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

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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...
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 113,333,949 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 in 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

| 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                 | 136                                       | 5                                 |
| April 2020   | 326                          | 1316                | 994                                       | 84                                |
| May 2020     | 7                            | 0                   | 136                                       | 5                                 |
| 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                   | 2528                                      | 0                                 |
| January 2021 | 1                            | 0                   | 2492                                      | 2                                 |
| February 2021| 1                            | 0                   | 347                                       | 0                                 |

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 (36,505,022 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 COVID-19 in China was significantly lower than that in the United States and Europe (Table 3).

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           | 497,842| 510,189| 2,199,894     | 1,751,905     | 812     |
| 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     | 3693    |
| January 2021 | 2,152,178           | 6,982,175| 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.
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 ($P > .05$).

### Table 4

| Region              | Total number | Incidence | Death | Mortality (%) |
|---------------------|--------------|-----------|-------|---------------|
| Asia (except China) | 22,168,591   | 364,980   | 1.65  |               |
| Europe              | 36,505,022   | 847,291   | 2.32  |               |
| Africa              | 3,904,767    | 1,03,227  | 2.64  |               |
| North America       | 32,592,376   | 745,456   | 2.29  |               |
| South America       | 17,772,583   | 536,545   | 3.02  |               |
| Oceania             | 58,455       | 1,220     | 2.09  |               |
| China (except Wuhan)| 59,566       | 767       | 1.93  |               |
| Wuhan               | 50,356       | 3,869     | 7.68  |               |

COVID-19 = coronavirus disease 2019.

### 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. 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
Since the emergence of SARS-CoV-2, numerous viral variants have been presented.\cite{21-23} The rate of genetic variations was approximately 2 mutations per month and arisen as a result of drift.\cite{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.\cite{27} By the end of December 2021, many variants of concern including Alpha to Omicron have been demonstrated.\cite{28,29} Since 2021, the SARS-CoV-2 vaccine had also been developed and widely used;\cite{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 epidemiologic 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.

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**Table 5**

| Continents       | Location (Hemisphere) | GDP per capita* (US dollars) | 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          |

\*GDP per capita: 2019 GBP = gross domestic product.

\†Coefficient of association between geospatial data and mortality of COVID-19.
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