South Korea having low temperatures showed a limited outbreak [37]. These exceptions interpret that the virus transmission may depend on the taken interventions by governments. Besides, the transmission can be influenced by population density, awareness of people, economic strength, and health system of a country. Therefore, we can’t directly relate the influence of temperature on the transmission of SARS-CoV-2. Robust studies should be taken to clarify this vague situation.

Prevention and control

To limit the loss associated with COVID-19 and stop its spread, immediate control measures are crucial [65].

Travel history is very important for the early detection of SARS-CoV-2 to prevent the local transmission [66]. In the present situation, travelers from the infected areas are the main route of virus entry to a new country. WHO stated several recommendations for travelers’ particularly international passengers in relation to the current outbreak [67]. WHO suggests only temperature screening at entry or exit, is always not enough to prevent international spread, since infected people may be in the early stage of the disease (incubation period) and may not show apparent symptoms, or may use antipyretics to dissimulate fever. In the current situation, it is better to collect contact details of passengers, detailed information where to move for contact tracing and provide a health card with details of what to do if the individual feels to notify authority, and best to quarantine individuals who came from the affected areas. Individual country can discourage their people to travel to an affected area if not emergency [67]. Many of the countries have already restricted the entry of flights from COVID-19 affected countries and issuing an on-arrival visa. Force institutional and home quarantine is also in function where required. Besides, universities, schools, and collages are now closed in many parts of the world to combat COVID-19. To control the local transmission, reducing human-to-human transmission through droplets and contact is crucial. WHO recommendations on virus control interventions to lower the general risks of spread includes avoiding close contact with confirmed or suspected patients or a traveler from the infected area; hand hygiene through the frequent wash with sanitizer.

Table 2. The mortality rate of COVID-19 based on age (reproduced from Worldometer [56]).

| Age (Year) | Death rate(confirmed cases) | Death rate(all cases) |
|-----------|-----------------------------|-----------------------|
| 80+       | 21.9%                       | 14.8%                 |
| 70–79     | 8.0%                        |                       |
| 60–69     | 3.6%                        |                       |
| 50–59     | 1.3%                        |                       |
| 40–49     | 0.4%                        |                       |
| 30–39     | 0.2%                        |                       |
| 20–29     | 0.2%                        |                       |
| 10–19     | 0.2%                        |                       |
| 0–9       | No fatalities               |                       |

Figure 1. Signs and symptoms of COVID-19 with their occurrence according to WHO-China joint mission, 2020 (reproduced from WHO [53]).
particularly after exposure with affected people or with their environment. Besides, affected people should use protective devices during coughing, keep up a distance, and follow the nation’s health tips. Following other updates and recommendations of WHO is important. Previous knowledge of MERS and SARS control is also useful [67], since COVID-19 is a member of the same group of viruses. Although knowledge dissemination is needed, the government should be careful about the misinformation and clarify them. Finally, the sharing of authentic knowledge and technologies, and health care facilities among the countries will be helpful.

Coronavirus changes its immunogenic structures frequently as COVID-19 has emerged after changing its antigenic structures several times. Thus, targeting a protein structure present in the virus that is comparatively stable can be a possible way for developing vaccine against COVID-19. Recently, Ahmed et al. [68] identified a set of B cell and T cell epitopes in the spike (S) and nucleocapsid (N) proteins that potentially offer protection against this novel virus. Interestingly, there was no mutation found in these epitopes considering the 120 available SARS-CoV-2 sequences [68].

China strategy

China aimed at COVID-19 control as the priority at all levels of government. China already has proved that COVID-19 is controllable and they reported only 31 cases on April 3, 2020. To control the disease, China undertook three phases that could be adopted by other countries currently having COVID-19 outbreaks (Fig. 2) [53]. Here, we focused on China strategy because it was the country where the first epidemic started. It was also the first success story too. Moreover, compared to other countries, much more people were affected in China. Basic approaches in Korea, Japan, and Norway who also controlled COVID-19 epidemic later were quite similar to China primarily focusing on test, isolation, and quarantine.

First phase

The first phase focused on the prevention of the spread of the virus from the epicenter Wuhan and other infected areas of Hubei to other provinces, therefore, aimed to control the infection source, stop transmission, and prevent further spread. Multi-sectoral approaches were taken for the prevention and control of the disease. Wet markets were identified and closed and necessary steps were taken to identify the zoonotic connection; strict supervision, and control measures were also made for live poultry and wildlife markets. They informed WHO about the epidemic on January 3, 2020, and also shared the whole genome sequence of SARS-CoV-2 on January 10, 2020. Besides, they established diagnostic and therapy, surveillance, management of exposure and laboratory detection protocols for COVID-19 and developed diagnostic kits for the test.

Figure 2. Major steps of the China strategy in brief (reproduced from WHO [53]).
Second phase

The second phase aimed to reduce the number of new cases as well as to treat patients, reduce deaths, and prevent explorations in Wuhan and nearby priority areas in Hubei province. The main focus of the other provinces was to prevent importations, curb the spread, and implement the joint control measures. The Chinese government categorized the COVID-19 as two types: Class B infectious disease and border health quarantine infectious disease based on the notifiable report on January 20, 2020. They attributed strong transportation law to prevent the transmission of disease by checking body temperature, declaring health care approbation, and practicing quarantine at the transportation depots. Moreover, on 23 January 2020, the Wuhan government implemented strict traffic restrictions. With the progress of the disease, diagnostic, treatment, and other associated protocols were improved; isolation of case and treatment of patients were strengthened. The public movement was restricted. Medical knowledge dissemination was strengthened and prevention and control measures were regularly released. New hospitals were built, medical supplies were coordinated and the best use of all other resources was done. The supply of daily needs and their prices were strictly monitored to make sure smooth daily operation of society.

Third phase

This stage focused to reduce the clusters of cases, introducing a scientific evidence-based policy for prevention and control. Patients in Wuhan and other potentially risky areas of Hubei province, patients were treated carefully to reduce virus transmission. A differentiated prevention and control measures were adopted for different regions of the country and provinces based on the level of risk they were exposed. Sophisticated hitch technologies, such as Big-data and artificial intelligence were used for strengthening contact tracing along with the management of priority populations. Health insurance payment, off-site settlement, and financial compensation were promulgated as a part of the better health management system. Other provinces supported in all ways to curb quickly the spread of the disease. Steps were being taken to re-establish the normal social activities in a stepwise fashion along with improving public awareness on disease prevention and control, and public health. Besides, research and development activities focusing on development of diagnostics, therapeutics, and vaccines were adopted.

Why European countries including the USA failed to control COVID-19?

A collective failure in taking swift measures in time and being unconcerned leads to enormous and unnecessary deaths to the public due to the coronavirus disease. Among European countries, Italy first faced the serious and disastrous outbreak of COVID-19. For the severity of the disease, lacking concern along with having a huge aged population are considered as foremost causes. The government failed to enforce full lockdown in time. Furthermore, the decision to lockdown northern Italy was leaked before being approved and the people started to escape from North to South. This may have caused the rapid spread of the virus. Besides, failure to rule proper social distance also made a big role in the spread of COVID-19. They failed to track contact tracing, comprehensive testing, and self-isolation.

Like Italy, most of the European countries also couldn't control the severity of COVID-19 because of waiting for long to enforce the lockdown and failure to maintain social distance. Even the USA is being exploded by COVID-19 due to the failure in pursuing widespread testing, maintaining contact tracing, and ascribing mandatory quarantine for risk individuals. Almost all countries, around the world where the COVID-19 is highly prevalent, faced the severity due to the lack of concern and failure of maintaining social distancing (Table 3).

Knowledge gap

There is evidence of SARS-CoV-2 presence in patient stools [25]. However, fecal-oral route transmission is still unclear. Previous reports revealed the capability of SARS and other coronaviruses of surviving on an inanimate object and environmental surfaces [69,70]. However, there is no report of SARS-CoV-2 presence in the environment except Hunan Market. The effectiveness of travel restriction, maintaining social distance, wearing a mask in the general public, home, or self-quarantine is not clear. Although there are some studies on the treatment of COVID-19, more study needed [25,71,72]. Several studies are focusing on the influence of environmental parameters, such as temperature and humidity, on SARS-like virus transmission [69,73]. The seasonality of the outbreak is also required to study. More studies are needed to explore the role of environment in the spread of the virus and its viability that are crucial for adopting strategies to control COVID-19 outbreaks. Besides the environment, more studies are required to identify the intermediate host(s) of COVID-19, because bats are known to be a reservoir of SARS-CoV-2 [38].
Conclusions

COVID-19 outbreak in China has been declared as pandemic due to its rapid and extensive spread in at least 204 countries and territories. After China, Europe is the new epicenter of the outbreak. The importation of infected individuals to uninfected countries was the main cause of the current pandemic and most of them occurred from Europe, especially Italy. More than 1 million people have been affected by the COVID-19 virus with more than 50,000 mortality until today. The number of new cases and death are increasing every day sharply. Earlier study and current data suggest that the transmission of SARS-CoV-2 can be influenced by some metrological parameters, population density, droplet, and direct-indirect contact; however, further study should be undertaken. In context to control the current outbreak, China’s strategy is a role model for the world. Besides, an effective vaccine will be a permanent solution along with the development of SARS-CoV-2 specific antiviral therapy.

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Conflict of interest

All the authors report no conflicts of interest in this paper.

Author’s contribution

MTR and MAS designed the study. MSI and MA collected data. MSI and MAS analyzed and interpreted the data. MSI, MAS, AT, and MA drafted the manuscript. MAS, AT, KHMNHN, and MTR critically reviewed and updated the

Table 3. Causes of being failed to control of COVID-19 in few countries.

| Country | Limitations                                                                                                                                                                                                 | References |
|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| USA     | Failed to Deciding in time; Widespread testing; Contact tracing; Attribute mandatory quarantine.                                                                                                             | [74]       |
| Spain   | Failed to Enforce lockdown in time; Maintain social distancing. Political issue                                                                                                                                 | [75,76]   |
| Italy   | Failed to Enforce lockdown in time; Maintain social distancing. Having a huge old population Lack of concern Playing football matches with huge supporters during the COVID-19 outbreak.                   | [75,77]   |
| France  | Failed to Maintain social distancing; Enforce lockdown in time; Take effective quarantine measures. Limitation in The capacity of test centers and existing diagnostic laboratories interms of personnel and reagents; Maintain social distancing. | [75]       |
| Switzerland | Limitation in The capacity of test centers and existing diagnostic laboratories interms of personnel and reagents; Maintain social distancing.                                               | [78]       |
| Iran    | Failed to Take effective quarantine measures; Disinfect the cities. Political issues                                                                                                                                 | [79,80]   |
| UK      | Failed to Implement restrictions timely Tried to adopt an “intelligent lockdown” but failed.                                                                                                               | [75]       |
| Turkey  | Failed to track the contact tracing Lack of seriousness among people of government.                                                                                                                                 | [81]       |
| Netherlands | Failed to implement restrictions timely Tried to adopt an “intelligent lockdown” but failed.                                                                                                           | [82]       |
manuscript to its final version. The final version of the manuscript was approved by all authors.

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### SUPPLEMENTARY MATERIAL

**Supplementary Table 1.** The total number of confirmed cases, death cases, and recovery cases.

| Reporting Country/ Territory/Area | Total confirmed cases | Total deaths | Total recovery |
|-----------------------------------|-----------------------|--------------|---------------|
| **Western Pacific Region**        |                       |              |               |
| China                             | 82724                 | 3327         | 76,571        |
| Republic of Korea                 | 9976                  | 169          | 6,021         |
| Australia                         | 4976                  | 21           | 585           |
| Malaysia                          | 2908                  | 45           | 827           |
| Japan                             | 2384                  | 57           | 514           |
| Philippines                       | 2311                  | 96           | 52            |
| Singapore                         | 1000                  | 3            | 282           |
| New Zealand                       | 723                   | 1            | 103           |
| Viet Nam                          | 218                   | 0            | 85            |
| Brunei Darussalam                 | 131                   | 1            | 65            |
| Cambodia                          | 109                   | 0            | 35            |
| Mongolia                          | 14                    | 0            | 2             |
| Lao People's Democratic Republic  | 10                    | 0            | 0             |
| Fiji                              | 5                     | 0            | 0             |
| Papua New Guinea                  | 1                     | 0            | 0             |
| Guam*                             | 77                    | 3            | 0             |
| French Polynesia*                 | 37                    | 0            | 0             |
| New Caledonia*                    | 16                    | 0            | 1             |
| Northern Mariana Islands*         | 6                     | 0            | 0             |
| **European Region**               |                       |              |               |
| Italy                             | 110574                | 13157        | 18,278        |
| Spain                             | 102136                | 9053         | 30,513        |
| Germany                           | 73522                 | 872          | 22,440        |
| France                            | 56261                 | 4019         | 12,428        |
| The United Kingdom                | 29478                 | 2532         | 135           |
| Switzerland                       | 17070                 | 378          | 4,846         |
| Turkey                            | 15679                 | 277          | 415           |
| Belgium                           | 13964                 | 828          | 2,872         |
| Netherlands                       | 13614                 | 1173         | 250           |
| Austria                           | 10711                 | 146          | 2,022         |
| Portugal                          | 8251                  | 187          | 68            |
| Israel                            | 5591                  | 21           | 338           |
| Sweden                            | 4947                  | 239          | 103           |
| Norway                            | 4665                  | 32           | 32            |
| Czechia                           | 3589                  | 39           | 71            |
| Ireland                           | 3447                  | 85           | 5             |
| Denmark                           | 3107                  | 104          | 1,193         |
| Russian Federation                | 2777                  | 24           | 281           |
| Poland                            | 2554                  | 43           | 56            |
| Romania                           | 2460                  | 85           | 283           |

*Continued*
| Reporting Country/ Territory*/Area† | Total confirmed cases | Total deaths | Total recovery |
|----------------------------------|-----------------------|--------------|---------------|
| Luxembourg                       | 2319                  | 29           | 80            |
| Finland                          | 1446                  | 17           | 300           |
| Greece                           | 1375                  | 50           | 61            |
| Iceland                          | 1220                  | 2            | 309           |
| Serbia                           | 1060                  | 13           | 42            |
| Croatia                          | 963                   | 6            | 92            |
| Slovenia                         | 841                   | 15           | 70            |
| Ukraine                          | 804                   | 20           | 19            |
| Estonia                          | 779                   | 5            | 48            |
| Lithuania                        | 581                   | 8            | 7             |
| Armenia                          | 571                   | 3            | 43            |
| Hungary                          | 525                   | 20           | 43            |
| Bosnia and Herzegovina           | 464                   | 13           | 27            |
| Latvia                           | 446                   | 0            | 1             |
| Republic of Moldova              | 423                   | 5            | 26            |
| Bulgaria                         | 422                   | 10           | 30            |
| Slovakia                         | 400                   | 0            | 10            |
| Andorra                          | 396                   | 13           | 16            |
| Kazakhstan                       | 386                   | 3            | 29            |
| Azerbaijan                       | 359                   | 5            | 30            |
| North Macedonia                  | 354                   | 11           | 17            |
| Cyprus                           | 320                   | 9            | 28            |
| Albania                          | 277                   | 15           | 89            |
| San Marino                       | 236                   | 28           | 21            |
| Belarus                          | 192                   | 2            | 53            |
| Uzbekistan                       | 190                   | 2            | 25            |
| Malta                            | 188                   | 0            | 2             |
| Georgia                          | 121                   | 0            | 27            |
| Montenegro                       | 120                   | 2            | 0             |
| Kyrgyzstan                       | 115                   | 0            | 5             |
| Liechtenstein                    | 72                    | 0            | 0             |
| Monaco                           | 37                    | 0            | 2             |
| Holy See                         | 6                     | 0            | 0             |
| Faroe Islands*                   | 173                   | 0            | 91            |
| Kosovo*                          | 125                   | 1            | 0             |
| Gibraltar*                       | 69                    | 0            | 46            |
| Jersey*                          | 81                    | 2            | 0             |
| Guernsey*                        | 78                    | 1            | 0             |
| Isle of Man*                     | 65                    | 0            | 0             |
| Greenland*                       | 10                    | 0            | 3             |
| **South-East Asia Region**       |                       |              |               |
| Thailand                         | 1771                  | 12           | 581           |
| Indonesia                        | 1677                  | 157          | 134           |
| India                            | 1636                  | 38           | 192           |

*Continued*
| Reporting Country/ Territory*/Area† | Total confirmed cases | Total deaths | Total recovery |
|-----------------------------------|-----------------------|--------------|---------------|
| Sri Lanka                         | 143                   | 2            | 24            |
| Bangladesh                        | 54                    | 6            | 26            |
| Maldives                          | 18                    | 0            | 13            |
| Myanmar                           | 15                    | 1            | 0             |
| Nepal                             | 5                     | 0            | 1             |
| Bhutan                            | 4                     | 0            | 2             |
| Timor-Leste                       | 1                     | 0            | 0             |
| **Eastern Mediterranean Region**  |                       |              |               |
| Iran (Islamic Republic of)        | 47593                 | 3036         | 17,935        |
| Pakistan                          | 2291                  | 31           | 126           |
| Saudi Arabia                      | 1720                  | 16           | 351           |
| Qatar                             | 835                   | 2            | 72            |
| United Arab Emirates              | 814                   | 8            | 96            |
| Egypt                             | 779                   | 52           | 201           |
| Iraq                              | 728                   | 52           | 202           |
| Morocco                           | 676                   | 39           | 49            |
| Bahrain                           | 569                   | 4            | 382           |
| Lebanon                           | 479                   | 12           | 46            |
| Tunisia                           | 423                   | 12           | 5             |
| Kuwait                            | 317                   | 0            | 82            |
| Jordan                            | 278                   | 5            | 45            |
| Afghanistan                       | 235                   | 4            | 10            |
| Oman                              | 231                   | 1            | 57            |
| Djibouti                          | 34                    | 0            | 8             |
| Libya                             | 10                    | 0            | 0             |
| Syrian Arab Republic              | 10                    | 3            | 0             |
| Sudan                             | 7                     | 2            | 2             |
| Somalia                           | 5                     | 0            | 1             |
| **Region of the Americas**        |                       |              |               |
| United States of America          | 187302                | 3846         | 10,411        |
| Canada                            | 9005                  | 105          | 1,979         |
| Brazil                            | 5717                  | 201          | 127           |
| Chile                             | 3031                  | 16           | 335           |
| Ecuador                           | 2372                  | 146          | 65            |
| Peru                              | 1323                  | 24           | 537           |
| Dominican Republic                | 1284                  | 57           | 16            |
| Mexico                            | 1215                  | 29           | 633           |
| Panama                            | 1181                  | 30           | 9             |
| Argentina                         | 1054                  | 27           | 256           |
| Colombia                          | 906                   | 16           | 55            |
| Costa Rica                        | 347                   | 2            | 6             |
| Uruguay                           | 338                   | 2            | 86            |
| Cuba                              | 212                   | 6            | 13            |

*Continued*
| Reporting Country/ Territory*/Area† | Total confirmed cases | Total deaths | Total recovery |
|-----------------------------------|-----------------------|--------------|---------------|
| Honduras                          | 172                   | 10           | 3             |
| Venezuela (Bolivarian Republic of)| 143                   | 3            | 43            |
| Bolivia (Plurinational State of)  | 115                   | 7            | 1             |
| Trinidad and Tobago               | 89                    | 5            | 1             |
| Paraguay                          | 69                    | 3            | 4             |
| Guatemala                         | 39                    | 1            | 12            |
| Jamaica                           | 38                    | 1            | 2             |
| Barbados                          | 33                    | 0            | 0             |
| El Salvador                       | 32                    | 1            | 0             |
| Guyana                            | 19                    | 2            | 0             |
| Haiti                             | 16                    | 0            | 1             |
| Bahamas                           | 15                    | 0            | 0             |
| Saint Lucia                       | 13                    | 0            | 1             |
| Dominica                          | 11                    | 0            | 0             |
| Grenada                           | 9                     | 0            | 0             |
| Saint Kitts and Nevis             | 8                     | 0            | 0             |
| Suriname                          | 8                     | 0            | 0             |
| Antigua and Barbuda               | 7                     | 0            | 0             |
| Nicaragua                         | 5                     | 1            | 0             |
| Belize                            | 3                     | 0            | 0             |
| Saint Vincent and the Grenadines  | 1                     | 0            | 1             |
| Puerto Rico                       | 286                   | 11           | 0             |
| Martinique                        | 128                   | 3            | 27            |
| Guadeloupe                        | 125                   | 6            | 24            |
| Aruba                             | 55                    | 0            | 1             |
| French Guiana                     | 51                    | 0            | 15            |
| United States Virgin Islands      | 30                    | 0            | 0             |
| Bermuda                           | 32                    | 0            | 0             |
| Sint Maarten                      | 6                     | 0            | 6             |
| Cayman Islands                    | 14                    | 1            | 0             |
| Curaçao                           | 11                    | 1            | 3             |
| Saint Barthélemy                  | 6                     | 0            | 1             |
| Saint Martin                      | 21                    | 2            | 2             |
| Montserrat                        | 5                     | 0            | 0             |
| Turks and Caicos Islands          | 5                     | 0            | 0             |
| British Virgin Islands            | 3                     | 0            | 0             |
| Anguilla                          | 2                     | 0            | 0             |

**African Region**

| South Africa                      | 1380                   | 5            | 95            |
| Algeria                           | 847                    | 58           | 61            |
| Burkina Faso                      | 261                    | 14           | 50            |
| Ghana                             | 195                    | 5            | 31            |
| Côte d’Ivoire                     | 190                    | 0            | 15            |
| Senegal                           | 190                    | 1            | 66            |

Continued
| Reporting Country/Territory/Area† | Total confirmed cases | Total deaths | Total recovery |
|----------------------------------|-----------------------|--------------|---------------|
| Mauritius                        | 154                   | 5            | 10            |
| Cameroon                         | 139                   | 6            | 20            |
| Nigeria                          | 139                   | 2            | 20            |
| Democratic Republic of the Congo | 123                   | 11           | 3             |
| Rwanda                           | 82                    | 0            | 0             |
| Kenya                            | 81                    | 1            | 4             |
| Niger                            | 74                    | 5            | 0             |
| Madagascar                       | 53                    | 0            | 0             |
| Uganda                           | 44                    | 0            | 0             |
| Togo                             | 36                    | 2            | 17            |
| Zambia                           | 36                    | 0            | 2             |
| Guinea                           | 30                    | 0            | 0             |
| Mali                             | 28                    | 0            | 0             |
| Ethiopia                         | 26                    | 0            | 0             |
| Congo                            | 22                    | 2            | 2             |
| United Republic of Tanzania      | 20                    | 1            | 3             |
| Eritrea                          | 15                    | 0            | 0             |
| Equatorial Guinea                | 14                    | 0            | 1             |
| Benin                            | 13                    | 0            | 1             |
| Namibia                          | 11                    | 0            | 3             |
| Mozambique                       | 10                    | 0            | 0             |
| Seychelles                       | 10                    | 0            | 0             |
| Eswatini                         | 9                     | 0            | 0             |
| Guinea-Bissau                    | 9                     | 0            | 0             |
| Angola                           | 8                     | 2            | 1             |
| Central African Republic         | 8                     | 0            | 0             |
| Zimbabwe                         | 8                     | 1            | 0             |
| Chad                             | 7                     | 0            | 0             |
| Gabon                            | 7                     | 1            | 1             |
| Liberia                          | 6                     | 0            | 0             |
| Cabo Verde                       | 5                     | 1            | 0             |
| Mauritania                       | 5                     | 0            | 2             |
| Botswana                         | 3                     | 1            | 0             |
| Gambia                           | 3                     | 1            | 2             |
| Burundi                          | 2                     | 0            | 0             |
| Sierra Leone                     | 2                     | 0            | 0             |
| Reunion                          | 281                   | 0            | 40            |
| Mayotte                          | 116                   | 2            | 10            |
| **Others**                       |                       |              |               |
| **International conveyance**     |                       |              |               |
| **(Diamond Princess)**           |                       |              |               |
|                                 | **712**               | **11**       | **619**       |
**Supplementary Table 2.** Data on imported cases.

| Reporting Country/Territory/Area | Imported from          | Border Transmission | Local Transmission |
|----------------------------------|------------------------|---------------------|--------------------|
| China (Except Hubei)             | Wuhan, **Italy**       | Yes                 | Local transmission |
| Taiwan                           | China, Hongkong, UK    | Yes                 | Local transmission |
| Hong Kong                        | China                  | Yes                 | Local transmission |
| **Western Pacific Region**       |                        |                     |                    |
| Republic of Korea                | **China**, Singapore   | No                  | Local transmission |
| Japan                            | **China**, USA         | No                  | Local transmission |
| Singapore                        | **China**              | No                  | Local transmission |
| Australia                        | **China**, Japan, **Iran**, **Italy** | No | Local transmission |
| Malaysia                         | **China**              | No                  | Local transmission |
| Philippines                      | Japan, Taiwan, USA, South Korea | No | Local transmission |
| Viet Nam                         | **China**, France/ UK, **Italy**, South Korea | No | Local transmission |
| Brunei Darussalam                | Malaysia               | No                  | Imported cases only|
| Cambodia                         | UK                     | No                  | Local transmission |
| New Zealand                      | **Iran**, **Italy**    | No                  | Local transmission |
| Mongolia                         | France                 | No                  | Imported cases only|
| French Polynesia*                | France                 |                     | Imported cases only|
| **European Region**              |                        |                     |                    |
| **Italy**                        | **China**              | No                  | Local transmission |
| Spain                            | **Italy**, **Iran**    | No                  | Local transmission |
| France                           | Singapore, **Italy**, **China** | Yes | Local transmission |
| Germany                          | Singapore, **Italy**, **China** | No | Local transmission |
| Switzerland                      | **Italy**              | Yes                 | Local transmission |
| Denmark                          | **Italy**              | No                  | Local transmission |
| Sweden                           | **Italy**, **Germany**, **Iran** | No | Local transmission |
| Netherlands                      | **Italy**              | No                  | Local transmission |
| The United Kingdom               | France, **China**, Japan, **Italy**, **Iran** | Yes | Local transmission |
| Austria                          | **Italy**              | Yes                 | Local transmission |
| Belgium                          | **China**, France, **Italy** | Yes | Local transmission |
| Norway                           | **China**, **Italy**, **Iran** | No | Local transmission |
| Czechia                          | **Italy**              | No                  | Local transmission |
| Finland                          | **Italy**              | No                  | Local transmission |
| Greece                           | **Italy**, Israel or Egypt | Yes | Local transmission |
| Israel                           | Japan, **Italy**, **Germany**, France, Spain, Switzerland | No | Local transmission |
| Ireland                          | **Italy**              | No                  | Local transmission |
| San Marino                       | **Italy**              | Yes                 | Local transmission |
| Iceland                          | **Italy**, Austria     | No                  | Local transmission |
| Slovenia                         | **Italy**              | Yes                 | Local transmission |
| Poland                           | Germany                | Yes                 | Local transmission |
| Romania                          | **Italy**              | No                  | Local transmission |
| Portugal                         | **Italy**              | No                  | Local transmission |
| Russian Federation               | **China**, **Italy**   | Yes                 | Imported cases only|
| Georgia                          | **Iran**, **Italy**    | No                  | Imported cases only|
| Albania                          | **Italy**              | Yes                 | Imported cases only|

*Continued*
| Reporting Country/ Territory*/Area | Imported from | Border Transmission | Local Transmission |
|-----------------------------------|---------------|---------------------|--------------------|
| Slovakia                          | Italy         | No                  | Local transmission |
| Serbia                            | Hungary       | Yes                 | Under investigation |
| Luxembourg                        | Italy         | No                  | Imported cases only |
| Croatia                           | Italy         | Yes                 | Local transmission |
| Hungary                           | Iran, Italy   | No                  | Local transmission |
| Latvia                            | Germany       | No                  | Imported cases only |
| Estonia                           | Iran, Italy   | No                  | Imported cases only |
| Belarus                           | Iran          | No                  | Local transmission |
| Azerbaijan                        | Iran, Italy   | Yes                 | Imported cases only |
| Malta                             | Italy         | Yes                 | Imported cases only |
| Bulgaria                          | Italy         | No                  | Local transmission |
| North Macedonia                   | Italy         | No                  | Local transmission |
| Cyprus                            | UK            | No                  | Imported cases only |
| Bosnia and Herzegovina            | Italy         | No                  | Local transmission |
| Liechtenstein                     | Switzerland   | Yes                 | Imported cases only |
| Republic of Moldova               | Italy         | No                  | Imported cases only |
| Lithuania                         | Italy         | No                  | Imported cases only |
| Ukraine                           | Italy         | No                  | Imported cases only |
| Andorra                           | Italy         | No                  | Imported cases only |
| Armenia                           | Iran          | No                  | Imported cases only |
| Monaco                            | Italy         | Yes                 | Under investigation |
| Turkey                            | Italy         | No                  | Imported cases only |
| Kazakhstan                        | Germany       | No                  | Imported cases only |
| Vatican City                      | Italy         | Yes                 | Under investigation |
| Faroe Islands*                    | Italy         | No                  | Imported cases only |
| Gibraltar*                        | Italy         | No                  | Under investigation |
| Guernsey*                         | Italy         | No                  | Imported cases only |
| Jersey*                           | Italy         | No                  | Imported cases only |
| South-East Asia Region            |               |                     |                    |
| Thailand                          | Japan, Iran, Italy | No | Local transmission |
| India                             | Italy, Iran, Thailand/ Malaysia, Greece | No | Local transmission |
| Indonesia                         | Italy         | No                  | Local transmission |
| Maldives                          | Italy         | No                  | Local transmission |
| Bangladesh                        | Italy, Germany | No | Local transmission |
| Sri Lanka                         | Italy         | No                  | Imported cases only |
| Bhutan                            | USA/India,     | Yes                 | Imported cases only |
| Nepal                             | China         | Yes                 | Imported cases only |
| Réunion*                          | USA/ France    | No                  | Imported cases only |
| Eastern Mediterranean Region      |               |                     |                    |
| Iran (Islamic Republic of)        | China         | No                  | Local transmission |
| Qatar                             | Iran          | No                  | Imported cases only |
| Bahrain                           | Iran          | No                  | Local transmission |
| United Arab Emirates              | China, Iran   | Yes                 | Local transmission |
| Kuwait                            | Iran          | Yes                 | Imported cases only |

Continued
| Reporting Country/ Territory* / Area | Imported from | Border Transmission | Local Transmission |
|-------------------------------------|---------------|---------------------|--------------------|
| Iraq                                | Iran          | Yes                 | Local transmission |
| Egypt                               | China, Italy  | No                  | Local transmission |
| Lebanon                             | Iran, UK      | No                  | Local transmission |
| Saudi Arabia                        | Iran          | No                  | Imported cases only|
| Pakistan                            | Iran          | Yes                 | Local transmission |
| Oman                                | Iran, Italy   | No                  | Imported cases only|
| Afghanistan                         | Iran          | Yes                 | Imported cases only|
| Tunisia                             | Italy, France | No                  | Imported cases only|
| Morocco                             | Italy         | No                  | Imported cases only|
| Jordan                              | Italy         | No                  | Imported cases only|
| Occupied Palestinian territory*     | Greece        | No                  | Local transmission|

**Region of the Americas**

| United States of America            | China, Japan, South Korea, Iran, Italy | No | Local transmission |
|-------------------------------------|----------------------------------------|----|--------------------|
| Canada                              | China, Iran, Egypt, Italy               | No | Local transmission |
| Brazil                              | Italy                                   | No | Local transmission |
| Chile                               | South-East Asian country, Italy         | No | Local transmission |
| Argentina                           | Italy                                   | No | Imported cases only|
| Costa Rica                          | Italy                                   | No | Local transmission |
| Peru                                | Spain, France                           | No | Local transmission |
| Ecuador                             | Italy                                   | No | Imported cases only|
| Panama                              | Spain, Italy                            | No | Imported cases only|
| Mexico                              | Italy                                   | No | Imported cases only|
| Colombia                            | Italy                                   | No | Imported cases only|
| Dominican Republic                  | Italy, Canada                           | No | Imported cases only|
| Paraguay                            | China                                   | No | Imported cases only|
| Bolivia (Plurinational State of)    | Italy                                   | No | Imported cases only|
| Cuba                                | Italy                                   | No | Imported cases only|
| Honduras                            | Spain, Switzerland                      | No | Imported cases only|
| Guyana                              | Italy                                   | No | Imported cases only|
| Jamaica                             | UK                                      | No | Imported cases only|
| St. Lucia                           | UK                                      | No | Imported cases only|
| Suriname                            | Netherlands                             | No | Imported cases only|
| Saint Vincent and the Grenadines    | Italy                                   | No | Imported cases only|
| Trinidad and Tobago                 | Switzerland                             | No | Imported cases only|
| Uruguay                             | Italy                                   | No | Imported cases only|
| Guatemala                           | Italy                                   | No | Imported cases only|
| French Guiana*                      | France                                  | No | Imported cases only|
| Martinique*                         | France                                  | No | Imported cases only|
| Saint Martin*                       | France                                  | No | Under investigation|
| Saint Barthelemy*                   | France                                  | No | Under investigation|

**African Region**

| Algeria                             | Italy                                   | No | Local transmission |
| South Africa                        | Italy, Germany, Portugal                | No | Imported cases only|
| Senegal                             | France                                  | No | Imported cases only|

*Continued*
| Reporting Country/Territory/Area | Imported from     | Border Transmission | Local Transmission   |
|----------------------------------|-------------------|---------------------|----------------------|
| Burkina Faso                     | Japan/ Burkina Faso| No                  | Imported cases only  |
| Cameroon                         | Norway, Turkey    | No                  | Imported cases only  |
| Nigeria                          | Japan/ Burkina Faso| No                  | Imported cases only  |
| Ivory Coast                      | Belgium           | No                  | Imported cases only  |
| Kenya                            | Germany/ France/ Turkey| No          | Local transmission |
| Guinea                           | Spain             | No                  | Imported cases only  |
| Sudan                            | Belgium           | No                  | Imported cases only  |
| Ghana                            | Norway, France    | No                  | Imported cases only  |
| Democratic Republic of the Congo| Japan/ Burkina Faso| No                  | Imported cases only  |
| Togo                             | Germany/ France/ Turkey| No          | Local transmission |
| Namibia                          | Japan/ Burkina Faso| No                  | Imported cases only  |
| Others                           | China, Japan      | Yes                 | Local transmission |

Supplementary Figure 1. Distribution of daily cumulative count of COVID-19 cases as of 22 January to 2 April, 2020 (reproduced from [49]).
Supplementary Figure 2. Worldwide distribution of daily new cases of COVID-19 (reproduced from [50]).

Supplementary Figure 3. Distribution of cumulative deaths by COVID-19 in some countries (reproduced from [55]).
Supplementary Figure 4. Distribution of daily new deaths by COVID-19; (A) Worldwide (reproduced from [37]), (B) Selective countries (reproduced from [55]).