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Clinical characteristics, laboratory findings, radiographic signs and outcomes of 61,742 patients with confirmed COVID-19 infection: A systematic review and meta-analysis

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ABSTRACT

Introduction: In the current time where we face a COVID-19 pandemic, there is no vaccine or effective treatment at this time. Therefore, the prevention of COVID-19 and the rapid diagnosis of infected patients is crucial.

Method: We searched all relevant literature published up to February 28, 2020. We used Random-effect models to analyze the appropriateness of the pooled results.

Result: Eighty studies were included in the meta-analysis, including 61,742 patients with confirmed COVID-19 infection. 62.5% (95% CI 54.5–79, p < 0.001) of patients had a history of recent travel endemic area or contact with them. The most common symptoms among COVID-19 infected patients were fever 87% (95% CI 73–93, p < 0.001), and cough 68% (95% CI 55.5–74, p < 0.001), respectively. The laboratory analysis showed that thrombocytosis was present in 61% (95% CI 41–78, p < 0.001), and lymphopenia in 57.5% (95% CI 42–79, p < 0.001). The most common radiographic signs were bilateral involvement in 81% (95% CI 62.5–87, p < 0.001), consolidation in 73.5% (95% CI 50.5–91, p < 0.001), and ground-glass opacity 73.5% (95% CI 40–90, p < 0.001) of patients. Case fatality rate (CFR) in <15 years old was 0.6%, in >50 years old was 39.5%, and in all range group was 6%.

Conclusions: Fever and cough are the most common symptoms of COVID-19 infection in the literature published to date. Thrombocytosis, lymphopenia, and increased CRP were common lab findings although most patients included in the overall analysis did not have laboratory values reported. Among Chinese patients with COVID-19, rates of hospitalization, critical condition, and hospitalization were high in this study, but these findings may be biased by reporting only confirmed cases.

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1. Introduction

In December 2019, the new COVID-19 coronavirus was recognized as a cause of respiratory illness. The first reports of pneumonia were from people who worked or lived in the Huanan seafood wholesale market in Wuhan, China raising concerns about a zoonotic viral infection [1,2]. Phylogenetic analysis showed that the COVID-19 belong to the beta-coronavirus [1]. Epidemiological studies have shown that the virus is spread relatively easily and can be transmitted by aerosol, droplets, and through infected surfaces [3]. The COVID-19 has now spread to more than 50 countries from December 2019 to February 2020 [4]. Most symptoms are non-specific in patients with respiratory disease. According to the latest WHO report, out of 83,652 confirmed cases of COVID-19 worldwide, 2791 deaths occurred in China and 67 deaths is recorded in other countries [4].

Thus far, 6 coronaviruses that are able to infect humans have been identified, coronavirus infections are typically asymptomatic or associated with mild respiratory symptoms [1]. The first coronavirus to cause severe disease in humans was the Severe Acute Respiratory Syndrome virus (SARS), which was appeared in the Guangdong province of southern China in 2002, there were 8098 reported case and 774 deaths [5]. In Saudi Arabia in 2012, the Middle East respiratory syndrome coronavirus (MERS-CoV), which was transmitted from the camels to humans, caused 2458 infections with 848 deaths [6].

Clinical studies have shown that COVID-19 can rapidly cause pulmonary damage and severe respiratory symptoms [3]. There is no vaccine or targeted treatment currently available for COVID-19 infection. Treatment is largely supportive although multiple experimental antiviral medications are being evaluated [7,8]. Thus, prevention and rapid diagnosis of infected patients is crucial. To date, the published clinical studies are quite small and give variable findings. With this in mind, here we evaluate the clinical features and laboratory findings using a large sample size of COVID-19 infected patients in order to assist in its understanding, prevention and treatment.

2. Methods

2.1. Search strategy

This study was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (PRISMA) guidelines [9]. We searched all studies published up to February 28, 2020 from the following databases: Embase, Scopus, PubMed, Web of Science and the Cochrane library. Search medical subject headings (MeSH) terms used were: “COVID-19”, “Coronavirus”, “severe acute respiratory syndrome coronavirus”, and all their synonyms like “Wuhan Coronavirus”, “SARS-CoV-2”, and “COVID-19”. Moreover, we searched for unpublished and grey literature with Google scholar, Center for Disease Controls (CDC) and WHO databases. We also examined references of included articles to find additional relevant studies. There was no language restriction and all included studies are written in English or Chinese languages, the latter were translated by https://translate.google.com.

![Fig. 1. Flow Diagram of Literature Search and Study Selection (PRISMA flow chart).](attachment:flow_diagram.png)
Table 1
Characterization of Included Studies with total 61, 742 COVID-19 Confirmed Patients. All Studies are Retrospective, from China, and Published in 2020.

| First Author | Sampling Center | Sampling Center Location | Sampling Center Name | Sample Collection Time | N Confirmed Patients | Mean age in years (IQR) | N sex (male) | Reference standard |
|--------------|-----------------|--------------------------|----------------------|-----------------------|----------------------|--------------------------|-------------|-------------------|
| Nanshan Chen | Wuhan Jinyintan Hospital | Wuhan, China | Jinyintan Hospital | Jan 1 to Jan 20, 2020 | 5–24 | 99 | 55.5 (21–82) | 67 | RT-PCR |
| Kaiyuan Sun | Multicenter | Beijing, China | Multicenter | Jan 20– Jan 29, 2020 | 42 | 288 | 49 (2–89) | 62.3 | CDC guideline |
| Jie Li | DaZhou Central Hospital | DaZhou, China | Central Hospital | Jan 22–Feb 10, 2020 | 1–21 | 17 | 45.1 (32–65) | 9 | RT-PCR |
| Dawei Wang | Zhongnan Hospital of Wuhan | Wuhan, China | Central Hospital | Jan 1–Jan 28, 2020 | 6–34 | 138 | 56 (42–68) | 75 | RT-PCR |
| Chaolin Huang | Jin Yintan Hospital (Wuhan) | Wuhan, China | Hospital | Dec 31, 2019–UN | NA | 41 | 49 (41–58) | 30 | RT-PCR |
| Weijie Guan | Multicenter | Beijing, China | Multicenter | NA | 1099 | 47 | 640 | RT-PCR |
| Yang Yang | NA | Wuhan, China | Tongji Hospital in Wuhan | Jan 14–29, 2020 | 15 day | 29 | 56 (26–79) | 21 | RT-PCR |
| Adam Bernheim | Multicenter | Beijing, China | Multicenter | Jan 18–Feb 2, 2020 | 12 days | 121 | 45 (18–80) | 61 | RT-PCR & CT scan |
| Feng Pan | Union Hospital | Wuhan, China | Union Hospital | Jan 12–Feb 5, 2020 | NA | 21 | 40 (25–63) | 15 | RT-PCR |
| jin Zhang | No.7 hospital of Wuhan | Wuhan, China | No.7 Hospital | Jan 16th to Feb 3rd, 2020 | NA | 140 | 57 (25–87) | 71 | RT-PCR |
| Yichun Cheng | Tongji hospital in Wuhan | Wuhan, China | Tongji Hospital | Jan 28–Feb 2020 | 10 (7–13) | 710 | 63 (51–71) | 374 | RT-PCR |
| Ming Yen | Hong Kong Shenzhen Hospital | Hong Kong, China | Hospital | Jan 15–Feb 1, 2020 | NA | 21 | 56 (37–65) | 13 | RT-PCR |
| SiJia Tian | Beijing Emergency Medical Service | Beijing, China | Hospital | Jan 20 to Feb 10, 2020 | Feb 10 | 262 | 47.5 (1–94) | 127 | RT-PCR |
| Qun Li | NA | Wuhan, China | NA | NA | 425 | 15–89 | 240 | WHO guideline |
| De Chang | 3 hospitals in Beijing | Beijing, China | Hospital | Jan 16–Jan 29, 2020 | Feb 4 | 13 | 34 (34–48) | 10 | NA |
| Xiao-Wei Xu | Zhejiang province | Zhejiang, China | Provice | Jan 10–Feb 26, 2020 | 10 days | 62 | 41 (32–52) | 36 | WHO guideline |
| Fengxia Song | Center for Disease Control, Shanghai | Shanghai, China | Hospital | Jan 20–Jan 27, 2020 | NA | 51 | 49 (16–76) | 25 | CT scan & nucleic acid test |
| Michael Chung | Multicenter | Beijing, China | Multicenter | Jan 18–27, 2020 | NA | 21 | 51 (29–77) | 13 | CT scan, NA |
| Zunyou Wu (CDC) | Multicenter | Wuhan, China | Multicenter | through February 11, 2020 | 15 days | 44,672 | 22,981 | nucleic acid test | result rt-pcr |
| Bing-Liang Zhang | Hospitalized death | Wuhan, China | Hospitalized hospital | January 11, 2020 to February 10 | 30 day | 82 | 72.5 (1–98) | 54 | rt-pcr |

| First Author | Sampling Center | Sampling Center Location | Sampling Center Name | Sample Collection Time | N Confirmed Patients | Mean age in years (IQR) | N sex (male) | Reference standard |
|--------------|-----------------|--------------------------|----------------------|-----------------------|----------------------|--------------------------|-------------|-------------------|
| Bo Hu | Multicenter | Beijing, China | Multicenter | Jan 8 to Feb 9 | 20 day | 50 | 62 | 34 | rt-pcr |
| Chuangsheng Zheng | Union Hospital, Wuhan | Wuhan, China | Hospital | Jan 16–Jan 20, 2015 | 30 day | 64 | 35 | 23 | rt-pcr |
| Lin Fu | Union Hospital | Wuhan, China | Hospital | Jan 1–Jan 30 | 30 day | 200 | 99 | rt-pcr |
| Fei Zhou | Multicenter | Beijing, China | Multicenter | NA | 191 | 56 | 119 | rt-pcr |
| Guo-Qing Qian | Multicenter | Beijing, China | Multicenter | as of 11 February | NA | 91 | 50 | 37 | rt-pcr and clinical |
| Guoping Zhang | Zhongnan Hospital | Wuhan, China | Hospital | Jan 2–February 10, 2020 | NA | 221 | 55 | 108 | rt-pcr |
| Qiannan Guo | Tongji Hospital | Wuhan, China | Hospital | UN | 11 | 57.55 | 9 | rt-pcr |
| Hang Fu | Chengu, hospital | Wuhan, China | Hospital | Jan 1 to Feb 20 | NA | 52 | 44.5 | rt-pcr |
| Heshui Shi | Union Hospital | Wuhan, China | Hospital | Dec 20, 2019, and Jan 23 | NA | 81 | 49.5 | 42 | rt-pcr |
| Huijun Chen | Multicenter | Wuhan, China | Multicenter | 20-Jan | NA | 9 | 26–40 | rt-pcr |
| Jian Wu | Multicenter | Wuhan, China | Multicenter | Jan 22-Jan | NA | 80 | 46.1 | 39 | rt-pcr |
| Jianli Cao | Multicenter | Wuhan, China | Multicenter | 3-Jan | NA | 102 | rt-pcr |
| Jie Liu | Union Hospital | Wuhan, China | Hospital | Jan 16–Jan 25, 2019 | NA | 64 | 35 | 23 | rt-pcr |
| Jing Yuan | Shenzhen hospital | Shenzhen, China | Hospital | Jan 23–Feb 21, 2020 | NA | 25 | 28 | 8 | rt-pcr |
| Jinjun Zhang | Multicenter | Wuhan, China | Multicenter | Jan 20 to Feb 20, 2020 | 30 DAY | 478 | 46.9 | 238 | rt-pcr |
| Jin-Wei Ai | Hubai | Hubai, China | Hospital | UN | 102 | 50.38 | 52 | rt-pcr |
| Jiong Wu | Yancheng City | Yancheng, China | City | 22-Jan | NA | 80 | 44 | 42 | rt-pcr |
| Jun Chen | Shanghai | Shanghai, China | Hospital | Jan 20 to Feb 6, 2020 | 14 day | 249 | 51 | 126 | rt-pcr |
| Kaiyuan Sun | Multicenter | Wuhan, China | Multicenter | Jan 13 and Jan 31 | NA | 507 | 46 | 281 | rt-pcr |
| Kaiyue Diao | Wuhan | Wuhan, China | Hospital | January 17th to February 5th | 30 DAY | 6 | 47.5 | 3 | rt-pcr |
| Kenneth W. Tsang | Hong Kong | Hong Kong, China | University | February 22, 2003, and March 22 | 30 DAY | 10 | 52.5 | 5 | rt-pcr |
| Kui Liu | Multicenter | Wuhan, China | Multicenter | December 30, 2019 to January 24 | 24 DAY | 137 | 57 | 61 | rt-pcr |
| L. Zhang | Multicenter | Wuhan, China | Multicenter | Jan 13, 2020, to Feb 26 | 40 DAY | 28 | 65 | 17 | rt-pcr |
| Lei Liu | Hospital in Chongqing | Chongqing, China | Hospital | January 20 to February 3, 2020 | 14 DAY | 51 | 45 | 32 | rt-pcr |
| lei du | Wuhan Stadium Cabin Hospital | Wuhan, China | Hospital | Feb 13 to Feb 29, 2010 | 14 DAY | 545 | 50 | 264 | rt-pcr |
| Lei Wang | Zhongzhou University | Wuhan, China | University | Jan 21 to Feb 5, 2020 | 14 DAY | 18 | 39 | 10 | rt-pcr |
| Li Yan | Tongji Hospital | Wuhan, China | Hospital | January 10th to February 18th | 18 DAY | 375 | 58.83 | 220 | rt-pcr |
| Li-Li Ren | Wuhan | Wuhan, China | Hospital | December 18 to December 29, 2019 | 12 DAY | 5 | UN | 3 | rt-pcr |
| Lin Fu | Union Hospital | Wuhan, China | Hospital | January 1 to January 30 | 30 DAY | 200 | 99 | rt-pcr |
| Xianning Li | Multicenter | Wuhan, China | Multicenter | 24-Feb | NA | 292 | 47.83 | 134 | rt-pcr |

(continued on next page)
Table 1 (continued)

| Author, Year | Location | Collection Period | Date of Diagnosis | Days Positive | Number of Positive | Test Method |
|--------------|----------|-------------------|------------------|--------------|-----------------|-------------|
| Matt Arentz [71], Evergreen hospital | - | February 20 to March 5 | - | 15 | 91 | RTPCR |
| Naihlin Yang [72], Zhejiang | - | 25th January to 28th February | NA | 10 | 3 | RTPCR |
| Ping Wu [73], Yichang Central People’s Hospital | - | February 8 to 15 | NA | 38 | 65 | RTPCR |
| Qifang Bi [74], Shenzhen, | - | January 14 to February 12 | 25 | 391 | 45 | RTPCR |
| Qiuqiong Ruan [75], Multicenter | - | - | - | 150 | - | RTPCR |
| Tao Yue [76], Renmin hospital | - | - | NA | 55 | 70.7 | RTPCR |
| Wen Zhao [77], Beijing YouAn Hospital | - | January 1 to February 10 | 14 | 77 | 52 | RTPCR |
| Yani Kuang [78], Zhejiang | - | January 17 | NA | 143 | 47 | RTPCR |
| Yani Kuang [79], Zhejiang | - | 1-Jan | NA | 944 | 47.4 | RTPCR |
| Wen Chen [80], Hospital of Guangxi Zhaung | - | 15-Jan | NA | 85 | 41 | RTPCR |
| Xiaomin Lue [81], Renmin hospital | - | Jan 30 to Feb 5 | 25 | 403 | 56 | RTPCR |
| Xiaoqiu Han [82], Union Hospital, | - | December 20th to February 2 | 12 | 17 | 40 | RTPCR |
| Xin Li [83], Wuhan | - | As of February 13 | NA | 25 | 71.48 | RTPCR |
| Yan Deng [84], Wuhan | - | January 1 | NA | 225 | 54 | RTPCR |
| Yang Wu [85], Wuhan | - | 13-Jan | NA | 14 | 59 | RTPCR |
| Yang Li [86], Guangdong | - | December 8, 2019 | NA | 13 | - | RTPCR |
| Yanli Liu [87], Hospital of Wuhan | - | January 2 to February | NA | 109 | 55 | RTPCR |
| Ying Huang [88], Wuhan | - | January 21 and February 10 | 20 | 36 | 69.22 | RTPCR |
| Ying Wen [89], Multicenter | - | - | NA | 417 | 45.4 | RTPCR |
| Yingjie Wu [90], Wuhan | - | 10-Jan | NA | 402 | 198 | RTPCR |
| Xuhai Wang [91], Wuhan | - | December 16 to February 17 | 30 | 90 | 45 | RTPCR |
| Zhibing Lu [92], Multicenter | - | January 1 to February 15 | 15 | 123 | 57.78 | RTPCR |
| Zhiqiang Hu [93], Multicenter | - | From Jan 28 to Feb 9, 2020 | 19 | 24 | - | RTPCR |
| Ping Yu [94], Shanghai | - | 7-Jan-20 | NA | 4 | 74.25 | RTPCR |
| Ali Aminian [95], Tehran | - | 9-Feb | NA | 4 | 63.5 | RTPCR |
| Hui Yu [96], Wuhan | - | Feb 3 to Mar 3 | NA | 105 | 1-16 year | RTPCR |
| Matthieu Million [97], France, multi center | - | March 3rd to March 31 | NA | 1061 | 43.6 | RTPCR |

Bai shaoli Gansu Prov center 22-January NA 8 53.71 4 Rt pcr

NA = not known, RT-PCR = Real Time Polymerase Chain Reaction, CDC = Centers for Disease Control and Prevention, WHO = World Health Organization, CT scan = CT scan of chest, N = number, IQR = interquartile range.

2.2. Study selection

Duplicate studies were removed using EndNote X7 (Thomson Reuters, New York, NY, USA). Records were initially screened by title and abstract by independently two authors (AP, SG). The full-text of potentially eligible records was retrieved and examined. Any discrepancies were resolved by consensus.

2.3. Inclusion criteria

Studies had to fulfill the following pre-determined criteria to be eligible for inclusion in our meta-analysis. Studies were included if they reported the number of confirmed cases of patients with demographic data, [AND] [OR] clinical data, [AND] [OR] laboratory data, [AND] [OR] risk factor data. Confirmed patients were defined as any patient with positive nucleic acid testing (most of the studies with Real-Time PCR) or those meeting CDC and WHO criteria at the time of their publication.

2.4. Exclusion criteria

Studies were excluded if they did not report number of confirmed cases, were letters to the editor or individual case reports or reviews. News reports were also excluded.

2.5. Data extraction

All included publications were published in 2020 and all patients are from China. The following items were extracted from each article: first author, Center and study location in China, sample collection time period, patient follow-up time, reference standard for infection confirmation, number of confirmed cases, and all demographic, clinical, laboratory data, and risk factor data. Two of our authors (AP and SG) independently extracted data and differences were resolved by consensus.

2.6. Quality assessment

Quality assessments of studies were performed by two reviewers independently according to the Critical Appraisal Checklist recommended by the Joanna Briggs Institute [11], and disagreements were resolved by consensus. The checklist is composed of nine questions that reviewers addressed for each study. The ‘Yes’ answer for each question received one point. Thus, final scores for each study could range from zero to nine (Table S2 in Supplementary Material).

2.7. Analysis

Data cleaning and preparation was done in Microsoft Excel 2010 (Microsoft©, Redmond, WA, USA) and further analyses were carried out via Comprehensive Meta-Analysis Software Version 2.0 (Biostat, Englewood, NJ). Determination of heterogeneity among the studies was undertaken using the chi-squared test (Cochran’s Q) to assess the appropriateness of pooling data. We used Random effect model (M – H heterogeneity) for pooled results [12]. P values reflect study heterogeneity with <0.05 being significant. We also used the Begg’s and Egger’s tests based on the symmetry assumption to detect publication bias.

3. Results

3.1. Characteristics of included studies

The process of study selection is displayed in Fig. 1. A total of 36,115 reports were screened for the analysis of patients with COVID-19, 36,014 were excluded after title and abstract screening and the full text of 342 reports were reviewed in full text. We excluded studies that did not report sufficient data and finally 80 studies met the inclusion criteria (Fig. 1). Characteristics of the selected articles are summarized in Table 1. Of the 80 studies that were included in the analysis, 79
studies were in English and the one of them was in the language of Chinese [13]. All studies were retrospective, published in 2020, and all patients were from China.

### Table 2
Demographics, baseline characteristics, and clinical outcomes of patients with confirmed COVID-19.

| Age, years | Clinical presentation* | Confidence interval 95% | Heterogeneity test, I2 (%)** | Heterogeneity test, P Value** | Number of Studies |
|------------|------------------------|-------------------------|-----------------------------|-------------------------------|------------------|
| 48 (mean)  | 43–50                  | 98                      | <0.001                      | 23                            |
| Sex (Male) | 55 (%)                 | 50–57.5                 | 88.4                        | <0.001                        | 24               |
| Fever      | 87 (%)                 | 73–93                   | 98                          | <0.001                        | 18               |
| Cough      | 68 (%)                 | 55.5–74                 | 86                          | <0.001                        | 18               |
| Fatigue    | 39 (%)                 | 29–52.5                 | 93                          | <0.001                        | 14               |
| Spum production/Expectoration | 31 (%) | 19–39                  | <0.001                      | 9                             |
| Myalgia    | 24 (%)                 | 14–43                   | <0.001                      | 2                             |
| Dyspnea    | 24 (%)                 | 12.6–32                 | 92                          | <0.001                        | 11               |
| Sore throat| 14 (%)                 | 7.8–17                  | 52                          | 0.06                          | 9                |
| Headache   | 14 (%)                 | 8.3–18                  | 77                          | <0.001                        | 16               |
| Diarrhea   | 8 (%)                  | 4.6–11.4                | 70                          | <0.001                        | 18               |
| Rhinorrhea | 7 (%)                  | 3–12                    | 0.43                        | 6                             |
| Nausea and vomiting | 6.5 (%) | 2.7–13                 | <0.001                      | 6                             |

### Table 3
Meta-analysis on clinical presentation of case fatality rate (CFR) in different age groups of confirmed COVID-19 cases.

| Age groups (year) | CFR (%) | Confidence Interval | patients | Number Studies | Included patients | Heterogeneity test* |
|-------------------|---------|---------------------|----------|----------------|-------------------|---------------------|
| All Range         | 6       | 4–8                 | 49       | 54,252         | 89.6              | <0.001              |
| <50               | 28.5    | 28–39               | 14       | 1935           | 97                | <0.001              |
| <15               | 0.6     | 0–3                 | 1        | 82             | 0                 | 1                   |

Case fatality rate (CFR), * Greater than 50% is considered high heterogeneity, less than 50% is considered low heterogeneity. A low p value (<0.05) is consistent with high heterogeneity. Case fatality rate (CFR).

### 3.2. Quality assessment

Quality assessment of included studies were performed based on the Critical Appraisal Checklist and the final scores for quality of included studies were in English and the one of them was in the language of Chinese [13]. All studies were retrospective, published in 2020, and all patients were from China.
Table 2 shows that 61,742 confirmed patients with COVID-19 infection were included in the Meta-analysis, of which 55% (95% CI 50–57.5, p < 0.001) were male. The most of the patients had fever 87% (95% CI 83.5–89.5, p < 0.001) and cough 68% (95% CI 65.5–71.4, p < 0.001). A much smaller proportion of patients had sore throat 14% (95% CI 7.8–17, p = 0.06), headache 14% (95% CI 8.3–18, p < 0.001), diarrhea 8% (95% CI 4.6–11.4, p < 0.001), rhinorrhea 7% (95% CI 3–12, p = 0.43) or nausea and vomiting 6.5% (95% CI 2.7–13, p < 0.001). Most patients required hospitalization 81% (95% CI 68–94, p < 0.001), 25.6% (95% CI 6.7–48, p < 0.001) were deemed to be in critical condition and the mortality rate was 6% (95% CI 4–8.5, p < 0.001) between all infected patients. Table 3 shows that case fatality rate (CFR) in <15 years old age groups was 0.6% (95% CI 0–0.9, p > 0.5), >50 years old was 39.5% (95% CI 28.5–52, p < 0.001) (Fig. 2), all range group was 6% (95% CI 4–8.5, p < 0.001) (Fig. 3).

3.3. Demographics, baseline characteristics, and clinical characterisation

The majority of patients, 62.5% (95% CI 54.5–79, p < 0.001), had a history of recent travel endemic area or contact with them. A significant minority of patients (39.5%, 95% CI 20–56, p < 0.001) had a history of chronic diseases and 26.5% (95% CI 9.6–49, p < 0.001) had exposure at the seafood market(s) (Table 4).
7

Table 4
Clinical Characteristics and Comorbid Conditions of patients with confirmed COVID-19.

| Risk Factor | Patients with risk factor (%) | Confidence interval 95% | Heterogeneity test, I² (%) | Heterogeneity test, P Value | Number of Studies reporting |
|-------------|-------------------------------|-------------------------|---------------------------|---------------------------|-----------------------------|
| History of recent travel endemic area or contact with them | 62.5 | 54.5-79 | 96 | <0.001 | 11 |
| Chronic diseases | 39.5 | 20-56 | 95 | <0.001 | 6 |
| Exposure to seafood market | 26.5 | 9-49 | 95 | <0.001 | 8 |
| Sick contacts with respiratory illness | 18 | 4-39.6 | 97 | <0.001 | 7 |
| Hypertension | 18 | 8-24.6 | 97.5 | <0.001 | 17 |
| ARDS | 17.5 | 4-26.7 | 95.7 | <0.001 | 8 |
| Diabetes | 9 | 4-15 | 96 | <0.001 | 11 |
| Current smoker | 8.2 | 3.7-15 | 69 | 0.01 | 8 |
| Chronic liver disease | 7 | 3.8-8.4 | 6 | 0.38 | 12 |
| Digestive system disease | 4.5 | 2.5-4.9 | 95 | <0.001 | 8 |
| Health care worker | 16 | 2-4.6 | 79 | 0.008 | 12 |
| Past smoker | 4 | 1.1-7.5 | 80 | 0.02 | 6 |
| Cardiovascular and cerebrovascular diseases | 3.3 | 2-2.5 | 98 | <0.001 | 14 |
| Chronic respiratory disease | 3.2 | 0.6-8 | 93 | <0.001 | 7 |
| Cancer | 2.7 | 0.4-7.4 | 96.3 | <0.001 | 9 |

ARDS = acute respiratory distress syndrome * Greater than 50% is considered high heterogeneity, less than 50% is considered low heterogeneity. A low p value (<0.05) is consistent with high heterogeneity.

Table 5
Laboratory features for confirmed patients with COVID-19.

| Risk Factor | Patients with risk factor (%) | Confidence interval 95% | Total Number of Studies |
|-------------|-------------------------------|-------------------------|-------------------------|
| Leukocytes (WBCs) (mean) | 6.2 (× 10⁹/L) | 5.3-6.9 | 2961 |
| Increase | 18.3 | 6.4-25.6 | 17 |
| Decreased | 28 (%) | 21-33 | 1212 |
| Neutrophils (mean) | 4.6 (× 10⁹/L) | 3.1-5.1 | 12 |
| Increased | 0.94 | 0.9-1.06 | 3161 |
| Decreased | 57.5 | 42-79 | 18 |
| Platelets (mean) | 196.5 (× 10⁹/L) | 167-205 | 2900 |
| Increase | 61 | 5-30 | 15 |
| Decreased | 32 | 19.7-46.5 | 880 |
| CRP (mean) | 79 (mg/L) | 65-91 | 1300 |
| Increased | 113 | 106-132 | 4 |
| ESR (mean) | 44 | 46.5-57 | 320 |
| Albumin (mean) | 36.8 | 24.5-46 | 420 |
| Decreased | 81 | 72-87 | 5 |
| Interleukin-6 (mean) | 8.1 | 6.8-8.6 | 509 |
| Increased | 56 | 42-61 | 6 |
| LDH (mean) | 286 | 268-294 | 2383 |
| Increased | 69.3 | 58-83 | 12 |

CRP = C Reaction Protein, ESR = Erythrocyte sedimentation rate. WBCs = White blood cells.

* Increased or Decreased refers to values above or below the normal range.

3.5. Laboratory findings of patients infected with COVID-19

The laboratory analysis and features showed that the most infected patients had increased platelets 61% (95% CI 41-78, p < 0.001), and CRP 79% (95% CI 65-91, p < 0.001), while others showed decreased lymphocytes, 57.5% (95% CI 42-79, p < 0.001) (Table 5).

3.6. Chest X-ray and CT scan findings in patients infected with COVID-19

Analysis showed that the most abnormality which finding with Chest X-ray and CT are bilateral involvement of chest radiography 81% (95% CI 62.5-87, p < 0.001), consolidation 73.5% (95% CI 50.5-91, p < 0.001), and ground-glass opacity 73.5% (95% CI 40-90, p < 0.001) (Table 6).

4. Discussion

COVID-19 belongs to the Coronavirus family and is the newest serious zoonotic virus after the related viruses SARS and MERS [23,24]. Prior to 2002, coronaviruses were associated with mild respiratory illness, but with the emergence of SARS in 2002, MERS in 2012, and now in late 2019, COVID-19, establishes that coronaviruses can be associated with severe respiratory disease. Genetic variation and phylogenetic analysis of these viruses show that the COVID-19 virus has 84% homology to other beta-coronaviruses, 96% sequence similarity at the whole genome level to a bat coronavirus and 79.5% similarity to the SARS virus [8,25]. These results suggest that bats are important coronavirus reservoirs.

A study by Adam Bernheim et al. showed that among 121 COVID-19 patients, fever, cough and sputum production were the most common clinical symptoms [3]. Our study found utilizing data from 52,251 patients with COVID-19 infection, that in additional to these, fatigue and myalgia (muscle soreness) were also common.

The large data set here finds that 81% of patients required hospitalization, 25.6% were found to be in critical condition and the mortality rate was 6% between all infected patients. The mortality rate is lower than some studies (for example, 11% in Nanshan et al. [14]), but still higher than many viral infections. It should be recognized that these numbers are bias due to the data set including publications related to screening practices (e.g. only those with symptoms being screened) increased the % value. The true mortality rate from COVID-19 is almost certainly much lower than that found in this study. As more data emerges from screening asymptomatic or mildly symptomatic individuals in China and around the world, the true mortality rate will be better understood. Additionally, at the time of submission of this
The manuscript only ~50% of reported infected patients had recovered (gisalnddatamaps.arcgis.com). Lymphopenia, age, multilobular infiltration, smoking history, hypertension, and bacterial coinfection have been reported as mortality risk factors. Underlying cardiovascular disease (40%) and bilateral pneumonia (81%) were common among those who have died. Recent travel endemic area or contact with them, exposure to persons with respiratory symptoms, and seafood market exposures were common amongst those contracting COVID-19. Among 2361 COVID-19 patients with laboratory data available, leukocytosis was found in 18.3% and leukopenia in 28% with lymphocytopenia in 57.5%. Among 2200 patients, thrombocytosis occurred in 61% and in a smaller sample (n = 290) CRP was increased in 79%.

A study by Yu Zhao et al. showed that ACE2 is a COVID-19 virus receptor and that it is normally expressed on pulmonary alveolar epithelial cells [26]. ACE2 activates the RAS cascade, which can lead to hypertension. The pathology in this pathway can also stimulate fibrogenesis, inflammation, cell hypertrophy, and cell proliferation [27,28]. ACE2 expression is increased in people with pulmonary ARDS and acute respiratory injury [29]. The data collected here shows that ARDS occurred in 17.5% of reported patients with COVID-19 infection.

4.1. Limitations

Several limitations of this study exist. Publication bias and study heterogeneity are unavoidable in this type of study, therefore it should be considered when interpreting the outcomes of the reports and our final data set. Further, this study likely overestimates disease severity due to lack of screening of asymptomatic or mildly symptomatic individuals and subsequent publication bias related to these factors. It is very likely that many infected persons have not been detected, thus falsely elevating the rates of hospitalization, critical condition, and mortality.

5. Conclusions

Fever and cough are the most common symptoms of COVID-19 infection in the literature published to date. Thrombocytosis, lymphopenia, and increased CRP were common lab findings although most patients included in the overall analysis did not have laboratory values reported. The most common radiographic sign was bilateral involvement in and consolidation. Among Chinese patients with COVID-19, rates of hospitalization, critical condition, and hospitalization were high in this study, but these findings may be biased by reporting of only confirmed cases.

Declaration of competing interest

The authors have declared that no competing interests exist.

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None.

Table 6

| Abnormality (%) | Confidence interval 95% | Heterogeneity test, I² (%) | Heterogeneity test, P Value | Number of Studies |
|-----------------|-------------------------|---------------------------|---------------------------|------------------|
| Bilateral involvement of chest radiography | 81 | 62.5–87 | 93 | <0.001 | 18 |
| Consolidation | 73.5 | 50.5–91 | 89 | <0.001 | 9 |
| Ground-glass opacity | 73.5 | 40–90 | 97 | <0.001 | 16 |
| Unilateral involvement of chest radiography | 18.5 | 8.5–29.5 | 94 | <0.001 | 9 |

* Greater than 50% is considered high heterogeneity, less than 50% is considered low heterogeneity. A low p value (<.05) is consistent with high heterogeneity. CT scan = CT scan.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.micpath.2020.104390.

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Author contributions

Conceived and designed the study: AP, SG, Comprehensive research: SG, AK, AP, Analyzed the data: A P, MAM, Wrote and revised the paper: AP, SG, BB, AK, RT, MAM, NB, DK, JPI, Participated in data analysis and manuscript editing: AP, SG, BB, AK, RT, MAM, NB, DK, JPI.

Ethical statement

The manuscript is a systematic review, so the ethical approval was not required for the study.

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