

TECHNICAL REPORT

Comorbidities Among Covid-19 Mortality Cases:

A Scoping Review



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Abstract

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by a novel coronavirus known as Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). Various studies have shown that COVID-19 patients with pre-existing comorbidities had a higher mortality rate compared to those who had none. The aim of this scoping review was to determine co-morbidities that influence mortality in COVID-19 patients. This scoping review was conducted following Arksey and O'Malley guidelines. The studies that were included were English language articles published between 1st January 2020 to 30th April 2020 related to comorbidities that were associated with COVID-19 mortalities among adults aged 18 years and above. A total of 780 articles were identified. Editorials, non-scientific commentaries, reports, brief communications and articles other than in the English language were removed. After eliminating 14 duplicates, 771 articles were obtained. A further 735 articles that did not meet the inclusion criteria were removed leaving us with 31 articles. Hypertension was reported in 21 articles to be the most prevalent among COVID-19 mortality cases. A few other articles concluded that diabetes, obesity, liver disease, cardiovascular and cerebrovascular disease were the most common comorbidity among COVID-19 mortality cases. Proper medical history taking to identify underlying comorbidities among COVID-19 patients is needed to determine the risk of having a severe form of COVID-19. COVID-19 patients with comorbidities, who are at risk of getting severe form of COVID-19, should be getting more aggressive treatment to reduce the risk of mortality.

Keywords:

COVID-19, comorbidities, mortality, adults

Word count (249 words)

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by a novel coronavirus known which was first identified in Wuhan, China at the end of 2019¹. It is widely regarded as very contagious and thus spreads relatively quickly if without any preventive measures. Even before it was declared a global pandemic on 11th March 2020 by World Health Organisation (WHO), it has not only spread to millions but also caused deaths of many. The latest statistics shows that there are about 1.8 million positive COVID-19 cases throughout the world, with more than 100,000 deaths spanning over 208 countries².

Most people infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without requiring special treatment. Older people, and those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness which may lead to death³

Various studies have shown that patients with pre-existing comorbidities had a higher mortality rate compared to those who had none. These patients also were more likely to be treated in Intensive Care Units (ICU) requiring ventilator support. According to a recent study, patients with previous cardiovascular and metabolic diseases may face a greater risk of developing into the severe conditions¹.

The aim of this scoping review was to systematically identify the comorbidities that influence the COVID-19 mortality cases. We hope that through this study, healthcare practitioners, policy makers and governments across the world could benefit from this study in a way that they could give higher priority to COVID-19 patients with comorbidities.

METHODOLOGY

A systematic approach to searching, screening, reviewing and data extraction was applied based on PRISMA extension for scoping reviews (PRISMA-ScR)⁴. Since the identification of the disease in early 2020, there were many scientific papers published. Therefore, we conducted a scoping review using the guideline from Arksey and O'Malley to achieve the objectives. A systematic literature review on the impact of COVID-19 mortalities was conducted. The steps of conducting a scoping review were described by Arksey and O'Malley using a 6 steps approach.

1. Identifying the research question

What are the comorbidities that influence the COVID-19 mortality cases?

What is the most common comorbidity among the COVID-19 mortality cases?

2. Identifying relevant studies

PICO

• Population

Population included in the search was adults aged 18 years and above, diagnosed with COVID-19 infection and who passed away due to COVID-19 infection

• Exposure

Those COVID-19 adult patients with at least one diagnosed comorbidity. Comorbidities included were Diabetes, Hypertension, Chronic Kidney Disease (CKD), Chronic Obstructive Pulmonary Disease (COPD), malignancy, Cerebrovascular Disease, obesity and overweight.

• Outcome

The outcome of interest was to identify the comorbidities that influence COVID-19 mortality cases.

Inclusion and exclusion criteria

Inclusion criteria were articles written in English, published from 1st January 2020 to 30th April 2020 related to COVID-19 mortality cases with underlying comorbidities among adults aged 18 years and above. We excluded articles that were not in English, guidelines, conference papers, commentaries, editorials or opinion pieces.

Type of studies

Types of studies that were included in the search strategy were (randomized controlled trials, cluster randomised controlled trials, quasi experimental and other experimental studies and observational studies) in this area from their earliest record.

Information sources

We searched electronic databases to search for publications such as Pubmed, Scopus, Google Scholar, Cochrane, Central, Embase and also grey literature, unpublished reports from universities and MREC databases.

Search strategy

A comprehensive search strategy was done by searching databases like Pubmed, Scopus, Google Scholar, Cochrane, Central, Embase and also grey literature, unpublished reports from universities and MREC databases. This was done using relevant keywords that were identified. Additional records were identified through relevant research websites such as

World Health Organisations (WHO) and the reference list of key articles was scrutinised for any additional studies that were related.

Predefined search terms determined by the Medical Subject Headings (MeSH) and keywords, such as “Novel coronavirus,” “2019 nCoV”, “COVID-19”, “SARS-CoV-2”, “Comorbidities”, “Diabetes”, “Hypertension”, “Cardiovascular Disease”, “Chronic Kidney Disease”, “Chronic Obstructive Pulmonary Disease”, “Cancer”, “Obesity”, “Overweight”, “Mortality”, “Death”, “Fatality” and “Casualty”. The combination of keywords used can be found in Appendix 1. References of retrieved articles were searched for potentially relevant articles.

3. Study selection:

- During the search of relevant papers for inclusion in the review, a total of 780 (560, 174, and 46 hits were found from PubMed, Scopus, and Cochrane respectively) potential papers were identified, and 766 articles were obtained after removal of duplicates (14 articles). The list of studies yielded from our initial search was transferred into Mendeley to remove duplicates.
- Two pairs of reviewers independently screened the titles and abstracts according to the inclusion and exclusion criteria. Any disagreements were resolved through discussion with a third reviewer. After the titles and abstracts were screened, a total of 766 full-text articles were retrieved. Three pairs of reviewers independently reviewed the full text. Out of these, 735 articles were excluded for reasons. Any disagreements were resolved through discussion or referred to the third reviewer as a referee. 31 articles met the inclusion criteria for this review.

4. Charting the data

- All included studies were recorded in the standardized data extraction form containing author name, year of publication, study design, sample size, place of study and key findings.
- A detailed description of the process is described in Figure 1

5. Collating, summarising and reporting the results

Analysis

We conducted descriptive analysis of the included articles. The characteristics of the articles included were described in detail. The characteristics include author, year of publication, place of study, study design, sample size, and key findings (Table 1).

Findings

The included studies were published between 1st January 2020 to 30th April 2020. A total of 780 articles were yielded from the initial search. The search was conducted according to the inclusion and exclusion criteria. After excluding 14 duplicates, 766 articles remained. Subsequently, screening of titles and abstracts excluded 735 articles that did not meet the inclusion criteria. Editorials, non-scientific commentaries, reports, brief communications and articles other than in English language were excluded (Figure 1). Therefore, the final 31 articles were tabulated as shown below. Majority of the included studies showed that nearly all COVID-19 mortality cases had underlying hypertension. The prevalence of COVID-19 mortality cases with underlying hypertension was higher compared to other comorbidities such as diabetes, lung disease

and malignancy. Majority of the included studies were from China (25), followed by the United States (3), Italy (2), United Kingdom (2), Iran (1), Poland (1), Bolivia (1) and India (1). Hypertension was reported by 21 articles to be the most prevalent comorbidity among the COVID-19 mortality cases^{5,6,7,8,9,10,11,12,13,14,15,16,17,18,19, 20, 21, 22, 23}. However, there were studies that identified diseases other than hypertension to be dominant among COVID-19 mortality cases. A study was conducted to investigate the link between comorbidities and the occurrence of composite end point such as, intensive care admission, invasive ventilation or mortality among 1590 patients infected with COVID-19 in China. Findings of the study showed that COPD had the highest hazards ratio compared to hypertension, diabetes and malignancy in reaching the composite end points²⁴. Another included study was a case-control study conducted in China. The study investigated 32 mortality cases, out of which, 46.9% had cardiovascular disease and cerebrovascular

disease, 37.5% had hypertension and 34.4% had endocrine related diseases^{25, 26}. Two included studies reported that severe obesity was associated with in hospital mortality, along with male sex and increasing age^{27, 28}. Other studies also concluded that diabetes was the more prevalent comorbidity as compared with hypertension and cardiac disease^{29, 30}. Two studies cited kidney disease was most prevalent among COVID-19 death cases^{31,32}, while chronic lung disease and chronic kidney disease were the main predictors for death based on the hazards ratio^{33, 34}. According to Docherty et al., moderate to severe liver disease had the highest hazards ratio for the risk of death compared to other underlying diseases³⁵.

6. Consultation exercise

The findings of this study will be disseminated to researchers and stakeholders from the National Institutes of Health (NIH).

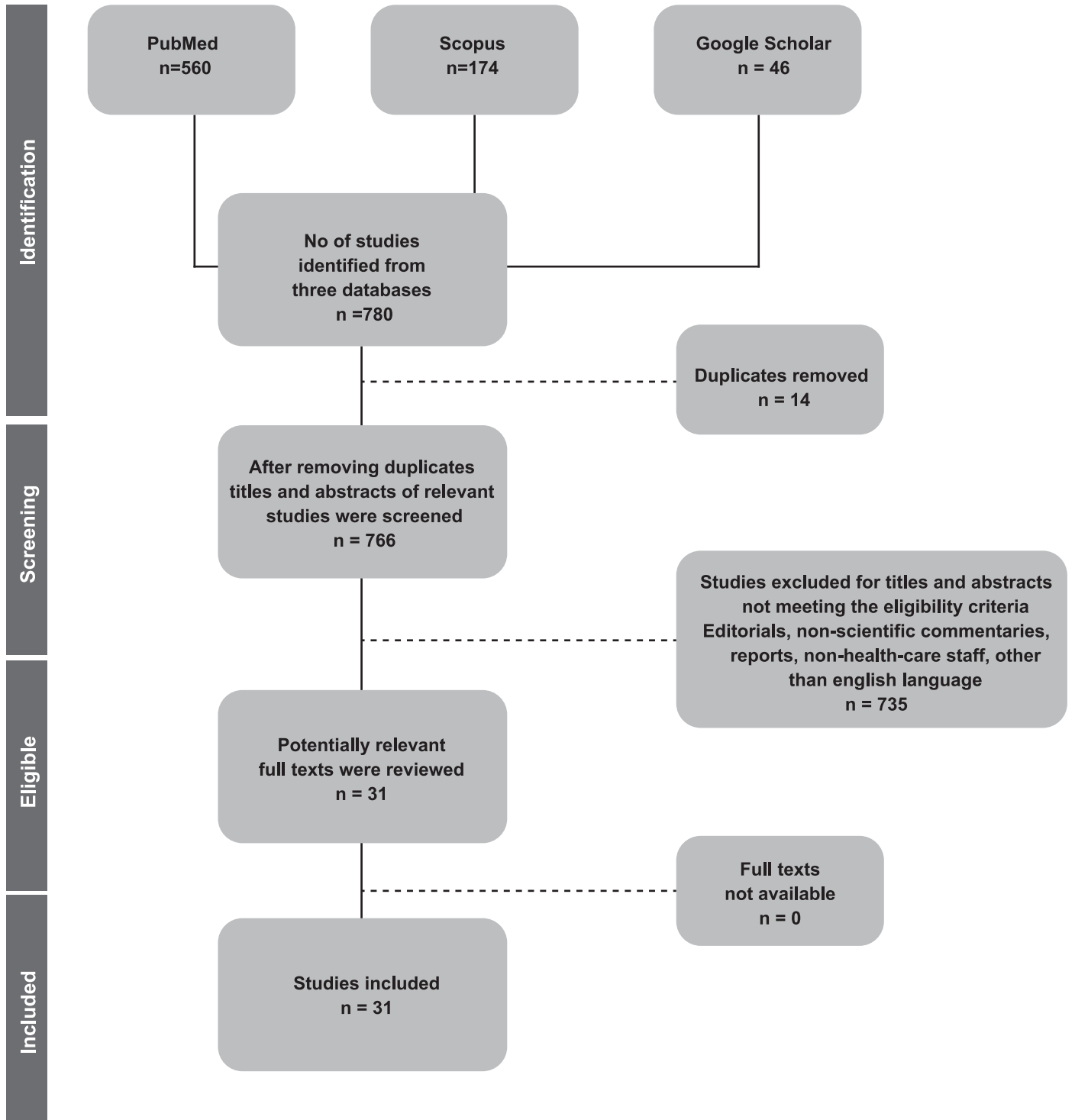


Figure 1: PRISMA flow diagram for database search of studies

Discussion

Evidence shows that comorbidities significantly increased the risk of mortality among COVID-19 patients. A systematic review and meta-analysis conducted by Ssentongo, P., et al. compared hospitalised COVID-19 patients with comorbidities and hospitalised COVID-19 patients without comorbidities. Findings showed that cardiovascular disease, hypertension, diabetes, congestive heart failure, chronic kidney disease and cancer were associated with a significantly greater risk of mortality among COVID-19 patients^{36, 37}. Similarly, a nationwide cross-sectional study conducted in Mexico showed that underlying chronic diseases were associated with death among COVID-19 patients³⁸. Chronic pulmonary disease and diabetes were found as the most common comorbidities in a study done among 31, 461 adults diagnosed with COVID-19³⁹. Results from a study conducted in Italy showed each additional comorbidity increased the risk of death by 35%⁴⁰. All the literature supports the findings of this scoping review. However, there are a few limitations to this study. First, majority of the included articles were carried out in China, hence we have not been able to get diverse characteristics of the mortality cases from other countries. Second, we excluded articles that were not written in the English

language and thus further narrowed the scope of the study. This scoping review has the potential to have an impact on practice and policy on the treatment plan for those with comorbidities with COVID-19 infection. It highlights the importance of combating non-communicable diseases in the population at large as preparatory method when an infectious pandemic like this occurs. This review may also help map the literature, identify research gaps and to propose recommendations for future research on COVID-19 related to comorbidities in Malaysia.

Conclusion

Proper medical history taking of comorbidities among COVID-19 is needed in order to determine the risk of having a severe form of COVID-19. COVID-19 patients with comorbidities, who are at risk of getting severe form of COVID-19, should be getting more aggressive treatment to reduce the risk of mortality. Thus, in order to be prepared to face an unprecedented pandemic like this, public health policies should aim to overcome the issue of non-communicable diseases in the community. By doing this, mortality from pandemics like this could be significantly reduced.

Table 1. Summary of 31 included studies

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
1	Fei Zhou (2020)	Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study	China	Retrospective cohort study	54	There were 54 non-survivors. Among the non-survivors, 40% had comorbidities with 23% hypertension, 14% diabetes, 1% coronary heart disease, 1% COPD, 1% malignancy, 4% CKD, others 20%. The most common comorbidity among the mortality cases was hypertension.
2	Wei-jie Guan (2020)	Comorbidity and its impact on 1590 patients with COVID-19 in China: a nationwide analysis	China	Retrospective case study	1590	The composite end-points, which consisted of admission to an intensive care unit, invasive ventilation or death was analysed. After adjusting for age and smoking status, COPD (HR (95% CI) 2.681 (1.424–5.048)), diabetes (1.59 (1.03–2.45)), hypertension (1.58 (1.07–2.32)) and malignancy (3.50 (1.60–7.64)) were risk factors of reaching the composite end-points.
3	Tao Chen (2020)	Clinical characteristics of deceased patients with coronavirus disease 2019: retrospective study	China	Retrospective study	113	Overall, 71 (63%) patients who died and 62 (39%) who recovered had at least one chronic medical condition. Hypertension, cardiovascular disease, and cerebrovascular disease were much more frequent among deceased patients (54 (48%), 16 (14%), and 4 (4%)) than among recovered patients (39 (24%), 7 (4%), and 0 (0%)). The most common comorbidity among the mortality cases was hypertension.
4	Xun Li (2020)	Clinical characteristics of 25 death cases with COVID-19: A retrospective review of medical records in a single medical center, Wuhan, China	Wuhan, China	Retrospective review of medical records	25	The age and underlying diseases (hypertension (64%), diabetes (40%), heart disease (32%), kidney disease (20%), cerebral infarction (16%), COPD (8%), malignant tumours (8%), acute pancreatitis (4%), were the most common risk factors for death of COVID-19 pneumonia.

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
5	Bicheng Zhang (2020)	Clinical characteristics of 82 death cases with COVID19	Wuhan, China	Retrospective study design	1334	6.2% (82/1334) of patients with Covid-19 were dead. The mortality rate of COVID-19 was higher than that of non-COVID-19 ($p < 0.001$). The bulk of death cases had comorbidity (75.6%), including hypertension (56.1%), heart disease (20.7%), diabetes (18.3%), cerebrovascular disease (12.2%), and cancer (7.3%). 30 out of 82 dead patients (30.5%) had 2 or more underlying diseases. The most common comorbidity among the mortality cases was hypertension.
6	Ying Huang (2020)	Clinical characteristics of 36 non survivors with COVID-19 in Wuhan, China	Wuhan, China	Retrospective study design	36	The mean age of the patients was 69.22 years (SD 9.64, range 50-90). Twenty-six (72.22%) patients had chronic diseases. The most common chronic diseases were hypertension (21, 58.33%), cardiovascular (8, 22.22%) and diabetes (7, 19.44%). Most non-survivors are older men with comorbidities (especially cardiovascular diseases).
7	Fan Zhang (2020)	Myocardial injury is associated with in-hospital mortality of confirmed or suspected COVID-19 in Wuhan, China: A single center retrospective cohort study	Wuhan, China	Retrospective cohort study design	110	A total of 110 patients (45.5% female, mean age 64.03 ± 16.54 -year-old) with suspected ($n=30$, 27.3%) or confirmed ($n=80$, 72.7%) COVID-19 17 non-survivors from 48 patients on admission have the following comorbidities: hypertension ($n=12$), diabetes ($n=5$), CKD ($n=5$).

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
8	Vincent Yi-Fong Su (2020)	The Risk of Death in 2019 Novel 2 Coronavirus Disease (COVID-19) in Hubei 3 Province	Hubei, China	Case-control study	32	When comparing the COVID-19 death cases and Huanan Seafood Market cases, univariate analysis showed that patients were more likely to be COVID-19 death cases if they were older [crude odds ratio (OR) 26.0, 95% CI 7.5–89.8], had a history of any comorbidity (OR 4.7, 95%CI 1.8–12.8), hypertension (OR 3.5, 95%CI 1.1–10.8), cardiovascular disease (OR 5.1, 95%CI 1.7–15.6), and shortness of breath (OR 4.7, 95%CI 1.5–14.5).
9	Menter (2020)	Post-mortem examination of COVID19 patients reveals diffuse alveolar damage with severe capillary congestion and variegated findings of lungs and other organs suggesting vascular dysfunction	Switzerland	Cohort	21	When comparing the COVID-19 death cases and Jinyintan hospital cases, univariate analysis showed that patients were more likely to be in the COVID-19 death group, if they were older (OR 9.0, 95%CI 3.2–25.5), had history of endocrine system disease (OR 3.5, 95%CI 1.4–8.8), and respiratory system disease (OR 18.1, 95%CI 2.0–162.0). However, this study only used crude analysis - using Simple Logistic regression.
10	Palaodimos, L. (2020)	Severe obesity is associated with higher in-hospital mortality in a cohort of patients with COVID-19 in the Bronx, New York	USA	Retrospective cohort study	200	Hypertensive, elderly, obese, male individuals with severe cardiovascular comorbidities as well as those with blood group A may have a lower threshold of tolerance for COVID-19. This provides a pathophysiological explanation for higher mortality rates among these patients. In the multivariable analysis (model 3), male sex (OR: 2.74, 95% CI: 1.25–5.98; p = 0.011), increasing age (OR: 1.73; 95% CI: 1.13–2.63; p = 0.011), and BMI ≥ 35 kg/m2 (OR: 3.78; 95% CI: 1.45–9.83; p = 0.006) were found to have significant associations.

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
11	Wu, C. (2020)	Risk Factors Associated with Acute Respiratory Distress Syndrome and Death in Patients with Coronavirus Disease 2019 Pneumonia in Wuhan, China	China	Retrospective	44 died	Death with comorbidity Diabetes 36.4% Hypertension 25.0% Cardiac disease 9.1%
12	Deng Y. (2020)	Clinical characteristics of fatal and recovered cases of coronavirus disease 2019 in Wuhan, China: a retrospective study	Wuhan, China	Retrospective	225	The fatal cases had more underlying diseases (72.5% vs. 41.4%, $\chi^2 = 22.105$, $P < 0.001$), mainly including hypertension (36.7% vs. 15.5%, $\chi^2 = 14.184$, $P < 0.001$), lung disease (20.2% vs. 2.6%, $\chi^2 = 17.619$, $P < 0.001$), and heart disease (11.9% vs. 3.4%, $\chi^2 = 5.783$, $P = 0.031$)
13	Cao, J (2020)	Clinical Features and Short-term Outcomes of 102 Patients with Corona Virus Disease 2019 in Wuhan, China	China	Retrospective cohort study	102	Among non-survivors (n=17) hypertension was the more prevalent (64.7%), DM (35.3%), respiratory diseases (9.8%), cerebrovascular disease (5.9%), cardiovascular disease (4.9%), malignancy (3.9%), chronic kidney disease (3.9%), chronic liver disease (2.0%)
14	Rongrong Yang (2020)	The role of essential organ-based comorbidities in the prognosis of COVID-19 infection patients	China	Retrospective cohort study	212	Moreover, compared to COVID-19 patients without comorbidities, the higher mortality was also shown in COVID-19 patients with heart-based comorbidities [6.1% (2/33) vs 0.6% (1/179), $P = 0.014$], with liver-based comorbidities [8.7% (2/23) vs 0.5% (1/189), $P = 0.002$], with kidney-based comorbidities [27.3% (3/11) vs 1.0% (2/201), $P < 0.001$], and with more than two kinds of essential organ-based comorbidities [40.9% (9/22) vs 2.6% (5/192), $P < 0.001$]

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
15	Nikpouraghdam, M. (2020)	Epidemiological characteristics of coronavirus disease 2019 (COVID-19) patients in IRAN: A single center study	Iran	retrospective study	2968	<p>Among the 239 deaths, 38 (15.89 %) had comorbidities such as diabetes, hypertension and chronic respiratory diseases etc.</p> <p>Patients with comorbid conditions had higher case fatality rate (CFR): 9.73% for diabetes, 10.81% for those with cardiovascular disease, 15% for those with chronic respiratory disease, and 13.55% for those with hypertension, 16.66 % for chronic kidney diseases and 5.88 % for patients with cancer.</p> <p>Results from multiple logistic regression shows, having underlying disease also increases the odds of mortality by 53 % (OR=1.53, 95 % CI: 1.04–2.24).</p>
16	Xu PP (2020)	Risk factors for adverse clinical outcomes with COVID-19 in China: a multicenter, retrospective, observational study	China	Multicenter retrospective observational study	703	<p>Out of 33 deceased patients, 36% had cardiovascular disease, 36% had DM, 52% had hypertension, 12% had COPD, 3% chronic liver disease, 9% had chronic kidney disease and 3% had malignancy.</p>
17	Nowak B (2020)	Clinical characteristics and short-term outcomes of patients with coronavirus disease 2019: a retrospective single-center experience of a designated hospital in Poland.	Poland	Retrospective cohort study	165	<p>There were 46 non-survivors, among them 58.7% had hypertension, 47.8% had CVD, 41.3% had CHD, 34.8% had DM, 32.6% had malignancy, 19.6% had COPD, and 17.4% had CRD</p>

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
18	Russo V (2020)	Clinical impact of pre-admission antithrombotic therapy in hospitalized patients with COVID-19: a multicenter observational study.	Italy	Retrospective cohort study	192	Thirty-five patients (18.5%) died during the hospitalization. Non survivors of COVID-19 patients showed a statistically significant increased age (77 ± 15.6 vs 65.6 ± 8.3 ; $P = 0.001$), hypertension (77.1% vs 53.5% ; $P = 0.018$) and CAD prevalence (28.6% vs 10.2% ; $P = 0.009$)
19	Huang S (2020)	COVID-19 patients with hypertension have more severe disease: a multicenter retrospective observational study.	China	Retrospective observational study	310	Compared with non-hypertensive patients, hypertensive patients had a higher mortality rate (24.8% vs 15.2%), a higher proportion of severe patients (63.7% vs 42.1%), a higher proportion of patients receiving non-invasive mechanical ventilation (16.8% vs 7.6%), and a higher proportion of patients transferred to the intensive care unit (ICU) (23.9% vs 12.2%)
20	Imam Z (2020)	Older age and comorbidity are independent mortality predictors in a large cohort of 1305 COVID-19 patients in Michigan, United States.	USA	Retrospective multicentre cohort	1305	The most common comorbidity was hypertension (HTN) (56.2%), followed by diabetes mellitus (DM) (30.1%), and chronic kidney disease (CKD) (17.5%). 304 (23.3%) patients had one comorbidity, 20.8% had two, 14.0% had three, 12.9% had four or more comorbidities and 27.4% of patients had no comorbidities.
21	Giacomelli A (2020)	30-day mortality in patients hospitalized with COVID-19 during the first wave of the Italian epidemic: a prospective cohort study.	Italy	Single centre prospective cohort study	233	Age (adjusted hazard ratio [aHR] 2.08, 95% CI 1.48–2.92 per ten years more) and obesity (aHR 3.04, 95% CI 1.42–6.49) were independently associated with an increased risk of death,
22	Escalera-Antezana JP (2020)	Risk factors for mortality in patients with Coronavirus Disease 2019 (COVID-19) in Bolivia: An analysis of the first 107 confirmed cases.	Bolivia.	Cross-sectional study	107	The number of comorbidities was significantly associated with a high proportion of deaths. In bivariate analyses, age (≥ 60 years old), hypertension, chronic heart failure, diabetes, and obesity were significantly exposure variables associated with death. In the multivariate analysis (logistic regression), two variables remained significantly associated, age, ≥ 60 years-old and hypertension (OR=3.3, 95%CI 1.3-6.3).

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
23	Galloway JB (2020)	A clinical risk score to identify patients with COVID-19 at high risk of critical care admission or death: an observational cohort study.	London, United Kingdom	cohort study	1,157	Background comorbidities (diabetes mellitus, hypertension and chronic lung disease) were all related to death or critical care admission in people with COVID19.
24	Asfahan (2020)	Extrapolation of mortality in COVID-19: Exploring the role of age, sex, co-morbidities and health-care related occupation.	India	Retrospective study	1,023	Multiple logistic regression revealed that only age and comorbidities significantly affected mortality. Age and presence of co-morbidities correlated negatively with survival with co-efficient of -1.23 and -2.33 respectively. OR for dying of COVID-19 was 10.3 for presence of any of the co-morbidities.
25	Cummings MJ (2020)	Epidemiology, clinical course, and outcomes of critically ill adults with COVID-19 in New York City: a prospective cohort study	USA	Prospective observational cohort study	257	In the multivariable Cox model (table 4), older age (adjusted HR [aHR] 1.31 [95% CI 1.09–1.57] per 10-year increase), chronic cardiac disease (aHR 1.76 [1.08–2.86]), chronic pulmonary disease (aHR 2.94 1.48 5.84), higher concentrations of IL-6 (aHR 1.11 [1.02–1.20] per decile increase), and higher concentrations of D-dimer (aHR 1.10 [1.01–1.19] per decile increase) were independently associated with in-hospital mortality.
26	Yang X (2020)	Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study	China	Retrospective, observational study,	52	21 (40%) patients had chronic diseases, including cerebrovascular diseases in seven (13.5%) patients, all of whom died at 28 days. Compared with survivors, non survivors were older (64.6 [SD 11.2] vs 51.9 [12.9]) and were more likely to have chronic medical illnesses (17 (53%) patients vs 4 (20%) patients)

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
27	Mingli Yuan (2020)	Association of radiologic findings with mortality of patients infected with 2019 novel coronavirus in Wuhan, China.	Wuhan, China	Retrospective study	27	10 patients died in hospital. The death patients have the following comorbidities; hypertension (n=5), diabetes (n=6), cardiac disease (n=3). There were significant differences between survival group and mortality group with respect to hypertension (n=5), diabetes (n=6), cardiac disease (n=3). The median age of mortality group was higher compared to survival group (68 (IQR 63–73) vs 55 (IQR 35–60), P = 0.003). The comorbidity rate in mortality group was significantly higher than in survival group (80% vs 29%, P = 0.018), especially comorbid hypertension, diabetes, and cardiac disease.
28	Yingzhen Du (2020)	Clinical Features of 85 Fatal Cases of COVID-19 from Wuhan. A Retrospective Observational Study.	Wuhan, China	Retrospective study	85	Of the 85 patients, 58 (68.2%) had one or more comorbidities. Hypertension (32 [37.6%]), diabetes (19 [22.4%]), coronary heart disease (10 [11.8%]), malignancy (6[7.1%]) and chronic kidney disease (3[3.5%]). In summary, most cases of death from COVID-19 were males over 50 years of age with noncommunicable chronic diseases, such as hypertension, diabetes, and coronary heart diseases.
29	Yao Q (2020)	A retrospective study of risk factors for severe acute respiratory syndrome coronavirus 2 infections in hospitalized adult patients.	China	Retrospective study	12	Out of 108 patients, 12 died. Among the 12, 58.3% had hypertension, 16.6% had CVD, 8.3% had Diabetes, 8.3% had chronic liver disease, and 1.9% had cancer.

No.	Author, Year	Title	Country	Study design	Sample size, n	Key findings
30	Docherty AB (2020)	Features of 20 133 UK patients in hospital with covid-19 using the ISARIC-WHO Clinical Characterization Protocol: prospective observational cohort study.	UK	Prospective observational cohort study	5,165	Increasing age, male sex, and comorbidities including chronic cardiac disease, non-asthmatic chronic pulmonary disease, chronic kidney disease, liver disease and obesity were associated with higher mortality in hospital. Chronic cardiac disease, chronic non-asthmatic pulmonary disease, chronic kidney disease, obesity, chronic neurological disorder (such as stroke), dementia, malignancy, and liver disease were also associated with increased hospital mortality. From Figure 5, Chronic cardiac disease Hazard Ratio 1.16 (1.08 to 1.24) p-value <0.001, Chronic pulmonary disease Hazard Ratio 1.17 (1.09 to 1.27) p-value <0.001, Chronic kidney disease Hazard Ratio 1.28 (1.18 to 1.39) p-value <0.001, Diabetes Hazard Ratio 1.06 (0.99 to 1.14) p-value 0.087, Obesity Hazard Ratio 1.33 (1.19 to 1.49) p-value <0.001, Chronic neurological disorder Hazard Ratio 1.17 (1.06 to 1.29) p-value 0.001, Dementia Hazard Ratio 1.40 (1.28 to 1.52) p-value <0.001, Malignancy Hazard Ratio 1.13 (1.02 to 1.24) p-value 0.017, Moderate/severe liver disease Hazard Ratio 1.51 (1.21 to 1.88) p-value <0.001.
31	Shi S (2020)	Characteristics and clinical significance of myocardial injury in patients with severe coronavirus disease 2019	China	Retrospective	62	Among those dead, Hypertension 59.7%, DM 27.4%, CHD 33.9%, Chronic renal disease 19.4%, COPD 3.2%, Cancer 6.5%, Chronic heart failure 21.0%, Cerebrovascular disease 12.9%, Atrial fibrillation 3.2%

Conflict of interest

The authors declare no conflict of interest

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Ethical Approval

This study was registered under the National Medical Research Register (NMRR) bearing the registration number (NMRR-20-766-54554) and an exemption was obtained for ethical approval from the Malaysian Ministry of Health Medical and Research Ethics Committee (MREC) since it did not involve any human subjects.

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Appendix 1

Keywords and search terms for related articles

Criteria 1	Criteria 2	Criteria 3
"COVID-19"	"Comorbidities"	"Mortality"
"SARS-CoV 2"	"Diabetes"	"Death"
"Novel coronavirus"	"Hypertension"	"Fatality"
"2019-nCoV"	"Cardiovascular disease"	"Casualty"
	"Chronic Kidney Disease"	
	"Chronic Obstructive Pulmonary Disease"	
	"Cancer"	
	"Obesity"	
	"Overweight"	

Combination of keywords:

Keyword 1: "COVID-19" OR "SARS-CoV 2" OR "Novel coronavirus" OR "2019-nCoV"

Keyword 2: "Comorbidities" OR "Diabetes" OR "Hypertension" OR "Cardiovascular disease" OR
"Chronic Kidney Disease" OR "Chronic Obstructive Pulmonary Disease" OR "Cancer" OR "Obesity"
OR "Overweight"

Keyword 3: "Mortality" OR "Death" OR "Fatality" OR "Casualty"



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