Observational Study

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Epidemiologic characteristics of SARS-CoV-2 in Wuhan, other regions of China, and globally based on data gathered from January 2020 to February 2021

Song Fengjiao, BS[a], Li Xiaodong, PhD[a], Li Jian, PhD[a], Liu Hui, MS[a,*]

Abstract

This observation study examines coronavirus disease 2019 (COVID-19) data from outbreak and other sites in China and worldwide in order to examine the epidemiological pattern of COVID-19 before the acquisition of immunity through widespread vaccination and infection. COVID-19–related morbidity and mortality data for January 2020 to February 2021 were obtained from the Chinese Center for Disease Control and Prevention, Hubei Provincial Center for Disease Control and Prevention, and the World Health Organization. The number of cases was logarithmically transformed for comparison of the rate of increase or decrease with time across areas. From January to February 2020, the number of new confirmed cases in Wuhan grew substantially but returned to zero by May 2020. In other parts of China, the rate of decrease was lower than that in Wuhan, and the mortality rate was lower outside Wuhan (1.93%) than in Wuhan (7.68%). The influenza trends were similar to those of COVID-19, but the mortality rate of influenza was much lower (0.011%) than that of COVID-19. After the early stage, similar increase in the incidence rate with time was observed globally, although the total number of cases differed between regions. The outbreak severe acute respiratory syndrome coronavirus 2 strain in Wuhan had low epidemic intensity and high virulence, but the epidemiological characteristics of severe acute respiratory syndrome coronavirus 2 may not be associated with race, geography, or economic status. Importantly, more effective prevention and control measures and vaccines should be applied for controlling the variants.

Abbreviations: COVID-19 = coronavirus disease 2019, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2, VOCs = variants of concern, WHO = World Health Organization.

Keywords: COVID-19, epidemiological trends, immunity acquisition, SARS-CoV-2, vaccination

1. Introduction

Coronavirus is a widely present RNA virus with a capsular membrane and a linear single positive-strand genome.[1,2] Some coronaviruses can infect human beings and cause diseases, for example, Middle East respiratory syndrome (MERS)[3,4] and severe acute respiratory syndrome (SARS),[5,6] and their symptoms can range from common flu-like symptoms to severe pulmonary infection. Coronaviruses, including MERS and SARS, have the ability to mutate and exhibit new epidemiological characteristics.[7,8] In fact, both MERS and SARS are associated with high mortality rates of 30% and 10%, respectively.[9,10]

On December 8, 2019, an unidentified pneumonia was reported in Wuhan, China. Subsequently, on January 12, 2020, it was found to be caused by a new member of the coronavirus family that was named 2019-nCov by the World Health Organization (WHO)[11–13]; on February 11, 2020, that coronavirus-associated disease had been officially named coronavirus disease 2019 (COVID-19) by WHO and severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is responsible for the COVID-19.[14] The draft genome sequence was released on January 10, 2020, 10 days after the outbreak was announced.[15] A viral nucleic acid detection kit was soon developed and used for the diagnosis of this new viral pneumonia.[16]

Soon after the first situation report of the 2019-nCov infection (Wuhan) and the first situation report from China (mainland) were issued on January 2020. The challenges associated with surveillance since the beginning of the epidemic in China and globally are that epidemiologic characteristics of SARS-CoV-2 were unknown. Therefore, the highest level of prevention and control measures were taken in mainland China after January 23, 2020, including wearing masks, minimizing large gatherings, frequent hand washing, keeping social distance, restrictions on public transport in order to prevent people from gathering. Staffs and students used online office and study to

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

[a] Department of Laboratory and Quarantine, Dalian Medical University, Dalian, China.

**Correspondence: Liu Hui, Department of Laboratory and Quarantine, Dalian Medical University, No.9 of the west section of South Lvshun Road, 116044, Dalian, China (e-mail: liuhui60@dmu.edu.cn).*

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adopt a decentralized work method. Good ventilation was required in room. Environmental elimination were carried out in public areas to prevent the spread of the virus.

As the epidemic stabilized in China, its center shifted to other countries in the world and led to a global health emergency. As of February 28, 2021, the total number of cases and deaths reported worldwide, except for China, was 113,335,949 and 2,519,781, respectively. At this point, although the SARS-CoV-2 vaccine had been developed and widely used, mutations of the virus posed a challenge to its prevention and control. It is too early to understand the impact of the developed vaccines on the virulence (ability to cause damage to a host) and transmissibility of the new strains and the acquisition of adequate immunity. Therefore, in order to design effective prevention and control strategies, it is important to understand the epidemiological characteristics of this pathogen before the acquisition of immunity through widespread vaccination programs and infection.

Epidemic intensity is the number of disease present in an area over a certain period and the degree of association between cases. This study analyzes the epidemiological trends in SARS-CoV-2 infection in China and the world up to February 28, 2021, before the impact of vaccination on its epidemic intensity (mass vaccination programs against COVID-19 being rolled out in early 2021),[17] observes differences of the morbidity and mortality rates between the outbreak (Wuhan) and other parts of China and compares the morbidity and mortality of COVID-19 with influenza in the corresponding period, in order to provide guidance for the formulation of appropriate control strategies.

2. Methods

The Institutional Ethics Committee of Dalian Medical University approved the study and waived the need for written informed consent due to this article does not contain any studies with human participants or animals performed by authors.

2.1. Data sources

Data on the monthly number of cases and deaths related to COVID-19 from January 2020 to February 2021 in Wuhan City were obtained from Wuhan Municipal Health Commission (http://wjw.wuhan.gov.cn/) and National Health Commission of the People's Republic of China (http://www.nhc.gov.cn/), and the corresponding data for China, USA and each of the continents were obtained from the WHO website (https://www.who.int/) (Tables 1 and 2).

The route of transmission and epidemiologic characteristics of SARS-CoV-2 are probably similar to those of the influenza virus.[18,19] Therefore, we used influenza as the reference disease for comparison with SARS-CoV-2. The number of new cases of influenza reported per month was obtained from the Chinese Center for Disease Control and Prevention (http://www.chinacdc.cn/) and is shown in Table 3.

2.2. Statistical analysis

In order to increase the robustness of the data, incidence rates of zero or less than 100 were not included in the analysis. Logarithmic transformation was applied to the number of cases in order to facilitate comparison of the rate of increase or decrease with time across different geographical areas.

Crude mortality was compared between different geographical areas and calculated as follows.

Crude mortality rate = (New deaths at a certain time point/number of cases at that time point) × 100%

The association between the geospatial data and mortality of COVID-19 can be ascertained by coefficient of association (Spearman method) with using the SPSS statistical analysis software (SPSS, Chicago, IL). A coefficient of association was considered to be statistically significant when the P value was < .05 (using a 2-tailed test).

3. Results

3.1. Comparison of epidemiological trends between Wuhan and the rest of China

In the outbreak region, Wuhan, there were 3215 new confirmed cases in January 2020 and 45,907 new confirmed cases in February. Thus, the number of COVID-19 shows a sharp increase of 1328% from January to February. The number of new confirmed cases from March to April exhibited a small increase, and sporadic cases have been confirmed since May 2002, as shown in Table 1. Across China, with the exception of Wuhan, there was a 158% increase in the number of new confirmed cases from January to February 2020 and a gradual decline from March to May 2020. However, the speed of decrease with time was slower than that in Wuhan, as shown as Figure 1. The mortality rate was 7.68% in Wuhan and 1.93% in the rest of China (except for Wuhan) from January 2020 to February 2021, as shown in Table 4.

Table 1

New confirmed COVID-19 cases and deaths in Wuhan and the rest of China's mainland.

Date	New confirmed cases in Wuhan	New deaths in Wuhan	New confirmed cases in China (except Wuhan)	New deaths in China (except Wuhan)
January 2020	3215	192	8576	67
February 2020	45,907	2003	22,126	608
March 2020	885	358	845	84
April 2020	326	1316	994	5
May 2020	7	0	136	1
June 2020	0	0	517	0
July 2020	0	0	803	0
August 2020	4	0	717	0
September 2020	0	0	356	0
October 2020	0	0	583	0
November 2020	9	0	536	0
December 2020	1	0	528	0
January 2021	1	0	2492	2
February 2021	1	0	347	0

COVID-19 = coronavirus disease 2019.

Table 2

New confirmed COVID-19 cases and deaths in the world.

Date	Asia (except China)	Europe	Africa	North America	South America	Oceania
January 2020	72	12	0	53	0	7
February 2020	2908	818	15	86	5	17
March 2020	72,724	424,834	4995	136,704	10,258	4735
April 2020	222,246	966,860	30,491	931,229	135,606	3361
May 2020	543,574	665,427	101,654	875,481	615,498	499
June 2020	1,107,390	487,601	247,223	1,009,778	1,344,727	627
July 2020	1,876,821	497,642	510,189	2,199,894	1,751,995	8106
August 2020	2,750,190	1,033,326	347,491	1,886,945	2,270,009	11,960
September 2020	3,471,617	1,676,540	233,213	1,502,423	1,793,689	3843
October 2020	3,054,139	5,035,948	298,861	2,147,355	1,604,310	8525
November 2020	2,810,058	7,625,719	389,453	4,751,254	1,463,834	9498
December 2020	2,416,016	7,090,749	548,162	6,849,825	1,952,739	3893
January 2021	2,152,178	6,982,178	842,308	7,238,238	2,716,847	2222
February 2021	1,688,658	4,017,348	350,712	3,063,111	2,113,066	1162
Total death	364,980	847,291	103,227	745,456	536,545	1220

COVID-19 = coronavirus disease 2019.

Table 3

New confirmed influenza cases and deaths from January 2020 to February 2021 in China (mainland).

Date	Incidence	Deaths	Date	Incidence	Deaths
January 2020	986,543	108	September 2020	18,432	0
February 2020	59,154	22	October 2020	20,401	1
March 2020	21,696	4	November 2020	22,783	1
April 2020	15,396	1	December 2020	23,546	1
May 2020	16,974	2	January 2021	20,232	1
June 2020	15,640	0	February 2021	10,894	1
July 2020	13,406	1	Total	1,257,930	143
August 2020	12,833	0	Mortality	0.011%	

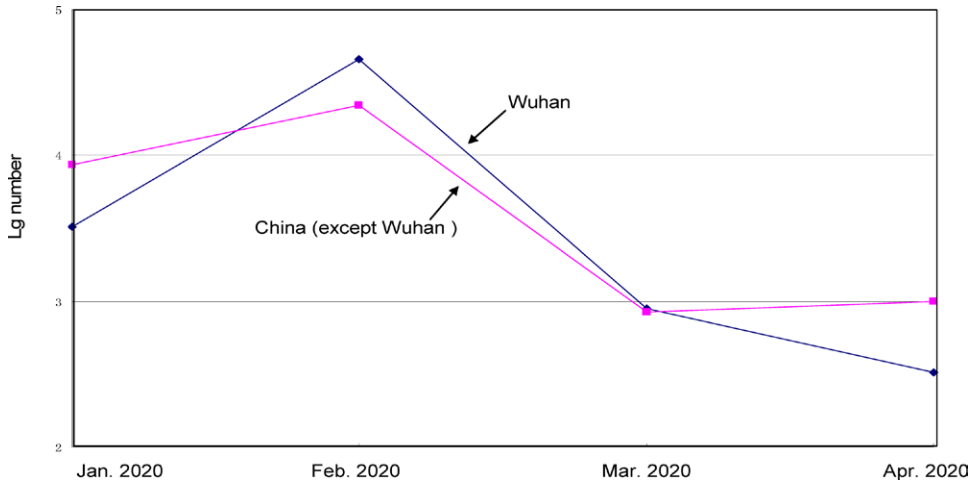

Figure 1. Trends of incidence in COVID-19 in Wuhan and the rest of China's mainland at the beginning of the outbreak. COVID-19 = coronavirus disease 2019.

3.2. Comparison of epidemiological trends between China and each of the continents

As of February 28, 2021, the cumulative number of confirmed cases was the highest in Europe (36,505,002 cases), which was followed by North America (32,592,376 cases). From May 2020 to February 2021, the rate of change in incidence with time was similar between each of the continents and China, despite fluctuation in a small range (Fig. 2).

3.3. Comparison of the characteristics of the virulence of SARS-CoV-2 over time between the United States and China

The changes characteristics of virulent of SARS-CoV-2 with time are shown in Figure 3. Both countries were very similar, with a rapid decline in mortality of COVID-19 at the beginning of the pandemic and then leveling off.

3.4. Comparison of the epidemiological trends of COVID-19 and influenza

In China, there were 986,543 new confirmed cases of influenza in January 2020 and 59,154 new confirmed cases of influenza in February 2020. The steep decline in influenza was accompanied by a steep increase in COVID-19 (Fig. 4). The incidence of influenza in January and February 2021 was still significantly lower than that in January and February 2021, respectively. The mortality rate (from January 2020 to February 2021) associated with

Table 4

Mortality rates associated with COVID-19 from January 2020 to February 2021 globally and in China (Mainland).

Region	Total number		Mortality (%)
	Incidence	Death	
Asia (except China)	22,168,591	364,980	1.65
Europe	36,505,002	847,291	2.32
Africa	3,904,767	103,227	2.64
North America	32,592,376	745,456	2.29
South America	17,772,583	536,545	3.02
Oceania	58,455	1220	2.09
China (except Wuhan)	39,556	767	1.93
Wuhan	50,356	3869	7.68

COVID-19 = coronavirus disease 2019.

influenza was 0.011% as shown in Table 3 and much lower than the corresponding mortality rate of COVID-19 (1.93%; Table 4).

3.5. Mortality associated with geospatial data

The mortality rate between January 2020 and February 2021 was also similar among each of the continents (Table 5). The correlations were not observed between mortality and geographic location, and between mortality and economy level as shown in Table 5 ($P > .05$).

4. Discussion

In the present study, we have studied the epidemiological characteristics of the COVID-19 pandemic and compared them between the first point of outbreak in Wuhan, regions of China other than Wuhan, and each of the continents of the world. As the influence of acquiring immunity, through infection as well as vaccination and other factors, was limited at the beginning of the pandemic, we chose data for the period between June 2020 and February 2021.

The COVID-19 outbreak first emerged in Wuhan, Hubei Province, China, in December 2019, and it was followed by a rapid spread of the epidemic from the point of outbreak to 34 provinces in China.[20] From January to February 2020, the number of new confirmed cases in Wuhan grew substantially, and China initiated the first-level response to major public health emergencies on January 23, 2020. As of May 2020, the number of cases in Wuhan city had returned to zero, and only sporadic cases were reported. Additionally, in other regions in mainland China, where the SARS-CoV-2 infection occurred later than in Wuhan, better prevention and control measures had also decreased COVID-19 spread, however, decreasing velocity was slower compared with Wuhan (Fig. 1). In China, more strategic prevention and control measures with longer time have been taken, which could be important factors that have reduced and made the outbreak come down to near zero (Table 1).

Accordingly, our data showed that the mortality rate was lower in the other parts of China (1.93%) than in the outbreak area of Wuhan (7.68%) (Table 4). These data indicate that the

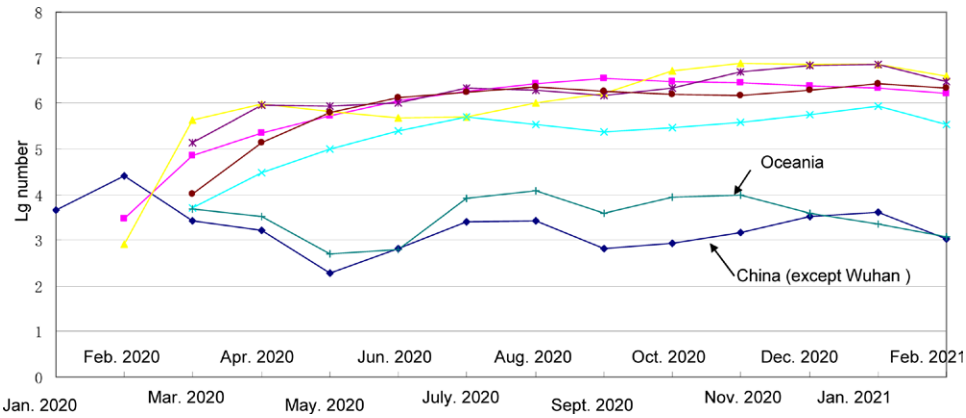

Figure 2. Trends of incidence in COVID-19 in China and the rest of the world before the widespread use of vaccines. COVID-19 = coronavirus disease 2019.

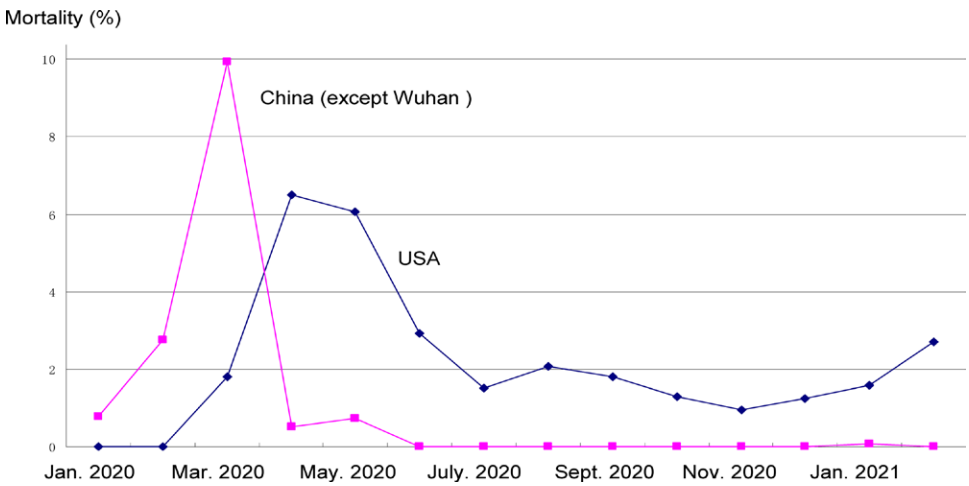

Figure 3. Comparison of virulence changes of SARS-CoV-2 with time between the United States and China. SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

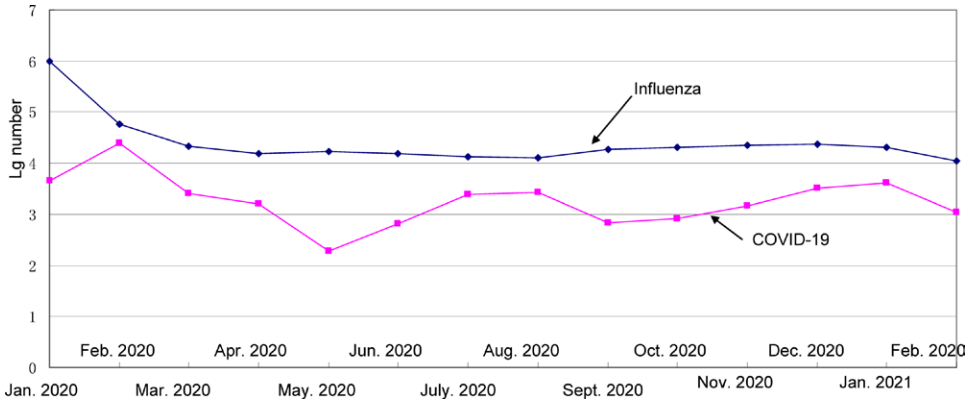

Figure 4. Incidence of COVID-19 and influenza trends in China. COVID-19 = coronavirus disease 2019.

Table 5

Mortality of COVID-19 associated with geospatial data from January 2020 to February 2021 globally.

Continents	Location (Hemisphere)	GDP per capita*	Mortality (%)
Asia	Northern	8120	1.66
Europe	Northern	31,911	2.32
Africa	Southern and Northern	1995	2.64
North America	Northern	45,703	2.29
South America	Southern	7678	3.02
Oceania	Southern	45,282	2.09
R†	0.401	–0.543	
P	0.413	0.266	

COVID-19 = coronavirus disease 2019, GDP = gross domestic product.
*GDP (US dollars).
†Coefficient of association between geospatial data and mortality of COVID-19.

virus outside the outbreak area may have been an attenuated strain transmitted from less seriously ill patients. The present results also revealed that the virulent of SARS-CoV-2 declined rapidly at the start and then leveling off, both countries (China and United States) were very similar (Fig. 3); indicating that the changes characteristics of virulent of SARS-CoV-2 with time could be nature rather than a role of strict prevention and control measures.

The present data showed that the incidence of influenza sharply decreased while the incidence of COVID-19 sharply increased from January to February 2020 in China, and both diseases showed similar low-level fluctuations from then on (Fig. 3). The incidence of influenza was still significantly lower in January and February 2021 than in January and February 2020. Thus, the prevention and control measures set for COVID-19 may also have affected the spread of influenza, although they did not completely block transmission. The mortality rate of influenza was 0.011%, which was lower than that of COVID-19. Thus, the SARS-CoV-2 strain was more virulent than the influenza.

As of February 28, 2021, there were 113,002,206 cumulative confirmed cases of COVID-19, 2,598,723 cumulative deaths, and a mortality rate of 2.3% worldwide, with the exception of China. Because the nonpharmaceutical intervention had been taken worldwide we consider that the current worldwide data still have strong comparability. After the early stage of the epidemic outbreak (after April 2020), similar time-wise trends were observed between each continent and China, although the total number of cases was different (Fig. 2). The mortality rate between January 2020 and February 2021 was also similar between each continent (Table 5). Thus, the epidemiological trends related to the SARS-CoV-2 infection may not be related to race, economic status, geography, or climate.

Since the emergence of SARS-CoV-2, numerous viral variants have been presented.[21–23] The rate of genetic variations was approximately 2 mutations per month and arisen as a result of drift.[24–26] WHO has outlined key criteria to designate variants of concern in relation to global public health, such as decreased effectiveness of vaccines, decreased available diagnostics and therapeutics, increased transmissibility, increase in virulence.[27] By the end of December 2021, many variants of concern including Alpha to Omicron have been demonstrated.[28,29] Since 2021, the SARS-CoV-2 vaccine had also been developed and widely used[30]; trends of variants (virulence increase or decrease) and epidemiologic characteristics of SARS-CoV-2 need to be investigated further.

One of the limitations of this study was that strict prevention and control measures combined with highly efficient vaccines could suppress the emergence of variants of SARS-CoV-2; however, it have been unknown when COVID-19 pandemic stop in the world and when the highest levels of prevention and control measures could be ended with higher epidemic intensity and lower virulence.

In conclusion, the outbreak strain of SARS-CoV-2 had low epidemic intensity and high virulence in Wuhan compared with other parts of China and the world. Based on the trends in the incidence of and mortality associated with COVID-19 among the continents until February 2021, it appears that the epidemiological characteristics of SARS-CoV-2 are not related to race, geography, or economy. Further, the initial sharp decline followed by low-level fluctuations in both influenza and COVID-19 cases indicate that the prevention and control measures were effective but could not entirely prevent the transmission of these 2 infections. Therefore, it can be speculated that strict prevention and control measures combined with highly efficient vaccines could suppress the emergence of variants of SARS-CoV-2 and improve the acquisition of immunity.

Author contributions

Conceptualization: Liu Hui. Acquisition of data: Song Fengjiao. Data curation: Song Fengjiao. Formal analysis: Liu Hui, Song Fengjiao, Li Xiaodong, Li Jian. Writing—original draft: Song Fengjiao, Li Xiaodong, Li Jian, Liu Hui. Writing—review & editing: Liu Hui.

References

[1] Shereen M, Khan S, Kazmi A, et al. COVID-19 infection: origin, transmission, and characteristics of human coronaviruses. J Adv Res. 2020;24:91–8.
[2] Weiss SR, Leibowitz JL. Coronavirus pathogenesis. Adv Virus Res. 2011;81:85–164.
[3] Assiri A, Al-Tawfiq JA, Al-Rabeeah AA, et al. Epidemiological, demographic, and clinical characteristics of 47 cases of Middle East

respiratory syndrome coronavirus disease from Saudi Arabia: a descriptive study. Lancet Infect Dis. 2013;13:752–61.
[4] de Groot RJ, Baker SC, Baric RS, et al. Middle East respiratory syndrome coronavirus (MERS-CoV): announcement of the Coronavirus Study Group. J Virol. 2013;87:7790–2.
[5] Drosten C, Günther S, Preiser W, et al. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. N Engl J Med. 2003;348:1967–76.
[6] Rota PA, Oberste MS, Monroe SS, et al. Characterization of a novel coronavirus associated with severe acute respiratory syndrome. Science. 2003;300:1394–9.
[7] Low ZY, Yip AJW, Sharma A, et al. SARS coronavirus outbreaks past and present-a comparative analysis of SARS-CoV-2 and its predecessors. Virus Genes. 2021;57:307–17.
[8] Gediz Erturk A, Sahin A, Bati Ay E, et al. A multidisciplinary approach to coronavirus disease (COVID-19). Molecules. 2021;26:3526.
[9] Willman M, Kobasa D, Kindrachuk J. A comparative analysis of factors influencing two outbreaks of Middle Eastern respiratory syndrome (MERS) in Saudi Arabia and South Korea. Viruses. 2019;11:11191119.
[10] Parry J. WHO warns that death rate from SARS could reach 10%. BMJ. 2003;326:999.
[11] Lu H, Stratton CW, Tang YW. Outbreak of pneumonia of unknown etiology in Wuhan China: the mystery and the miracle. J Med Virol. 2020;92:401–2.
[12] Li Q, Guan X, Wu P, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med. 2020;382:1199–207.
[13] Hui DS, Azhar E I, Madani TA, et al. The continuing 2019-nCoV epidemic threat of novel coronaviruses to global health - the latest 2019 novel coronavirus outbreak in Wuhan, China. Int J Infect Dis. 2020;91:264–6.
[14] Gralinski LE, Menachery VD. Return of the coronavirus: 2019-nCoV. Viruses. 2020;12:135.
[15] To KK, Sridhar S, Chiu KH, et al. Lessons learned 1 year after SARS-CoV-2 emergence leading to COVID-19 pandemic. Emerg Microbes Infect. 2021;10:507–35.
[16] Zhang N, Wang L, Deng X, et al. Recent advances in the detection of respiratory virus infection in humans. J Med Virol. 2020;92:408–17.
[17] Leung K, Wu JT, Leung GM. Effects of adjusting public health, travel, and social measures during the roll-out of COVID-19 vaccination: a modelling study. Lancet Public Health. 2021;6:e674–82.
[18] Li Y, Li J, Zhong D. Clinical practice guidelines and experts' consensuses of traditional Chinese herbal medicine for novel coronavirus (COVID-19): protocol of a systematic review. Syst Rev. 2020;9:170.
[19] Jiang X, Tan M, Xia M, et al. Intra-species sialic acid polymorphism in humans: a common niche for influenza and coronavirus pandemics? Emerg Microbes Infect. 2021;10:1191–9.
[20] Ji W, Camara MA, Xia J, et al. Knowledge, attitude and practice toward COVID-19: a cross-sectional study of staff in China-Guinea friendship hospital, Guinea. Front Public Health. 2022;10:889227.
[21] Korber B, Fischer WM, Gnanakaran S, et al. Tracking changes in SARS-CoV-2 spike: evidence that D614G increases infectivity of the COVID-19 virus. Cell. 2020;182:812–27.e19.
[22] Butowt R, Bilinska K, Von Bartheld CS. Chemosensory dysfunction in COVID-19: integration of genetic and epidemiological data points to D614G spike protein variant as a contributing factor. ACS Chem Neurosci. 2020;11:3180–4.
[23] Becerra-Flores M, Cardozo T. SARS-CoV-2 viral spike G614 mutation exhibits higher case fatality rate. Int J Clin Pract. 2020;74:e13525.
[24] Duchene S, Featherstone L, Haritopoulou-Sinanidou M, et al. Temporal signal and the phylodynamic threshold of SARS-CoV-2. Virus Evol. 2020;6:veaa061.
[25] Worobey M, Pekar J, Larsen BB, et al. The emergence of SARS-CoV-2 in Europe and North America. Science. 2020;370:564–70.
[26] Harvey WT, Carabelli AM, Jackson B, et al. SARS-CoV-2 variants, spike mutations and immune escape. Nat Rev Microbiol. 2021;19:409–24.
[27] Twohig KA, Nyberg TZaidi A, et al. Hospital admission and emergency care attendance risk for SARS-CoV-2 delta (B.1.617.2) compared with alpha (B.1.1.7) variants of concern: a cohort study. Lancet Infect Dis. 2022;22:35–42.
[28] Lopez Bernal J, Andrews N, Gower C, et al. Effectiveness of Covid-19 vaccines against the B.1.617.2 (Delta) variant. N Engl J Med. 2021;385:585–94.
[29] Viana R, Moyo S, Amoako DG, et al. Rapid epidemic expansion of the SARS-CoV-2 Omicron variant in Southern Africa. Nature. 2022;603:679–86.
[30] Ledford H. Six months of COVID vaccines: what 1.7 billion doses have taught scientists. Nature. 2021;594:164–7.