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Original Article

Epidemiological and clinical characteristics of 1663 hospitalized patients infected with COVID-19 in Wuhan, China: a single-center experience

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\textbf{A B S T R A C T}

\textbf{Background:} The COVID-19 outbreak in late December 2019 has quickly emerged into pandemic in 2020. We aimed to describe the epidemiological and clinical characteristics of hospitalized COVID-19 patients, and to investigate the potential risk factors for COVID-19 severity.

\textbf{Method:} 1663 hospitalized patients with laboratory-confirmed diagnosed COVID-19 from Tongji Hospital between January 14, 2020, and February 28, 2020 were included in the present study. Demographic information, exposure history, medical history, comorbidities, signs and symptoms, chest computed tomography (CT) scanning, severity of COVID-19 and laboratory findings on admission were collected from electronic medical records. Multivariable logistic regression was used to explore the association between potential risk factors with COVID-19 severity.

\textbf{Results:} In the present study, the majority (79%) of 1663 COVID-19 patients were aged over 50 years old. A total of 2.8% were medical staff, and an exposure history of Huanan seafood market was documented in 0.7%, and 7.4% were family infection. Fever (85.8%), cough (36.0%), fatigue (23.6%) and chest tightness (11.9%) were the most common symptoms in COVID-19 patients. As of February 28, 2020, of the 1663 patients included in this study, 26.0% were discharged, 10.2% were died, and 63.8% remained hospitalized. More than 1/3 of the patients had at least one comorbidity. Most (99.8%) patients had abnormal results Chest CT, and the most common manifestations of chest CT were local patchy shadowing (70.7%) and ground-glass opacity (44.8%). On admission, lymphocytopenia was present in 51.1% of the patients, mononucleosis in 26.6%, and erythrocytopenia in 61.3%. Most of the patients had increased levels of C-reactive protein (80.4%) and D-dimer (64.4%). Compared with non-severe patients, severe patients had more obvious abnormal laboratory results related to inflammation, coagulation disorders, liver and kidney damage (all P < 0.05). Older age (OR = 2.37, 95% CI: 1.47–3.83), leukocytosis (OR = 2.37, 95% CI: 1.47–3.83), and increased creatine kinase (OR = 2.37, 95% CI: 1.47–3.83) on admission were significantly associated with COVID-19 severity.

\textbf{Conclusion:} Timely medical treatment and clear diagnosis after the onset might be beneficial to control the condition of COVID-19. Severe patients were more likely to be be elderly, and tended to have higher proportion of comorbidities and more prominent laboratory abnormalities. Older age, leukocytosis, and increased creatine kinase might help clinicians to identify severe patients with COVID-19.

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Introduction

Since early December 2019, several pneumonia cases of unknown origin were identified in Wuhan, Hubei province, China [1,2]. The pathogen has been identified as a novel coronavirus and belongs to ß-coronavirus genus that has been named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) by International
Committee on Taxonomy of Viruses [3]. Additionally, the pneumonia caused by SARS-CoV-2 has been named as coronavirus disease 2019 (COVID-19) by World Health Organization (WHO) [4]. COVID-19 has soon become a serious worldwide health problem and was declared as pandemic in March 2020 [5–8]. By June 16, 2020, 7.94 million cases were confirmed globally, including 84.82 thousand cases in China and 434.80 thousand patients have died from this viral infection worldwide, 4.65 thousand in China [7]. This novel virus shared 79.5% sequence identity to severe acute respiratory syndrome coronavirus (SARS-CoV), and spread from person to person [9–11].

Many studies have reported the clinical characteristics of COVID-19 patients [1,5,12–14], but the outbreak is still progressing, an updated analysis of cases in a relative large sample might help identify the defining the epidemiology and clinical features of COVID-19.

In the present study, we aimed to describe the epidemiology and clinical characteristics of 1663 hospitalized COVID-19 patients at single-center hospital, and to explore the associations between potential risk factors with COVID-19 severity.

Materials and methods

Data collection

We obtained the medical records for 1663 hospitalized patients with laboratory-confirmed diagnosed COVID-19 from Tongji Hospital between January 14, 2020, and February 28, 2020. Admission criteria: the patient has clinical symptoms, a positive nucleic acid test, or CT suggests viral pneumonia. Demographic information, exposure history (Huanan seafood market exposure and family infection), medical history, comorbidities, signs and symptoms, chest computed tomography (CT) scanning, severity of COVID-19 and laboratory findings on admission were collected from electronic medical records. More detailed information on fundamentals and method has been previously reported elsewhere [15]. The study was approved by Tongji Hospital Ethics Committee.

Severity of COVID-19 was defined according to the diagnostic and treatment guideline (Version 5–6) published by the government [16,17]. Severe COVID-19 was defined if they meet one of following criteria: (1) Respiratory distress with respiratory frequency ≥30 breaths per min with shortness of breath or difficulty breathing; (2) Oxygen saturation ≤93% at rest; (3) Artery partial pressure of oxygen (PaO2)/inspired oxygen fraction (FiO2) ≤300 mmHg (1 mmHg = 0.133 kPa).

SARS-CoV-2 nucleic acid detection

Throat swab specimens were collected for the SARS-CoV-2 viral nucleic acid detection and stored in 5 mL virus preservation solution. Virus RNA was extracted with 24 h on Tianlong PANA9600 automatic nucleic acid extraction system (Tianlong, China). The open reading frame 1ab (ORF1ab) and nucleocapsid protein (N) genes were simultaneously tested with RT-PCR. RT-PCR assay was performed on Tianlong Gentier 96E real-time PCR system with the following conditions: incubation at 50 °C for 15 min, pre-denaturation at 95 °C for 15 min, 45 cycles of denaturation at 94 °C for 15 s, and extension at 55 °C for 45 s (collecting fluorescence signal). A Ct-value less than 40 for both genes was defined as a positive test, and a Ct-value of 40 or more was defined as a negative test.

Statistics analysis

Shapiro–Wilk Test was used to test data normality. Two-tailed t-test was conducted to test difference in means between no-severe and severe groups, and Mann Whitney U test was to test difference in skewed parameters. Chi-square tests or Fisher’s exact test, when appropriate, was used for categorical variables. Multivariate logistic regression model was conducted to explore the associations of potential risk factors with COVID-19 severity. SAS version 9.4 (SAS Institute, Cary, North Carolina, USA) was used to conduct all statistical analyses. Two-sided statistical tests considered to be significant at p values below 0.05.

Results

Epidemiological characteristics

On January 20, COVID-19 was included in the legal category B infectious diseases in China, with reference to category A management. COVID-19 was included in the legal category B infectious diseases according to Law of the People’s Republic of China on the Prevention and Treatment of Infectious Diseases. Category A management: patients and carriers of pathogens shall be treated in isolation, and the period of isolation shall be determined according to the results of medical examinations; for suspected patients, be isolated and treated in designated places before diagnosis; for patients in medical institutions, pathogen carriers, and close contacts of suspected patients, conduct medical observations and take other necessary preventive measures in designated places. During the traditional Chinese New Year, the number of onset cases was increasing, reaching the highest on February 1, and then gradually decreasing. SARS-CoV-2 confirmed positive patients gradually increased from January 23, reached the highest on February 9, and then gradually declined. The number of COVID-19 patients admitted in the hospital gradually increased from January 25 to February 4, and then decreased. The inpatients reached the peak on February 10–11 (Fig. 1).

Baseline characteristics of the non-severe (n = 799) and severe (n = 864) COVID-19 patients were presented in Table 1. In total 1663 hospitalized patients infected with COVID-19 (825 females, 838 males) were included in the present study. The median age of the all patients was 64.0 years (IQR, 52.0–71.0), and 79% of them were over 50 years old. A total of 2.8% were medical staff, and an exposure history to Huanan seafood market was documented in 0.7%, and 7.4% were family infection. The median interval from onset of symptoms to COVID-19 confirmation was 9.0 days (IQR, 5.0–14.0), the median interval from onset of symptoms to hospital admission was 10.0 days (IQR, 6.0–14.0), the median interval from onset of symptoms to hospital admission was 18.0 days [IQR, 11.0–23.0, data not shown], and the length of hospital stay was 17.0 days (IQR, 13.0–19.0). Of 1663 patients, 433 (26.0%) people improved and discharged, 169 (10.2%) died, and 1061 (63.8%) were still in hospital by date of February 28, 2020. Among the whole patients, 39.0% had at least one comorbidity, and hypertension (20.9%), diabetes (14.7%), and coronary heart disease (7.9%) were the most common coexisting diseases. Compared with non-severe patients, the severe patients were more likely to be male, older and tended to have a longer time from onset of symptoms to hospital admission, from onset of symptoms to COVID-19 confirmation, and shorter time of hospital stay. In addition, severe patients had higher proportion of comorbidity such as hypertension, diabetes and coronary heart disease (all P < 0.01).

Symptomatic and radiological characteristics

Of 1663 patients, the main clinical symptoms were fever (85.8%), cough (36.0%), fatigue (23.6%) and chest tightness (11.9%), followed by diarrhea (4.6%), dyspnea (4.4%), loss of appetite (4.2%), myalgia (3.4%), dizziness/headache (1.7%), pharyngalgia (1.4%), nausea
Fig. 1. Epidemic curve of the confirmed cases of hospitalized COVID-19 at Tongji Hospital. Daily numbers of confirmed cases are plotted by date of onset of symptoms (blue), by date of diagnosis (red), and by date of hospitalization (green). COVID-19, coronavirus disease 2019.

| Table 1 | Baseline characteristics of patients infected with COVID-19. |
|---------|-------------------------------------------------------------|
|         | All patient | Disease Severity | p value |
|         | N           | Non-severe | Severe |
| Age     | Median (IQR) | 61.0(47.0–69.0) | 66.0(57.0–73.0) | <0.0001 |
| Age groups (years), n (%) | 38(2.3) | 12(1.4) | <0.0001 |
| 30–49   | 311(18.7) | 109(12.6) | <0.0001 |
| 50–69   | 826(49.7) | 448(51.9) | <0.0001 |
| ≥70     | 488(29.3) | 295(34.1) | <0.0001 |
| Women, n (%) | 825(49.6) | 415(51.9) | <0.0001 |
| Occupation, n (%) | 896(53.9) | 476(59.6) | <0.0001 |
| Others  | 11(0.7) | 3(0.3) | <0.0001 |
| Medical staff | 46(2.8) | 13(1.5) | <0.0001 |
| Retirees | 568(34.2) | 352(40.7) | <0.0001 |
| Farmers / workers | 153(9.2) | 79(9.1) | <0.0001 |
| Exposure history, n (%) | 11(0.7) | 5(0.6) | 0.67 |
| Huanan seafood market exposure | 58(3.3) | 65(7.5) | 0.84 |
| Family infection | 108(6.6) | 10.0(5.0–15.0) | 0.007 |
| Time from onset to diagnosis, Median (IQR), days | 9.0(4.0–14.0) | 10.0(7.0–15.0) | 0.01 |
| Time from onset to admission, Median (IQR), days | 10.0(6.0–14.0) | 17.0(11.0–18.0) | <0.0001 |
| Length of hospital stay, Median (IQR), days | 17.0(10.0–20.0) | 17.0(11.0–18.0) | <0.0001 |
| Clinical outcomes at data cutoff, n (%) | 1061(63.8) | 542(62.7) | <0.0001 |
| Hospitalization | 11(0.6) | 142(17.8) | 0.003 |
| Improvement and discharge | 85(10.6) | 160(18.5) | <0.0001 |
| Death | 46(5.8) | 85(9.8) | 0.002 |
| Comorbidity, n (%) | 62(3.7) | 37(4.3) | 0.21 |
| Hypertension | 37(2.3) | 22(2.6) | 0.46 |
| Diabetes | 31(1.9) | 15(1.7) | 0.69 |
| Cancer | 1(0.1) | 13(1.5) | 0.15 |

Data are medians (IQR) or number (%). COVID-19, coronavirus disease 2019; IQR, inter-quartile ranges. The percentages were calculated column-wise.
Table 2
Symptomatic and radiological characteristics of patients infected with COVID-19.

| Signs and symptoms, n (%) | All patient | Disease Severity | p value |
|---------------------------|-------------|------------------|---------|
|                          | N           | Non-severe       | Severe  |
| Fever                    | 1427(85.8)  | 1663             | 799     | 864 | 0.04 |
| Cough                    | 598(36.0)   | 232(31.5)        | 346(40.1)| 0.0003 |
| Fatigue                  | 198(11.9)   | 12(1.5)          | 17(2.0)| 0.47 |
| Loss of appetite         | 29(1.7)     | 12(1.5)          | 17(2.0)| 0.47 |
| Myalgia                  | 69(4.2)     | 25(3.1)          | 44(5.1)| 0.04 |
| Dizziness/headache       | 8(0.5)      | 1(0.1)           | 3(0.4)| 0.36 |
| Chest CT images, n (%)   | 1475        | 763              | 712    | 1.00 |
| Lesion distribution      |             |                  |        |     |
| Bilateral lung lobe      | 1348(91.4)  | 691(90.6)        | 657(92.3)| 0.24 |
| Unilateral lung lobe-left| 78(5.3)     | 39(5.1)          | 39(5.5)| 0.75 |
| Unilateral lung lobe-right| 46(3.1)    | 30(3.9)          | 16(2.3)| 0.06 |
| Upper lobe-Lower lobe    | 919(62.3)   | 478(62.6)        | 441(61.9)| 0.70 |
| Upper lobe               | 179(12.1)   | 87(11.4)         | 92(12.9)| 0.39 |
| Lower lobe               | 374(25.4)   | 195(25.6)        | 179(25.1)| 0.82 |
| Normal lung              | 3(0.2)      | 3(0.4)           | 0(0.0)| 1.00 |
| Image characteristics    |             |                  |        |     |
| Ground-glass opacity     | 661(44.8)   | 334(43.8)        | 327(45.9)| 0.41 |
| Local patchy shadowing   | 1043(70.7)  | 542(71.0)        | 501(70.4)| 0.78 |
| Pleural effusion         | 216(14.6)   | 88(11.5)         | 128(18.0)| 0.0005 |
| Bronchiectasis           | 2(1.6)      | 5(0.7)           | 19(2.7)| 0.002 |
| Atelectasis              | 6(0.4)      | 3(0.4)           | 3(0.4)| 1.00 |

COVID-19, coronavirus disease 2019. The percentages were calculated column-wise.

(1.1%), vomiting (1.1%), runny nose (0.2%), and stuffy nose (0.1%). Compared with non-severe patients, the severe patients had a higher proportion of symptoms such as fever, cough, fatigue, chest tightness and loss of appetite (all P < 0.05). We observed similar results after further excluding the patients with underlying diseased. Among patients without fever, the main clinical symptoms were cough (57.2%), chest tightness (23.3%), and fatigue (17.8%) (Supplementary Table 2). Cluster analysis found that clinical symptoms could be divided into three categories: first category: fever; second category: cough; third category: fatigue, chest tightness, diarrhea, dyspea, loss of appetite, myalgia, dizziness/headache, pharyngalgia, nausea, vomiting, runny nose, and stuffy nose (Supplementary Fig. 1).

Due to 188 missing CT results on admission (CT done in other hospitals), 1475 were included in the radiological characteristics analysis. Among 1475 patients, 99.8% patients had abnormal results (91.4% in bilateral lung lobe, 5.3% in unilateral lung lobe-left, and 3.1% in unilateral lung lobe-right, Table 2, Fig. 2A–C). The most common manifestations of chest CT were local patchy shadowing (70.7%, Fig. 3A) and ground-glass opacity (44.8%, Fig. 3A), followed by pleural effusion (14.6%, Fig. 3B), bronchiectasis (1.6%, Fig. 3C) and atelectasis (0.4%, Fig. 3D). Compared with non-severe patients, the severe patients had a higher proportion of symptoms such as pleural effusion and bronchiectasis (all P < 0.01).

Laboratory findings

As Table 3 shown, most of patients had normal white blood cell count (81.2%), with 9.2% increased and 9.6% decreased cases on admission. Decreased levels of lymphocyte count (51.1%), lymphocyte percentage (47.0%), albumin (50.1%), hemoglobin (59.3%) and increased levels of lactate dehydrogenase (76.9%), procalcitonin (51.0%), alanine aminotransferase (20.6%), and aspartate aminotransferase (21.0%), had been observed. C-reactive protein was increased in 90.4% of the patients, and 64.4% of the patients had increased D-dimer, and some patients had prolonged prothrombin time (22.0%), activated partial thromboplastin time (28.9%), and thrombin time (6.9%).

Compared to non-severe patients, severe individuals tended to have higher levels of white blood cell count, neutrophil count/percentage, platelet count, aspartate aminotransferase, urea, lactate dehydrogenase, and procalcitonin (all P < 0.05, Table 3). In addition, severe patients had lower levels of lymphocyte count/percentage, monocyte percentage, hemoglobin, and albumin (all P < 0.05, Table 3). Prothrombin time was longer in severe patients than in non-severe patients. In the present study, we observed that non-severe and severe patients had higher levels of D-dimer. Compared to non-severe patients, severe individuals had higher levels of D-dimer, and the median (IQR) of D-dimer was 0.6 (0.4–1.4) mg/L in non-severe population, and 0.9 (0.4–1.9) mg/L in severe participants.

Logistic regression for COVID-19 severity with its potential risk factors

Age (<65, ≥65, years), gender (female, male), time from onset to admission history of hypertension (yes/no) and diabetes (yes/no), lymphopenia (<1.1, ≥1.1, ×10⁹/L), leukocytosis (<9.5, ≥9.5, ×10⁹/L), increased alanine aminotransferase (<40, ≥41, U/L), increased lactate dehydrogenase (<214, ≥214, U/L), increased creatinine kinase, and increased D-dimer (<0.5, ≥0.5 mg/L) were included in the logistic regression for COVID-19 severity. As Table 4 presented, compared with the patients aged <65, patients aged ≥65 had higher odds of COVID-19 severity risk [OR = 1.73, 95% CI:
Leukocytosis [OR = 2.30, 95% CI: (1.25–4.25)] and increased creatine kinase [OR = 2.09, 95% CI: (1.06–4.09)] tended to have higher odds of COVID-19 severity risk.

Discussion

In the present study, the majority (79%) of 1663 COVID-19 patients were aged over 50 years old. A total of 2.8% were medical staff, and an exposure history of Huanan seafood market was documented in 0.7%, and 7.4% were family infection. Fever (85.8%), cough (36.0%), fatigue (23.6%) and chest tightness (11.9%) were the most common symptoms in COVID-19 patients. A few people had symptoms such as diarrhea, dyspnea, loss of appetite, myalgia, dizziness/headache, pharyngalgia, nausea, vomiting, runny nose, and stuffy nose. Cluster analysis found that clinical symptoms could be divided into three categories: fever, cough and others (fatigue, chest tightness, diarrhea, dyspnea, loss of appetite, myalgia, dizziness/headache, pharyngalgia, nausea, vomiting, runny nose, and stuffy nose).

As of February 28, 2020, of the 1663 patients included in this study, 26.0% were discharged, 169 died (10.2%), and 63.8% remain hospitalized. More than 1/3 of the patients had at least one comorbidity. Most (99.8%) patients had abnormal results Chest CT, and the most common manifestations of chest CT were local patchy shadowing (70.7%) and ground-glass opacity (44.8%). On admission, lymphocytopenia was present in 51.1% of the patients, mononucleosis in 26.6%, and erythrocytopenia in 61.3%. Most of the patients had increased levels of C-reactive protein.

Daily numbers of COVID-19 confirmed cases by date of onset and by date of diagnosis were similar to previous studies [5]. During the traditional Chinese New Year (January 25, 2020–January 31, 2020), the number of onset cases was increasing, reaching the
highest on February 1, which might be related to the large people movement during the Spring Festival. On the ninth day after the Spring Festival, SARS-CoV-2 confirmed positive patients reached the highest on February 9, which was consistent with previous findings that median incubation period of COVID-19 was 4 days (IQR, 2–7). Wuhan City shut down was conducive to COVID-19 prevention and control. The establishment of Wuhan’s Huoshenshan hospital, Wuhan’s Leishenshan hospital, and Wuhan Fangcang Hospital were of great significance to the prevention and control of epidemics. To prevent COVID-19, we should not go to densely populated areas.

The median age (64.0 y, IQR, 52.0–71.0) of all patients in the present study were older than other studies, which might be associated with the fact that more serious patients were admitted to Tongji hospital. Moreover, severe patients tended to be elder, when compared to non-severe patients, which was consistent with the previous findings [12]. In the present study, 2.8% of the patients were medical staff, and the percentage is lower than that reported by Wang et al., which might due to the size of the sample and policy of the hospital [14]. In the present study, we found that severe and non-severe patients had a significant difference regarding the median days from symptom onset to hospital admission and from onset of symptoms to COVID-19 confirmation, which might indicate that timely medical treatment after the onset might be beneficial to control the condition.

Hypertension, diabetes mellitus and cardiovascular diseases were the most common underlying diseases, consistent with other previous studies [12–14]. In addition, we found severe patients had higher proportion of comorbidity such as hypertension, diabetes and coronary heart disease, which was consistent with Guan’s report based on 1099 patients from 552 hospitals. However, Zhang et al. did not observed the similar findings, which might be associ-
The present study was the first comprehensive analysis of 1663 hospitalized patients with laboratory-confirmed diagnosis of COVID-19 from January 14, 2020 to February 28, 2020 in Tongji Hospital. Nonetheless, some limitations should be taken into consideration. Firstly, the present study was performed in single-center thus the findings may not be representative of general population. Secondly, we have not yet collected information on treatments in the present study.

**Conclusions**

In the present study, the majority of all COVID-19 patients were aged over 50 years old. Fever, cough, fatigue and chest tightness were the most common symptoms in COVID-19 patients. As of February 28, 2020, of the 1663 patients included in this study, 26.0% were discharged, 169 died (10.2%). Most patients had abnormal results Chest CT, and the most common manifestations of chest CT were local patchy shadowing and ground-glass opacity. Most patients with COVID-19 had higher levels of D-dimer, which might increase the risk of cardiovascular disease. Severe patients were more likely to be to be elder, and tended to have higher proportion of comorbidities and more prominent laboratory abnormalities. Older age, leukocytosis, and increased creatine kinase may help clinicians to identify severe patients with COVID-19.

**Authors’ contributions**

Caizheng Yu, Qing Lei, Wei Liu, and Wengang Li designed the study, interpreted data, and wrote the first draft of the paper; Caizheng Yu, Qing Lei, Wenkai Li and Xiong Wang took responsibility for the accuracy of the data analysis; Caizheng Yu, Qing Lei, Wei Liu, and Wengang Li performed data collection and designed the study’s analytic strategy. All authors have read and approved the final manuscript.

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**Conflict of interest**

There are no conflicts of interest.

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**Appendix A. Supplementary data**

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jiph.2020.07.002.

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| Table 4: Logistic regression model for COVID-19 severity with its potential risk factors, odds ratios (95% confidence intervals). |
|---------------------------------------------------------------|
| **Variable** | **OR** | **95% CI** | **p value** |
| Age (years) | | | |
| <65 | Reference | - | - |
| ≥65 | 1.73 | (1.18–2.53) | 0.005 |
| Gender (male) | 0.91 | (0.64–1.30) | 0.60 |
| Time from onset to admission, days | | | |
| <10 | Reference | - | - |
| ≥10 | 0.94 | (0.66–1.35) | 0.74 |
| History of hypertension | 1.26 | (0.70–2.27) | 0.45 |
| History of diabetes | 1.16 | (0.72–1.89) | 0.54 |
| Lymphopenia | 1.03 | (0.66–1.61) | 0.89 |
| Leukocytosis | 2.30 | (1.25–4.25) | 0.008 |
| Increased alanine aminotransferase | 0.84 | (0.54–1.31) | 0.44 |
| Increased lactate dehydrogenase | 1.44 | (0.93–2.22) | 0.10 |
| Increased creatine kinase | 2.09 | (1.06–4.09) | 0.03 |
| Increased D-dimer | 1.17 | (0.78–1.76) | 0.45 |

COVID-19, coronavirus disease 2019; OR, odds ratio; CI, confidence interval. Lymphopenia (<1.1, ≥1.1, >10/L); leukocytosis (<5.0, ≥5.0, >10/L); increased alanine aminotransferase (>40, >41, U/L); increased lactate dehydrogenase (>214, >214, U/L); increased creatine kinase, and increased D-dimer (>0.5, >0.5, mg/L).

ated with study sample size, different age and gender of the study subjects.

In line with previous study [12–14,18], of 1663 patients in the present study, the main clinical symptoms were fever, cough, fatigue and chest tightness. We found serious patients had a higher proportion of symptoms such as fever, cough, fatigue, chest tightness and loss of appetite, which was consistent with the study conducted by Guan et al. based on 1099 patients. We still observed that serious patients had a higher proportion of symptoms such as fever, cough, and chest tightness after further excluding the patients with underlying disease. However, several previous researches [12–14] did not found the significant difference. The most common manifestations of chest CT were local patchy shadowing and ground-glass opacity, which were consistent with previous studies [12,19]. Additionally, we observed that the severe patients had a higher proportion of symptoms such as pleural effusion and bronchiectasis, when compared with non-severe patients, which had not been reported yet.

Consistent with previous studies [12–14,18], most of patients had normal white blood cell count, decreased levels of lymphocyte count/percentage, hemoglobin, and albumin, increased levels of lactate dehydrogenase, C-reactive protein, increased D-dimer, procalcitonin, alanine aminotransferase, and aspartate aminotransferase. These abnormal laboratory findings showed sustained inflammatory response, disturbed coagulation mechanism, liver and kidney damage after patients infected [12]. Compared to non-severe patients, severe individuals tended to have higher levels of white blood cell count, neutrophil count/ percentage, platelet count, aspartate aminotransferase, urea, lactate dehydrogenase, D-dimer, and procalcitonin, which indicated severe patients might have more obvious inflammation, disturbed coagulation mechanism, liver and kidney damage. Previous study found that five COVID-19 patients younger than 50 years had a large-vessel stroke [20], which indicated that COVID-19 might increase the risk of cardiovascular disease. In the present study, we also found that non-severe and severe patients had higher levels of D-dimer. Additionally, we observed that leukocytosis and increased creatine kinase were positively associated with COVID-19 severity.

The strengths of present study included the relatively large sample size, and the ability to provide more information of epidemiological and clinical characteristics of patients infected with COVID-19. It would enable us to investigate the associations between potential risk factors and COVID-19 severity with moderate statistical power. Different from previous studies [15,21,22], the
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