Over the past decade, Middle East Respiratory Syndrome (MERS) coronavirus has emerged in the human population and accounted for a large number of deaths worldwide. In early December 2019, a series of pneumonia cases caused by SARS-CoV-2 emerged in Wuhan, Hubei, China, with the name of coronavirus disease 2019 (COVID-19). Both MERS-CoV and SARS-CoV-2 belong to the Coronavirus genus in the Coronaviridae family. MERS-CoV spread across Africa and East Asia from 2012 and had caused 1600 infections and 574 deaths by 2016, while SARS-CoV-2 has induced 81,099 infections with 3218 deaths in China and 91,216 infections with 3421 deaths outside of China as of 16 March 2020. Both SARS-CoV-2 and MERS-CoV target the respiratory tract and share many similar clinical symptoms. Common symptoms include fever, fatigue and dry cough, followed always by anorexia, myalgia, dyspnoea and so on. Lymphopaenia and prolonged prothrombin time are also most common characteristics.

Metabolic comorbidities were defined as the presence of one or more of the following conditions known to be associated with obesity: diabetes, hypertension, hypercholesterolaemia or cardiovascular disease. A systematic analysis of 637 MERS-CoV cases showed that diabetes and hypertension are prevalent in about 50% of the patients and cardiac diseases are present in 30% of the cases. With spread of SARS-CoV-2, more and more individuals exhibit comorbidities such as hypertension, diabetes and cardio-cerebrovascular disease. In Chen’s study of 99 cases, 40% of patients had cardiocerebrovascular disease, and in Huang’s study of 41 cases, 20% of patients had diabetes. These cardiovascular metabolic comorbidities might render them more susceptible to poor prognosis. The mechanisms by which coronavirus influences the cardiovascular system include: direct damage to cardiomyocytes by the virus, hypoxaemia and higher-level oxygen support, high concentration of inflammatory factors, repeated floods of catecholamines due to anxiety and the side effects of medication. In addition, studies found that patients with higher N-terminal pro-brain natriuretic peptide level and d-dimer greater than 1 μg/ml had more risk of death. COVID-19 can activate also coagulation cascade, leading to severe hypercoagulability and poor prognosis.

Comparing the epidemiological characteristics of MERS and COVID-19 will be helpful for us to understand the characteristics of the novel coronavirus and to carry out targeted treatment. Prevalence of comorbidities including hypertension, diabetes and cardiovascular and cerebrovascular diseases in COVID-19 and MERS (Supplementary Material Tables 1 and 2 and Figure 1 online) together with clinical outcomes (intensive care unit (ICU) admission, death and cardiac injury) were...
Figure 1. Meta-analysis for the proportions of hypertension, cardio-cerebrovascular disease, diabetes, intensive care unit admission, death and cardiac injury in COVID-19 and MERS cases. Weights are calculated from binary random-effects model analysis. Values and 95% confidence interval represent proportions of the comorbidities in the COVID-19 and MERS patients. Heterogeneity analysis was carried out using Q test, the among studies variation ($I^2$ index).

CI: confidence interval; ICU: intensive care unit; MERS: Middle East Respiratory Syndrome.
extracted from the identified studies (Figure 1). All analyses were performed using OpenMeta Analyst version 10.10 (www.cebm.brown.edu/open_meta). In order to identify all the studies elucidating the prevalence and impact of cardiovascular metabolic diseases on COVID-19 in China and MERS in Middle East and South Korea, EMBASE and PubMed were carefully searched from 2012 to March 2020. The following search terms or keywords were used alone or in combination: ‘MERS’, ‘COVID-19’, ‘SARS-CoV-2’, ‘novel coronavirus’, ‘influenza’, ‘pneumonia’, ‘cardiovascular disease’, ‘hypertension’, ‘diabetes’ and ‘cardiac injury’. All of the included cases were confirmed ones, with the suspected cases being excluded. Studies written in non-English (for fear of data duplication) were excluded.

Systematic analysis (Table 1 and Supplementary Figure 1) has identified eight reports with 1893 patients (Supplementary Table 1) and 18 reports with 1457 patients, respectively (Supplementary Table 2). The mean age in COVID-19 was 51.2 years and men (58.2%) were more likely to be infected. The majority of MERS cases were from Middle East and South Korea, with an average age of 49.3 years and males accounting for 63.7%. The results suggested that men seemed to be more susceptible to the two coronaviruses than women, and men had an even higher proportion in MERS than in COVID-19. It was hypothesized that there could be a relationship between a sex-susceptibility and sex-related cardiovascular risk, which might be mainly caused by the protective effect of oestrogen in females.

The most prevalent cardiovascular metabolic comorbidity in COVID-19 was hypertension (16.1%, 95% confidence interval [CI]: 10.9–21.2%), followed by cardio-cerebrovascular diseases (13.1%, 95% CI: 7.8–18.4%) and diabetes (8.8%, 95% CI: 5.9–11.7%) (Figure 1(a) to (c)). For MERS, the most prevalent comorbidity was diabetes (41.7%, 95% CI: 32.6–50.7%), followed by hypertension (37.2%, 95% CI: 29.4–45.1%) and cardio-cerebrovascular diseases (25.5%, 95% CI: 17.3–33.8%) (Figure 1(a) to (c)). It seems that the proportions of cardiovascular metabolic comorbidities were much higher in patients with MERS than those with COVID-19. According to the reports of COVID-19, about 12.3% of infected patients were admitted to the ICU (95% CI: 6.8–17.8%) and 3.2% patients died (95% CI: 1.4–5.0%). But when summarizing the data of MERS, we were astonished that 57.1% of infected patients were admitted to ICU (95% CI: 42.2–72.0%), while 43.3% died (95% CI: 33.8–52.8%) (Figure 1(d) and (e)). The results suggested that the risk of ICU admission in MERS was 4.7 times higher than that in COVID-19, while the risk of death in MERS was 13.5 times higher than that of COVID-19. In addition, 13.0% (95% CI: 4.1–21.9%) of patients suffered from acute cardiac injury in COVID-19 (Figure 1(f)).

When analysing the association between ICU admission rates and the increasing percentage of comorbidities in COVID-19, the overall effects in the meta-regression model were statistically significant for hypertension ($\beta = 0.010$ (95% CI: 0.004–0.015), $p < 0.001$), diabetes ($\beta = 0.020$ (95% CI: 0.010–0.030), $p < 0.001$) and cardio-cerebrovascular diseases ($\beta = 0.007$ (95% CI: 0.003–0.010), $p < 0.001$), respectively (Supplementary Figure 2). For the association of mortality and the comorbidities in COVID-19, the overall effects in the meta-regression model were statistically significant for diabetes ($\beta = 0.009$ (95% CI: 0.003–0.015), $p = 0.004$) and cardio-cerebrovascular diseases ($\beta = 0.003$ (95% CI: 0.000–0.005), $p = 0.016$), but with no statistical significance for hypertension ($\beta = -0.001$ (95% CI: 0.005–0.004), $p = 0.784$) (Supplementary Figure 3). That means the patients with higher proportions of diabetes and cardio-cerebrovascular diseases had higher mortality.

For the association of ICU admission rates and the comorbidities in MERS, the overall effects were not significant for hypertension ($\beta = 0.007$ (95% CI: –0.008–0.022), $p = 0.356$), diabetes ($\beta = 0.004$ (95% CI: –0.001–0.010), $p = 0.146$) and cardio-cerebrovascular diseases ($\beta = 0.004$ (95% CI: –0.003–0.011), $p = 0.249$), respectively (Supplementary Figure 2). For the association of mortality and the comorbidities in MERS, the overall effects were statistically significant for hypertension ($\beta = 0.008$ (95% CI: 0.001–0.015), $p = 0.036$) and diabetes ($\beta = 0.006$ (95% CI: 0.002–0.010), $p = 0.006$), but with no significance for cardio-cerebrovascular diseases ($\beta = 0.005$ (95% CI: –0.001–0.011), $p = 0.092$) (Supplementary Figure 3). That meant prevalence of the comorbidities was not related to ICU admission.

| Infection | Number of patients | Mean age | Sex (male, %) | Hypertension (%) | Diabetes (%) | Cardio-cerebrovascular disease (%) | ICU (%) | Death (%) |
|-----------|--------------------|----------|---------------|------------------|--------------|-----------------------------------|---------|-----------|
| COVID-19  | 1893               | 51.2     | 58.0          | 16.1             | 8.8          | 13.1                              | 12.3    | 3.2       |
| MERS      | 1457               | 49.3     | 62.1          | 37.2             | 41.7         | 25.5                              | 57.1    | 43.3      |

ICU: intensive care unit; MERS: Middle East Respiratory Syndrome.
rate, but mortality progressively increased with advancing proportions of hypertension and diabetes in MERS. The prevalence of cardiovascular related comorbidities in MERS is as much as twice to four times that in patients with COVID-19. The large gap in the incidence of comorbidities can hardly be explained by the difference of age. Cardiovascular diseases are highly prevalent in the Middle East, more than in many regions of the world, which might be one of the reasons. But when we analysed the data of South Korea only, the proportions of hypertension and diabetes were still much higher than the data of COVID-19. So there must be something else. Then we thought about the spread speed of the two viruses. In only two months, SARS-CoV-2 has infected more than 80,000 persons, but MERS-CoV only infected less than 3000 over the world through more than three years spread. As a result, we have reason to believe that SARS-CoV-2 is much more capable of spreading than MERS-CoV. According to the results, we speculate that SARS-CoV-2 is infectious enough to infect individuals regardless of age and underlying conditions, but weaker in virulence and mortality. However, compared with COVID-19, MERS-CoV has a lower infectivity, which tends to infect people with underlying cardiovascular comorbidities, but leads to higher mortality.

The present analysis provides some evidence of a lesser prevalence of hypertension, diabetes and cardio-cerebrovascular comorbidities in COVID-19 compared with MERS. But the comorbidities in COVID-19 have a closer relationship with deterioration and death than in MERS. The results provide a more intuitive comparison to our understanding of this virus and help us take more resolute and effective strategies for the individuals with cardiovascular metabolic diseases to reduce the incidence of COVID-19 infection.

In conclusion, SARS-CoV-2 is more infectious, but weaker in virulence and mortality, while MERS-CoV has a lower infectivity but is more fatal.

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