

# Clinical symptoms, comorbidities and complications features in severe and non-severe patients with COVID-19: a systematic review and meta-analysis without cases duplication

**Zhufeng Wang**

Guangdong Hospital of Traditional Chinese Medicine

**Hongsheng Deng** (✉ [hs\\_deng96@126.com](mailto:hs_deng96@126.com))

Guangzhou Medical College First Affiliated Hospital

**Changxing Ou**

The first affiliated hospital of Guangzhou Medical University

**Jingyi Liang**

The first affiliated hospital of Guangzhou Medical University

**Yingzhi Wang**

The first affiliated hospital of Guangzhou Medical University

**Mei Jiang**

The first affiliated hospital of Guangzhou Medical University

**Shiyue Li**

The first affiliated hospital of Guangzhou Medical University

---

## Research

**Keywords:** Coronavirus Disease 2019 (COVID-19), Severe, Meta-analysis

**DOI:** <https://doi.org/10.21203/rs.3.rs-30787/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

**Background:** The pandemic of COVID-19 posed a challenge to global healthcare. The mortality rates of severe cases range from 8.1% to 31.8%, and it is particularly important to identify risk factors that aggravate the disease.

**Methods:** We performed a systematic review of the literature with meta-analysis, using 7 databases to assess clinical characteristics, comorbidities and complications in severe and non-severe patients with COVID-19. All the observational studies were included. We performed a random or fixed effects model meta-analysis to calculate the pooled proportion and 95% CI. Measure of heterogeneity was estimated by Cochran's Q statistic,  $I^2$  index and *P* value.

**Results:** 4881 cases from 25 studies related to COVID-19 were included. The most prevalent comorbidity was hypertension (severe: 33.4%, 95% CI: 25.4% - 41.4%; non-severe 21.6%, 95% CI: 9.9% - 33.3%), followed by diabetes (severe: 14.4%, 95% CI: 11.5% - 17.3%; non-severe: 8.5%, 95% CI: 6.1% - 11.0%). The prevalence of ARDS, AKI and shock were all higher in severe cases, with 41.1% (95% CI: 14.1% - 68.2%), 16.4% (95% CI: 3.4% - 29.5%) and 19.9% (95% CI: 5.5% - 34.4%), rather than 3.0% (95% CI: 0.6% - 5.5%), 2.2% (95% CI: 0.1% - 4.2%) and 4.1% (95% CI: -4.8% - 13.1%) in non-severe patients, respectively. The death rate was higher in severe cases (30.3%, 95% CI: 13.8% - 46.8%) than non-severe cases (1.5%, 95% CI: 0.1% - 2.8%).

**Conclusions:** Hypertension, diabetes and cardiovascular diseases may be risk factors for COVID-19 patients to develop into severe cases.

## Background

Since the end of 2019, there's been a surge in cases of COVID-19 with 153517 laboratory-confirmed cases and 5735 death as of March 15<sup>th</sup>. COVID-19 exerted an adverse influence on globally, especially increasing the burden of healthcare. According to latest report[1-3], mortality rates of severe cases(8.1%-31.8%) is significantly higher than general estimation of WHO (2.9%)[4]. Severe patients often have dyspnea or hypoxemia one week after onset, which may rapidly progress to acute respiratory distress syndrome (ARDS), septic shock, metabolic acidosis that is difficult to correct, and coagulation dysfunction. Therefore, it's critical to reveal early risk factors of severe cases under the circumstance of wide-spread outbreak, which is helpful for precise treatment and prognosis improvement. Notably, previous studies have clarified that patients particularly vulnerable to severe disease are those with pre-existing medical conditions such as diabetes, cardiovascular diseases, renal failure, obesity, and immunodeficiency[5, 6]. Wang et al. reported 138 cases of COVID-19 and the result indicated that almost half of hospitalized patients had comorbidities, and patients admitted to ICU with comorbidities was twice as high as without comorbidities[2]. To sum up, evaluating the prevalence of underlying diseases is fundamental to mitigate COVID-19 complications. However, this effort has been hindered by the limited number of cases and confounding classification in pre-exist studies.

The present study was undertaken to provide a systematic evaluation without cases duplication to compare the prevalence of demographic, comorbidities, symptoms, complications and outcomes between severe and non-severe COVID-19 cases. This assessment may aid the public health sector while developing policies for surveillance and response to COVID-19 and its severe outcomes.

## Aims

The followings are the aims of the study:

- To demonstrate the differences in the field of demographic, comorbidities, clinical symptoms, complications and outcomes between severe and non-severe patients with COVID-19.
- To figure out the risk factor of conversion to severe.

## Methods

We registered the study protocol with PROSPERO (registration number ID: CRD42020177414) (Supplemental material: study protocol).

### Search strategy

We searched PubMed, Web of Science, Cochrane Library, CBM (Chinese Biomedical), CNKI (China National Knowledge Infrastructure), WanFang, and VIP databases up to March 16, 2020. The search terms were used as follows: “Wuhan coronavirus” OR “COVID-19” OR “novel coronavirus” OR “2019-nCoV” OR “coronavirus disease” OR “SARS-CoV-2” OR “SARS2” OR “severe acute respiratory syndrome coronavirus 2”; the full search strategy is shown in Supplemental material: search strategy. The search was limited to English and Chinese language. We hand-searched included papers’ reference lists and contacted experts in the field to ensure a comprehensive review.

### Inclusion and exclusion criteria

We included studies which:

- Examined laboratory-confirmed patients with COVID-19.
- Examined the demographic, early comorbidities, clinical symptoms, complications, and outcomes of severe and (or) non-severe patients with COVID-19.
- Reported mean  $\pm$  SDs or proportion and 95% confidence interval (95% CI) of these factors.
- Observational studies.

We excluded papers which:

- Did not contribute to any conducted factors of this study. (We will include the maximum sample size of the same hospital according to specific indicators. If the article does not contribute to all

indicators of this study, it will be excluded even if it meets all inclusion criteria, so as to avoid the duplication of sample size.)

- Did not provide full-text.
- Did not publish in neither English nor Chinese.

## Screening papers

After excluding duplicate papers, one researcher (ZW) screened the titles and abstracts using the eligibility criteria. Then two researchers (HD, CO) assessed the rest full-text articles for eligibility. The Kappa value for study inclusion between them was 0.82, which showed strong consistency. Consensus on the inclusion of all studies was agreed by two researchers (HD, CO) with any disagreements resolved in a discussion with researcher (ZW).

## Data Extraction and synthesis

Where available, the following information from each article was extracted using a standardized data extracted form: title, study design, study period, location, first author, publication year, sample size, sex distribution, any comorbidities, clinical symptoms, complications.

We extracted the counting data as the number of occurrences of an event versus the total number of people reported for that event (n/N). Additionally, we used the mean and standard deviation (SD), or median and interquartile range (IQR) (or median and range), to record the measurement data.

## Data analysis

### Quality assessment and analysis

Two researchers (CO, HD) assessed the risk of bias in individual papers using the Newcastle-Ottawa Scale (NOS) for assessing the quality of cohort studies and case-control studies[7]. This considered the domains of selection, comparability and ascertainment of the outcome of interest. A study with a score of 0-3, 4-6 and 7-9 was considered as poor, intermediate and high quality, respectively. The Weighted Kappa value was 0.67 on quality rating criteria, and consensus was reached through discussion in cases of disagreement on individual rating criteria.

### Statistical analysis

All analyses were conducted using STATA Version 15. Unit discordance for variables will be resolved by converting all units to a standard measurement for that variable. We conducted analyses by severity (severe vs non-severe). We used a random-effects model or a fixed-effects model to calculate the pooled proportion or mean and 95% confidence interval (95% CI) of all reported variables. All *P* values were based on two-sided tests and were considered statistically significant at  $P < 0.05$ . Measure of heterogeneity, including Cochran's Q statistic and the  $I^2$  index were estimated and reported. The pooled results from a random-effects model would be reported when the  $I^2 > 50\%$  and  $P < 0.10$ , which indicated

substantial heterogeneity. Publication bias was checked by visual inspection of funnel plots and tested using Egger's test when ten or more studies reported the variable, and the Egger test with  $P < 0.05$  was considered to be an indication of substantial publication bias.

## Results

We extracted data from 25 studies reported COVID-19 cases between December, 2019 and February, 2020 (Table 1), including a total of 4881 laboratory-confirmed patients with COVID-19. The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) diagram (Fig.1) describes the results of the search and reasons for excluding studies. All included studies were from hospitals in China mainland, with 12 from Hubei, 4 from Chongqing, 3 from Beijing and 1 each from Anhui, Henan, Hunan, Shanxi, Liaoning and Wenzhou. Publication bias was assessed with a funnel plot for the standard error by logit event, with no evidence of bias (Fig.2). Additionally, the Egger test ( $P=0.312$ ) suggested that there was no notable evidence of publication bias. We analyzed 20 variables for the meta-analysis, the following results were all presented in detail in Table 2.

### Comparison on demographic

The average age was higher in severe cases as compared with non-severe cases (48.5 vs. 38.5,  $P < 0.10$ ;  $P=0.01$ ). The sex ratio (male to female) was 1.33 in severe cases and 0.95 in non-severe cases. Being aged or male were considered as risk factors to severe COVID-19 (RR=1.29, 95% CI: 1.12 - 1.47). ( Figure 3 )

### Comparison in comorbidities

Prevalence of comorbidity in severe cases was remarkably higher in severe cases (58.4%, 95% CI: 48.8% - 67.9%) than non-severe cases (27.6%, 95% CI: 18.6% - 36.6%) ( $P=0.00$ ). Meta-analysis showed that in both groups, the most prevalent comorbidity was hypertension (severe case: 33.4%, 95% CI: 25.4% - 41.4%; non-severe cases: 21.6%, 95% CI: 9.9% - 33.3%;  $P=0.00$ ), followed by diabetes (severe case: 14.4%, 95% CI: 11.5% - 17.3%; non-severe cases: 8.5%, 95% CI: 6.1% - 11.0%;  $P=0.00$ ). With any comorbidity (RR=1.96, 95% CI: 1.69 - 2.26), especially diabetes (RR=1.53, 95% CI: 1.29 - 1.82), hypertension (RR=1.40, 95% CI: 1.22 - 1.60), cardiovascular disease (RR=1.79, 95% CI: 1.50 - 2.13) and COPD (RR=2.10, 95% CI: 1.70 - 2.58) were considered as risk factors to severe COVID-19. ( Figure 3 )

### Comparison on clinical symptoms

Both in severe and non-severe case, the most common clinical symptom was fever (severe: 90.0%, 95% CI: 86.7% - 93.3%; non-severe: 78.4%, 95% CI: 70.7% - 86.2%;  $P=0.00$ ), followed by cough (severe: 69.0%, 95% CI: 60.4% - 77.5%; non-severe: 54.2%, 95% CI: 47.0% - 61.5%;  $P=0.00$ ). Myalgia or fatigue (severe: 36.7%, 95% CI: 25.5% - 48.0%; non-severe: 28.8%, 95% CI: 20.2% - 37.4%;  $P=0.00$ ) and sputum production (severe: 37.3%, 95% CI: 23.3% - 51.3%; non-severe: 23.3%, 95% CI: 18.4% - 28.1%;  $P=0.00$ ) were almost

equally prevalent in two groups. The overall proportion of clinical symptoms was about 10%-15% higher in severe patients (RR: 1.60~2.47). ( Figure 3 )

### **Comparison on complications**

Severe cases have significantly higher prevalence as compared with control group for ARDS (41.1% vs. 3.0%,  $P=0.00$ ), AKI (16.4% vs. 2.2%,  $P=0.00$ ), shock (19.9% vs. 4.1%,  $P=0.00$ ). ARDS (RR=5.06, 95% CI: 4.08 – 6.27), AKI (RR=2.17, 95% CI: 1.81 – 2.60) and shock (RR=3.17, 95% CI: 2.36 – 4.27) were all risk factors to severe COVID-19. ( Figure 3 )

### **Comparison on outcomes**

The mortality was obviously higher in severe cases than non-severe cases (30.3% vs. 1.5%,  $P=0.00$ ). Severe patients were 2.30 times more likely to die than non-severe patients (RR=2.30, 95% CI: 2.02 – 2.63). ( Figure 3 )

## **Discussion**

This is the first meta-analysis that avoids the phenomenon of included cases duplication, which compares severe and non-severe COVID-19 in the field of demographic features, clinical symptoms comorbidities, complications and outcomes. Based on 4881 laboratory-confirmed cases with COVID-19 in mainland China from 25 studies, we found that being male was more susceptible to severe COVID-19. In terms of comorbidities, patients combining diabetes, hypertension, cardiovascular disease and COPD were more likely to develop severe COVID-19, which was consistent with the findings of Guan Wei-jie et al. to some degree[31]. Fever and cough were the main clinical symptoms in both severe and non-severe cases, which was consistent with previous studies[1, 2, 32] . As for complications, ARDS, AKI or shock were much more likely to observed in severe cases, which was in accordance with the finding on MERS-CoV[6, 33]. The death rate of severe cases was obviously higher than the WHO estimates as 2.90%, while it was lower in non-severe cases.

Based on results of clinical symptoms, we found that a significant difference between severe and non-severe patients with COVID-19 on overall factors. But in clinical practice, it is difficult to conclude whether a patient is more likely to develop severe or non-severe COVID-19 based on such clinical symptoms. Nonetheless, clinical symptoms are undoubtedly essential for susceptible cases screening.

According to our analysis results on comorbidities, severe patients used to be with comorbidities on admission especially as diabetes, hypertension and cardiovascular disease, which could affect some key mediators of the host's innate immune response[33]. Previous findings on MERS-CoV also found that people with severe illness were more likely to combine these underlying comorbidities[33]. This can be explained by the phenomenon of cytokine storm that a variety of cytokines gather in the body fluids. Early studies of MERS-CoV found that the amount of Th1/Th2 cytokines profile was higher in patients with diabetes, hypertension or cardiovascular disease which was linked with exacerbation of pro-inflammatory

state and generation of oxidative stress[17, 34-38]. Studies have shown that cytokine storm indicate poor prognosis and tissue damage[10] . So far in COVID-19 patients, research has shown that ICU patients had higher plasma levels of IL-2, IL-7, IL-10, GSCF, IP10, MCP1, MIP1A, and TNF- $\alpha$  compared with non-ICU patients[1].

Considering that these cytokines mainly belong to Th1 or Th2 subgroups, we infer that patients with comorbidities, especially those with diabetes, hypertension or cardiovascular disease, are more likely to develop severe COVID-19. Therefore, we suggest that clinicians can pay more attention to patients with comorbidities, which may prevent the development of severe COVID-19 and its progressive complications with suitable care.

Also, it is believed that cytokine storm is also an important cause of ARDS and multiple organ failure in patients with viral infections[39, 40].

Therefore, we believed that patients combined with diabetes, hypertension or cardiovascular disease were more likely to develop progressive complications, which was fatal and difficult to cure.

As mentioned on complications of severe and non-severe patients, we found that the incidence of ARDS, AKI and shock were remarkably higher in severe patients. This was also consistent with the conclusion of previous research that secondary pneumonia, ARDS, encephalitis, myocarditis and other fatal complications could occur in severe patients[6, 33]. These severe clinical manifestations caused by the underlying comorbidities can also be seen in other respiratory diseases such as influenza and influenza H1N1[32, 39, 41]. With evaluating the occurrence of complications induced by SARS-CoV-2 infection, it helps us fully understand the adverse impact and disease burden of severe COVID-19.

In general, figuring out differences on comorbidities, clinical symptoms and complications between severe and non-severe patients may serves as the superb way to effectively prevent patients who are non-severe but combined comorbidities from developing severe COVID-19. Besides, due to the similarity between COVID-19 with SARS and MERS to a certain extent, we could draw some experience in the previous studies of SARS and MERS while comparing with the studies of COVID-19 as well. We hope that this assessment may aid the public health sector while developing policies for surveillance and response to COVID-19 and its severe outcomes. Also, we hope that it may aid the development of vaccination for those vulnerable people.

## **Strengths And Limitations**

We followed the PRISMA procedure in this meta-analysis for medical evidence searching. For the sake of data sources from each literature, we excluded the potential repeated cases from the same hospital or region according to every specific variable which we are about to conduct, avoiding to amplify the false effect of some factors by including many duplicate cases.

There are still some limitations in this study. First, all the included studies are conducted in mainland China, so the outcomes may not be suitable for the international situation at present. Second, there were some differences in the proportion of diabetes, hypertension or cardiovascular diseases between the studies, which may be a source of heterogeneity.

But these results can play a certain reference value and alert role for future epidemic prevention and treatment measures.

## **Conclusion**

There is a significant difference between severe and non-severe patients with COVID-19 in terms of demographic features, clinical symptoms, comorbidities, complications and outcomes. Hypertension, diabetes and cardiovascular diseases may be risk factors for COVID-19 patients to develop into severe cases.

## **Abbreviations**

COVID-19: corona virus disease 2019

SARS : severe acute respiratory syndrome

MERS-CoV: middle east respiratory syndrome coronavirus

WHO: world health organization

SD: standard deviation

IQR: interquartile range

CI: confidence interval

RR: relative risk

ARDS: acute respiratory distress syndrome

AKI: acute kidney injury

## **Declarations**

### **Ethics approval and consent to participate**

No ethical approval was required for this systematic review of existing published literature.

### **Consent for publication**



Not applicable.

## Competing interests

The authors declare that they have no competing interests.

## Funding

None.

## Authors' contributions

Conception and design: Mei Jiang, Shiyue Li, Zhufeng Wang, Yingzhi Wang; (II) Administrative support: Mei Jiang, Shiyue Li; (III) Collection and assembly of data: Zhufeng Wang, Hongsheng Deng, Changxing Ou and Jingyi Liang; (V) Data analysis and interpretation: Zhufeng Wang, Hongsheng Deng, Changxing Ou and Yingzhi Wang; (VI) Manuscript writing: All authors; (VII) All authors have read and approved the manuscript.

## Acknowledgements

Not applicable.

## References

1. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X *et al*: Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet (London, England)* 2020, 395(10223):497-506.
2. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, Wang B, Xiang H, Cheng Z, Xiong Y *et al*: Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. *Jama* 2020.
3. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, Shan H, Lei CL, Hui DSC *et al*: Clinical Characteristics of Coronavirus Disease 2019 in China. *The New England journal of medicine* 2020.
4. Batlle D, Wysocki J, Satchell K: Soluble angiotensin-converting enzyme 2: a potential approach for coronavirus infection therapy? *Clinical science (London, England : 1979)* 2020, 134(5):543-545.
5. Al-Tawfiq JA, Hinedi K, Ghandour J, Khairalla H, Musleh S, Ujayli A, Memish ZA: Middle East respiratory syndrome coronavirus: a case-control study of hospitalized patients. *Clinical infectious diseases : an official publication of the Infectious Diseases Society of America* 2014, 59(2):160-165.
6. Assiri A, Al-Tawfiq JA, Al-Rabeeah AA, Al-Rabiah FA, Al-Hajjar S, Al-Barrak A, Flemban H, Al-Nassir WN, Balkhy HH, Al-Hakeem RF *et al*: Epidemiological, demographic, and clinical characteristics of 47 cases of Middle East respiratory syndrome coronavirus disease from Saudi Arabia: a descriptive study. *The Lancet Infectious diseases* 2013, 13(9):752-761.

7. Wells G, Shea B, O'Connell J: The Newcastle-Ottawa Scale (NOS) for Assessing The Quality of Nonrandomised Studies in Meta-analyses. *Ottawa Health Research Institute Web site* 2014, 7.
8. Cheng K, Wei M, Shen H, Wu C, Chen D, Xiong W, Zhou X, Zhang D, Zheng J.: Clinical characteristics of 463 patients with normal and severe COVID-19 rehabilitation. *Shanghai Medical Journal* 2020.
9. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, Wu Y, Zhang L, Yu Z, Fang M *et al*: Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *The Lancet Respiratory medicine* 2020.
10. Xu S, Hu H, Hu Y, Shui H: Clinical features of 62 cases of critical COVID-19 with acute renal injury. *Medical Journal of Wuhan University* 2020.
11. Bai P, He W, Zhang X, Jin J, Liu S: Clinical characteristics of 58 patients with severe and critical COVID 19 . *Chin J Emerg Med* 2020, 29.
12. Peng YD, Meng K, Guan HQ, Leng L, Zhu RR, Wang BY, He MA, Cheng LX, Huang K, Zeng QT: Clinical characteristics and outcomes of 112 cardiovascular disease patients infected by 2019-nCoV. *Chin J Cardiol* 2020, 48(0):E004-E004.
13. Wen K, Li W, Zhang D, Zhang A, Zhang T, Zhao P, Qin E: Epidemiological and clinical characteristics of 46 COVID - 19 patients in Beijing. *Chinese Journal of Infectious Diseases* 2020, 38.
14. Xu YH, Dong JH, An WM, Lv XY, Yin XP, Zhang JZ, Dong L, Ma X, Zhang HJ, Gao BL: Clinical and computed tomographic imaging features of novel coronavirus pneumonia caused by SARS-CoV-2. *The Journal of infection* 2020, 80(4):394-400.
15. Wan Q, Shi A, He T, Tang L: Clinical characteristics of 153 cases infected with COVID - 19 in Chongqing area. *Chin J Clin Infect Dis* 2020, 13.
16. Yuan J, Sun Y, Zuo Y, Chen T, Cao Q, Yuan G, Yang M, Zhang W, Peng A, Chen Y: Clinical characteristics of 153 cases infected with COVID - 19 in Chongqing area. *Journal of Southwest University(Natural Science Edition)* 2020.1-7.
17. Xiong J, Jiang W, Zhou Q, Hu X, Liu C: Clinical characteristics, treatment and prognosis of 89 patients with COVID-19. *Medical Journal of Wuhan University* 2020.
18. Lu Z, He R, Jiang W, Fan C, Geng Q: Analysis of clinical characteristics and immune function of COVID-19 patients. *Medical Journal of Wuhan University* 2020.
19. Fang X, Mei Q, Yang T, Zhang L, Yang Y, Wang Y, Tong F, Ye C, Gao Y, Huang Y *et al*: Clinical features and treatment of 79 cases infected by COVID-19. *Chinese Pharmacological Bulletin* 2020, 36.
20. Xiao K, Shui L, Pang X, Mou H, Wang J, Lang C, Lv J, Sun K, Li W, Chen Y: Analysis of clinical characteristics of 143 patients with COVID-19 in northeast Chongqing. *Journal of Third Military Medical University* 2020.
21. Li K, Wu J, Wu F, Guo D, Chen L, Fang Z, Li C: The Clinical and Chest CT Features Associated with Severe and Critical COVID-19 Pneumonia. *Investigative radiology* 2020.
22. Cheng J, Huang C, Zhang G, Liu D, Li P, Lu C, Li J: Epidemiological characteristics of COVID-19 in Henan province. *Chinese Journal of Tuberculosis and Respiratory Diseases* 2020, 43.

23. Dai Z, Gao L, Luo K, Xiao J, Huang C, Zeng K, Liu Z, Zhao S, Yang H, Sun Q *et al*: Analysis of clinical characteristics of COVID-19 in Hunan province. *Practical Preventive Medicine* 2020, 27.
24. Gao T, He X, Su H, Zheng H, Jiang Y, Chen J, Xu X: Clinical characteristics of COVID-19 in 11 cases. *Chinese Journal of Infectious Diseases* 2020, 13.
25. Li D, Liu H, Wang Y, Guo H, Wang Y, Wang K, Zhao R, Wu Y, Li X: Clinical characteristics of COVID-19 in 30 cases. *Chin J Infect* 2020, 38.
26. Chen C, Chen C, Yan J, Zhou N, Zhao J, Wang D: Analysis of myocardial injury and cardiovascular disease in critically ill patients with COVID-19. *Chin J Cardiol* 2020, 48.
27. Tian S, Hu N, Lou J, Chen K, Kang X, Xiang Z, Chen H, Wang D, Liu N, Liu D *et al*: Characteristics of COVID-19 infection in Beijing. *The Journal of infection* 2020, 80(4):401-406.
28. Zhang JJ, Dong X, Cao YY, Yuan YD, Yang YB, Yan YQ, Akdis CA, Gao YD: Clinical characteristics of 140 patients infected with SARS-CoV-2 in Wuhan, China. *Allergy* 2020.
29. Chen M, An W, Xia F, Yang P, Liao Y, Fang S, Xu X, Zhang M: Retrospective analysis of case data of COVID-19 patients with different clinical type. *Herald of Medicine* 2020.
30. Yang W, Cao Q, Qin L, Wang X, Cheng Z, Pan A, Dai J, Sun Q, Zhao F, Qu J *et al*: Clinical characteristics and imaging manifestations of the 2019 novel coronavirus disease (COVID-19): A multi-center study in Wenzhou city, Zhejiang, China. *The Journal of infection* 2020, 80(4):388-393.
31. Guan WJ, Liang WH, Zhao Y, Liang HR, Chen ZS, Li YM, Liu XQ, Chen RC, Tang CL, Wang T *et al*: Comorbidity and its impact on 1590 patients with Covid-19 in China: A Nationwide Analysis. *The European respiratory journal* 2020.
32. Akbar DH: Bacterial pneumonia: comparison between diabetics and non-diabetics. *Acta diabetologica* 2001, 38(2):77-82.
33. Badawi A, Ryoo SG: Prevalence of comorbidities in the Middle East respiratory syndrome coronavirus (MERS-CoV): a systematic review and meta-analysis. *International journal of infectious diseases : IJID : official publication of the International Society for Infectious Diseases* 2016, 49:129-133.
34. Mahlangu T, Dlodla PV, Nyambuya TM, Mxinwa V, Mazibuko-Mbeje SE, Cirilli I, Marcheggiani F, Tiano L, Louw J, Nkambule BB: A systematic review on the functional role of Th1/Th2 cytokines in type 2 diabetes and related metabolic complications. *Cytokine* 2020, 126:154892.
35. Al-Shukaili A, Al-Ghafri S, Al-Marhoobi S, Al-Abri S, Al-Lawati J, Al-Maskari M: Analysis of inflammatory mediators in type 2 diabetes patients. *International journal of endocrinology* 2013, 2013:976810.
36. Limonta D, Torres G, Capo V, Guzman MG: Apoptosis, vascular leakage and increased risk of severe dengue in a type 2 diabetes mellitus patient. *Diabetes & vascular disease research* 2008, 5(3):213-214.
37. Kaviarasan K, Jithu M, Arif Mulla M, Sharma T, Sivasankar S, Das UN, Angayarkanni N: Low blood and vitreal BDNF, LXA4 and altered Th1/Th2 cytokine balance are potential risk factors for diabetic retinopathy. *Metabolism: clinical and experimental* 2015, 64(9):958-966.

38. Dharmashankar K, Widlansky ME: Vascular endothelial function and hypertension: insights and directions. *Current hypertension reports* 2010, 12(6):448-455.
39. Mertz D, Kim TH, Johnstone J, Lam PP, Science M, Kuster SP, Fadel SA, Tran D, Fernandez E, Bhatnagar N *et al*: Populations at risk for severe or complicated influenza illness: systematic review and meta-analysis. *BMJ (Clinical research ed)* 2013, 347:f5061.
40. Gupta DL, Bhoi S, Mohan T, Galwnkar S, Rao DN: Coexistence of Th1/Th2 and Th17/Treg imbalances in patients with post traumatic sepsis. *Cytokine* 2016, 88:214-221.
41. Kuszniarz G, Uboldi A, Sosa G, Torales S, Colombo J, Moyano C, Escobar H, Lejona S, Anchart E, Gomez A *et al*: Clinical features of the hospitalized patients with 2009 pandemic influenza A (H1N1) in Santa Fe, Argentina. *Influenza and other respiratory viruses* 2013, 7(3):410-417.

## Tables

### Table 1. Description of 25 studies retrieved from systematic search

PLA People's Liberation Ar

### Table 2. Meta-analysis Results

First Authour	Year	Location	Study Design	Number of Patients	Study period	Quality score
Chaolin Huang[1]	2020	Wuhan, China (Jin-Yintan hospital)	prospective study	41	By Jan. 2, 2020	7
Cheng Kebin[2]	2020	Wuhan, China (Jin-Yintan hospital)	retrospective study	463	By Feb. 6, 2020	5
Xiaobo Yang[3]	2020	Wuhan, China (Jin-Yintan hospital)	retrospective study	52	Dec. 2019 to Jan. 26, 2020	6
Xu Shen[4]	2020	Wuhan, China (Zhongnan hospital)	retrospective study	62	Jan. 8, 2020 to Feb. 24, 2020	5
Dawei Wang[5]	2020	Wuhan, China (Zhongnan hospital)	retrospective study	138	Jan. 1, 2020 to Jan. 28, 2020	7
Bai Peng[6]	2020	Wuhan, China □ Xiehe hospital)	retrospective study	58	Jan. 29, 2020 to Feb. 26, 2020	6
Peng Yudong[7]	2020	Wuhan, China □ Xiehe hospital)	retrospective study	112	Jan. 20, 2020 to Feb. 15, 2020	5
Wen Ke[8]	2020	Beijing, China (The Fifth Medical Center of Chinese PLA General Hospital)	retrospective study	46	Jan. 20, 2020 to Feb. 8, 2020	4
Yuhuan Xu[9]	2020	Beijing, China (The Fifth Medical Center of Chinese PLA General Hospital)	retrospective study	59	Jan. 2020 to Feb. 2020	5
Wan Qiu[10]	2020	Chongqing, China (Treatment center)	retrospective study	153	Jan. 26, 2020 to Feb. 5, 2020	5
Yuan Jing[11]	2020	Chongqing, China (Treatment center)	retrospective study	223	Jan. 24, 2020 to Feb. 23, 2020	6
Xiong Juan[12]	2020	Wuhan, China (Renmin Hospital of Wuhan University)	retrospective study	89	Jan. 17, 2020 to Feb. 20, 2020	6
Lu Zilong[13]	2020	Wuhan, China (Renmin Hospital of Wuhan University)	retrospective study	101	Jan. 15, 2020 to Feb. 15, 2020	4
Fang Xiaowei[14]	2020	Anhui, China	retrospective study	79	Jan. 22, 2020 to Feb. 18, 2020	5

Xiao Kaihu[15]	2020	Chongqing, China (San-Xia hospital)	retrospective study	143	Jan. 23, 2020 to Feb. 8, 2020	4
Kunhua Li[16]	2020	Chongqing, China (the Second Affiliated Hospital of Chongqing Medical University)	retrospective study	83	Jan. 2020 to Feb. 2020	5
Cheng Jiuling[17]	2020	Henan, China	cross sectional	1265	By Feb. 19, 2020	3
Dai Zhihui[18]	2020	Hunan, China	retrospective study	918	Jan. 21, 2020 to Feb. 13, 2020	4
Gao Ting[19]	2020	Shanxi, China (Xianyang central hospital)	retrospective study	11	Jan. 20, 2020 to Feb. 15, 2020	5
Li Dan[20]	2020	Liaoning, China	retrospective study	30	Jan. 22, 2020 to Feb. 8, 2020	6
Chen Chen[21]	2020	Wuhan, China (Tongji hospital)	retrospective study	150	Jan. 2020 to Feb. 2020	5
SiJia Tian[22]	2020	Beijing, China (Emergency center)	retrospective study	262	By Feb. 10, 2020	5
Jin-jin Zhang[23]	2020	Wuhan, China (No.7 hospital of Wuhan)	retrospective study	140	Jan. 16, 2020 to Feb. 3, 2020	5
Chen Min[24]	2020	Hubei, China (the third Renmin hospital of Jiangnan university)	retrospective study	54	Jan. 24, 2020 to Feb. 8, 2020	6
Wenjie Yang[25]	2020	Wenzhou, China	retrospective study	149	Jan. 17, 2020 to Feb. 10, 2020	6

---

Variable	Group	number	event	n	Mean (y-old)/ Prevalence, (95% CI)	Heterogeneity			Test for subgroup differences	
						Q	I <sup>2</sup>	Pvalue	RR (95% CI)	Pvalue
Age	severe	14	-	599	48.5 (42.7 - 54.4)	823.14	98.4%	0.00	-	0.01
	non-severe	15	-	1586	38.5 (34.3 - 42.6)	2530.23	99.4%	0.00		
Male	severe	14	351	613	57.8% (53.9% - 61.6%)	13.22	1.7%	0.43	1.29 (1.12 - 1.47)	0.00
	non-severe	15	778	1600	48.2% (44.6% - 51.8%)	26.95	48.0%	0.02		
Female	severe	14	263	613	42.4% (38.5% - 46.2%)	13.50	3.7%	0.41	0.78 (0.68 - 0.90)	0.00
	non-severe	15	822	1600	51.8% (48.2% - 55.4%)	26.95	48.0%	0.02		
Any comorbidity	severe	9	281	500	58.4% (48.8% - 67.9%)	36.95	78.3%	0.00	1.96 (1.69 - 2.26)	0.00
	non-severe	10	337	1061	27.6% (18.6% - 36.6%)	100.21	91.0%	0.00		
Diabetes	severe	12	85	551	14.4% (11.5% - 17.3%)	9.05	0.0%	0.62	1.53 (1.29 - 1.82)	0.00
	non-severe	12	100	1189	8.5% (6.1% - 11.0%)	19.85	49.6%	0.03		
Hypertension	severe	13	188	569	33.4% (25.4% -	45.16	75.6%	0.00	1.40 (1.22 - 1.60)	0.00

	non-severe	13	277	1212	41.4% 21.6% (9.9% - 33.3%)	410.13	97.1%	0.00		
Cardiovascular disease	severe	12	56	521	10.4% (6.4% - 14.4%)	19.03	47.5%	0.04	1.79 (1.50 - 2.13)	0.00
	non-severe	6	33	891	3.3% (1.1% - 5.4%)	20.02	75.0%	0.00		
COPD	severe	8	31	413	6.8% (4.3% - 9.2%)	5.73	0.0%	0.45	2.10 (1.70 - 2.58)	0.00
	non-severe	7	13	769	1.8% (0.8% - 2.9%)	1.38	0.0%	0.85		
Malignancy	severe	6	17	388	3.5% (1.6% - 5.4%)	4.89	18.3%	0.30	1.09 (0.76 - 1.57)	0.65
	non-severe	5	22	579	3.7% (0.9% - 6.4%)	10.82	63.0%	0.03		
Chronic liver disease	severe	7	16	423	3.5% (1.7% - 5.3%)	2.17	0.0%	0.83	0.93 (0.62 - 1.42)	0.74
	non-severe	8	37	889	3.8% (2.5% - 5.1%)	5.81	0.0%	0.45		
Fever	severe	14	600	672	90.0% (86.7% - 93.3%)	23.31	48.5%	0.03	2.47 (1.96 - 3.10)	0.00
	non-severe	16	1711	2323	78.4% (70.7% - 86.2%)	364.59	95.9%	0.00		
Cough	severe	14	454	646	69.0% (60.4% - 77.5%)	82.55	84.3%	0.00	1.86 (1.59 - 2.16)	0.00
	non-severe	16	1204	2314	54.2%	164.90	90.9%	0.00		



Myalgia or fatigue	severe	13	220	652	(47.0% - 61.5%) 36.7%	130.41	90.8%	0.00	1.60 (1.40 - 1.84)	0.00
	non-severe	15	476	2234	(25.5% - 48.0%) 28.8%	416.18	96.6%	0.00		
Sputum production	severe	9	192	492	(23.3% - 51.3%) 37.3%	88.94	91.0%	0.00	1.68 (1.44 - 1.96)	0.00
	non-severe	9	420	1723	(18.4% - 28.1%) 23.3%	35.20	77.3%	0.00		
ARDS	severe	4	67	144	(14.1% - 68.2%) 41.1%	43.54	93.1%	0.00	5.06 (4.08 - 6.27)	0.00
	non-severe	5	7	360	(0.6% - 5.5%) 3.0%	1.37	0.0%	0.50		
Acute kidney injury	severe	4	36	170	(3.4% - 29.5%) 16.4%	21.56	86.1%	0.00	2.17 (1.81 - 2.60)	0.00
	non-severe	4	6	211	(0.1% - 4.2%) 2.2%	2.23	10.2%	0.33		
Shock	severe	3	17	80	(5.5% - 34.4%) 19.9%	5.29	62.2%	0.07	3.17 (2.36 - 4.27)	0.00
	non-severe	3	4	188	(-4.8% - 13.1%) 4.1%	2.70	62.9%	0.10		
Hospitalization	severe	7	149	295	(32.6% - 75.3%) 53.9%	109.43	94.5%	0.00	0.90 (0.74 - 1.10)	0.31
	non-severe	7	439	814	48.9%	245.86	97.6%	0.00		

Disc harg e	severe	7	89	295	(28.7 % - 69.1 %) 30.4 %	90.0 2	93.3 %	0.00	0.60 (0.48 - 0.75)	0.00
	non-severe	7	374	814	(13.4 % - 47.4 %) 50.6 %	241. 00	97.5 %	0.00		
Deat h	severe	7	77	267	(30.5 % - 70.6 %) 30.3 %	103. 70	94.2 %	0.00	2.30 (2.02 - 2.63)	0.00
	non-severe	4	9	308	(13.8 % - 46.8 %) 1.5% (0.1 % - 2.8% )	4.86	38.2 %	0.18		

---

## Figures

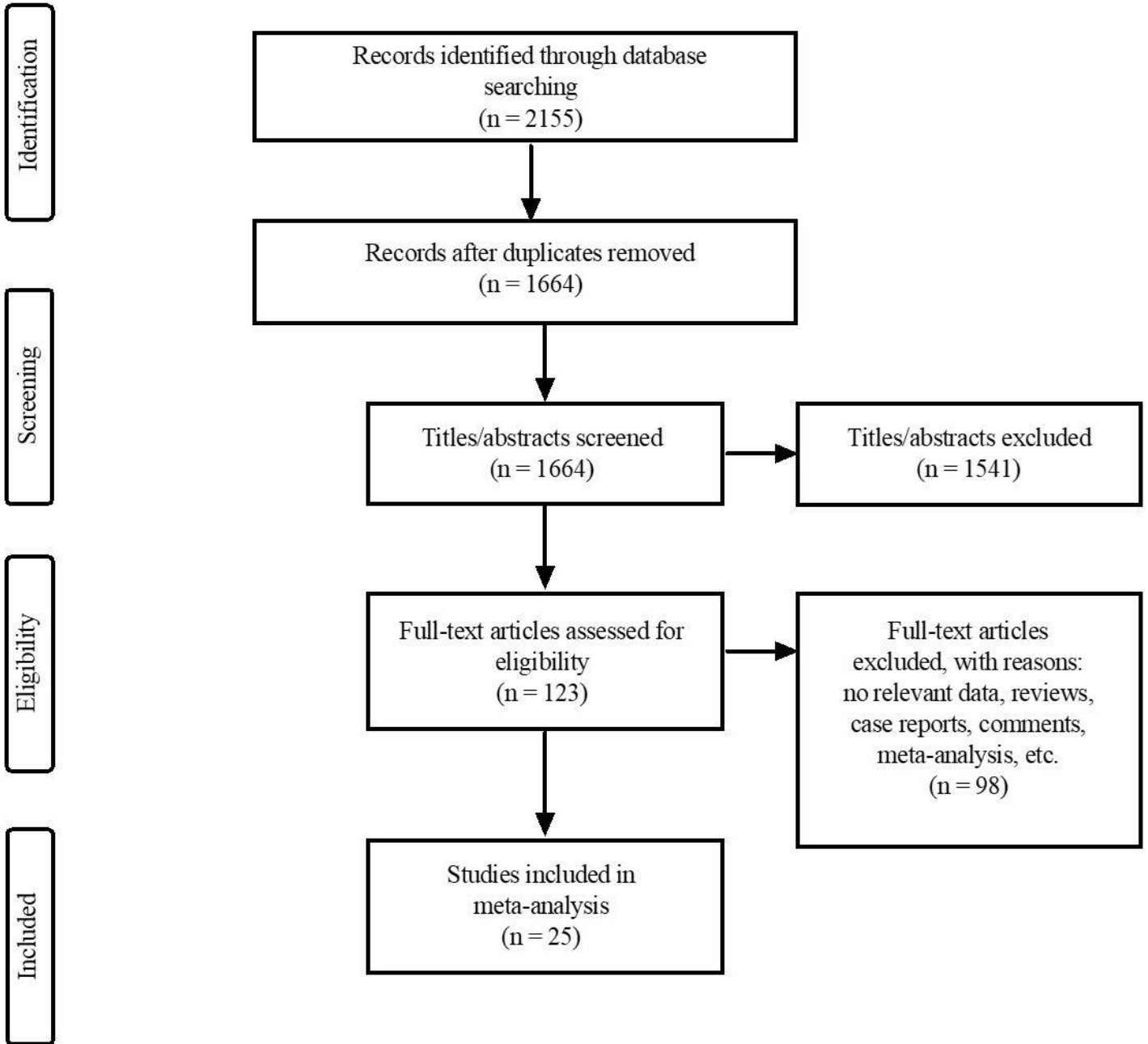


Fig. 1 PRISMA flow diagram of included studies

**Figure 1**

PRISMA flow diagram of included studies

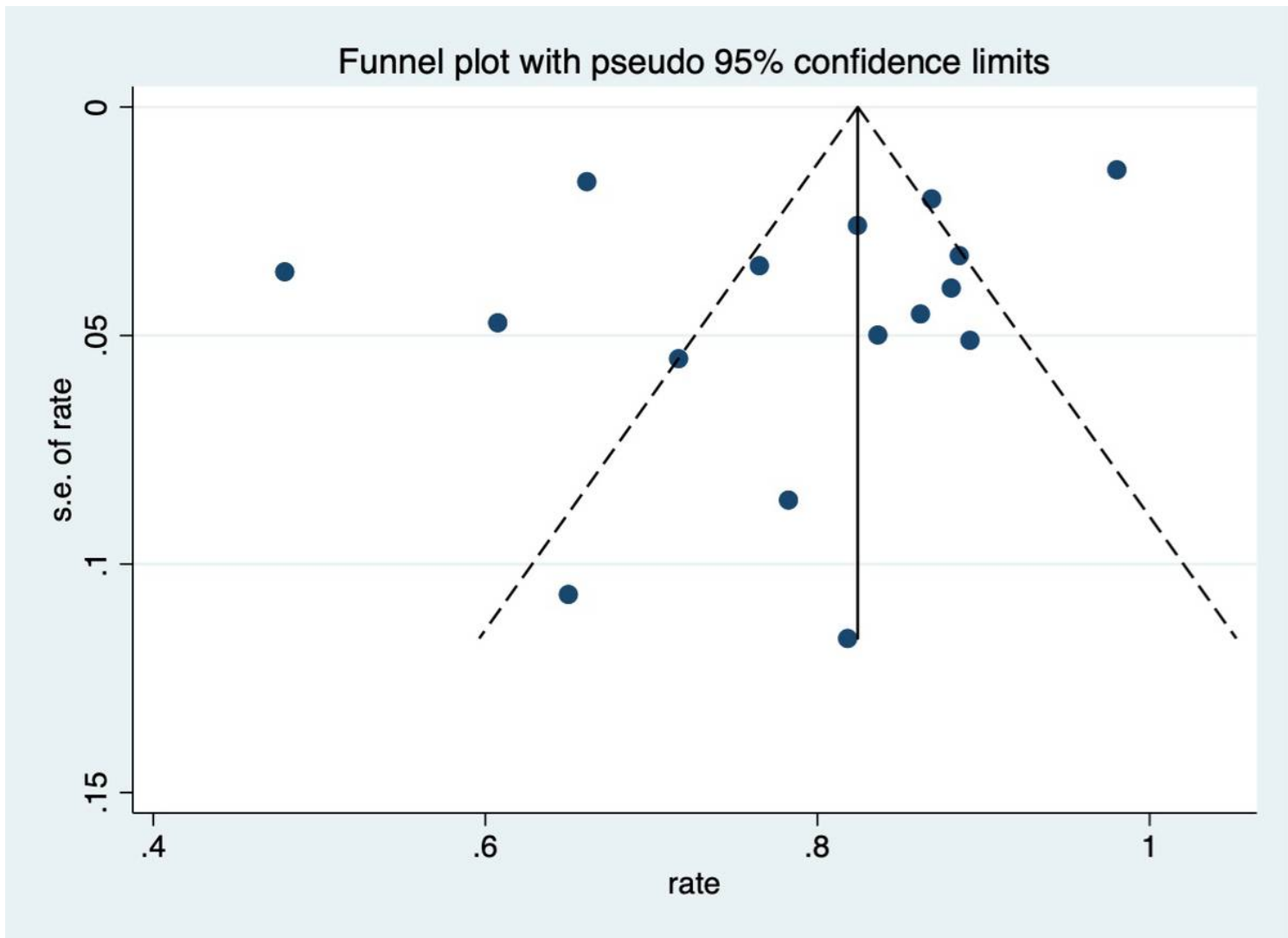


Figure 2

Funnel plot for the standard error by logit event that assess publication bias

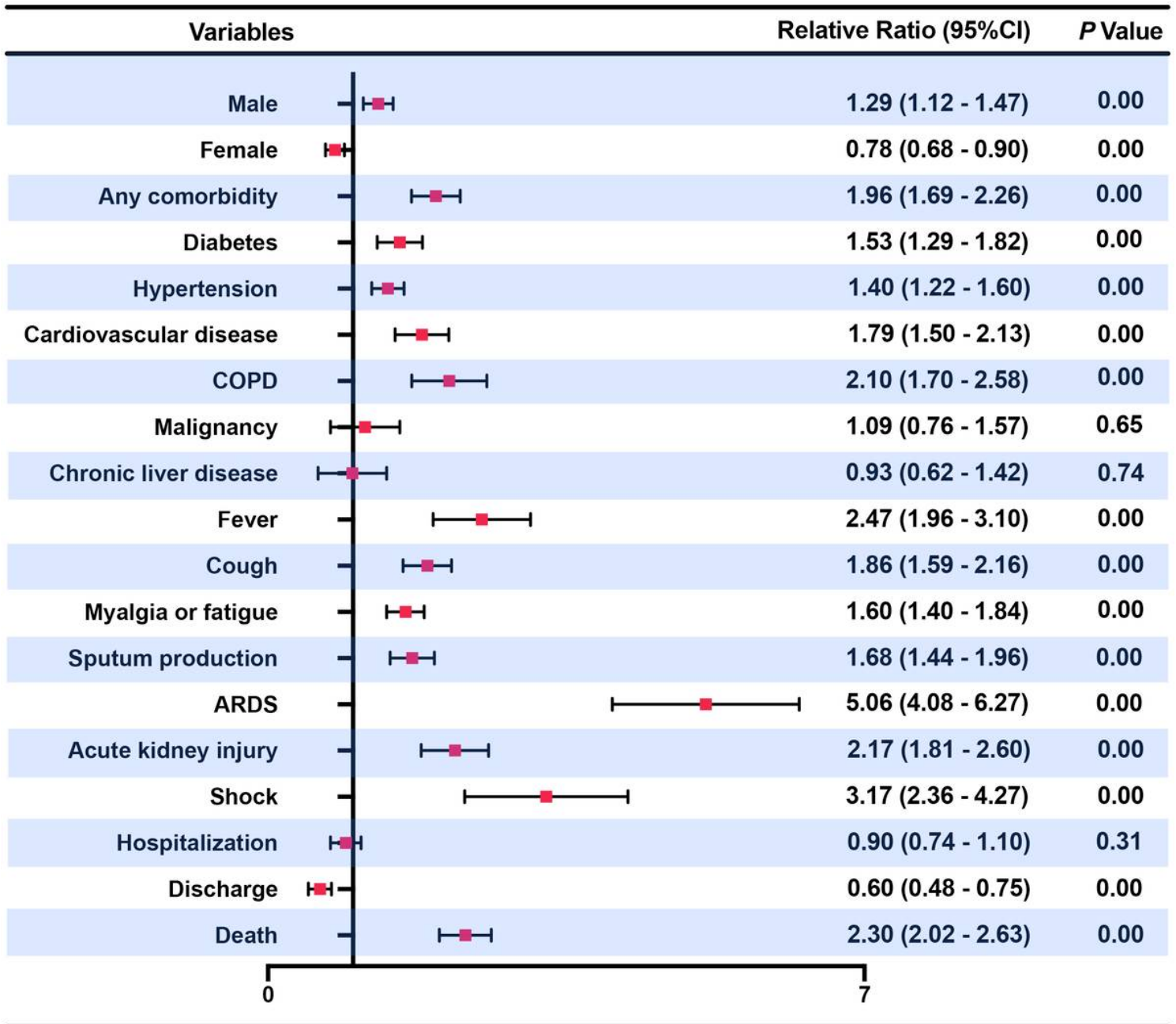


Figure 3

The Relative Ratio (RR) and the 95% confidence interval (95%CI) for the factors associated with the severe COVID-19.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [FigureS4.tif](#)
- [FigureS5.tif](#)
- [FigureS6.tif](#)

- [FigureS7.tif](#)
- [FigureS8.tif](#)
- [FigureS9.tif](#)
- [FigureS10.tif](#)
- [searchstrategy.pdf](#)
- [studyprotocol.pdf](#)