Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Original Article

Clinical characteristics and risk factors of patients with severe COVID-19 in Riyadh, Saudi Arabia: A retrospective study

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ABSTRACT

Background: COVID-19 is newly emerging infectious disease that spread globally at unpredictable and unique pattern to the extent that the World Health Organization announced COVID-19 as a pandemic in the first couple months of 2020. This study aims to describe clinical and demographic features of COVID-19 patients and the influence of various risk factors on the severity of disease.
Methods: This research is a retrospective study based on Saudi Arabia's ministry of health's Covid-19 data. The analysis relies on data of all COVID-19 patients recorded in Riyadh between 1st, March 2020 and 30th, July 2020. Statistical analyses were performed to investigate the effect of demographic characteristic, clinical presentation, and comorbidities on infection severity.
Results: A total number of 1026 COVID-19 patients were identified based on the demographic data as follows: 709 cases (69% of cases) were males and 559 cases (54% of cases) were Saudi. Most of patients were diagnosed with mild signs and symptoms 697 (68% of cases), while 164 patient (16% of cases) demonstrated moderate signs and symptoms, and 103 cases (10%) were severe and 62 (6%) had critical febrile illness. Fever, cough, sore throat, and shortness of breath were the most common symptoms among patients with COVID-19. Among studied comorbidities in COVID-19 patients, diabetes mellitus and hypertension were the most prevalent. The results from the bivariate logistic regression analysis revealed that older age, diabetes mellitus, asthma, smoking, and fever are associated with severe or critically ill cases.
Conclusion: The findings of this study show that old age, fever, and comorbidities involving diabetes mellitus, asthma, and smoking were significantly associated with infection severity.

Introduction

In late December 2019, an outbreak caused by a novel coronavirus, called sever acute respiratorysyndrome coronavirus 2 (SARS-CoV-2), was initially reported in Wuhan, China [1]. Three months later, the disease caused by SARS-CoV-2 which designated as COVID-19 was declared as pandemic by World Health Organi-

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zation (WHO). By November 17, 2020, there were more than 54 million cases of COVID-19 and over 1,325,752 deaths were reported worldwide [2]. Saudi Arabia has recorded 418,411 covid-19 cases during the same period of time; with death rising to 6968. Those who had the ability to recover are 401,544 people.

This virus belongs to the same coronavirus family as Middle East Respiratory Syndrome (MERS-COV) and Severe Acute Respiratory Syndrome (SARS-COV), however, its virologic course and pathogenesis are not yet fully understood. Bats of the genus *Rhinolophus* were hypothesized to be the potential reservoir hosts of COVID-19, however, exact reservoir has not been determined [3]. Due to the high person-to-person transmissibility of SARS-CoV-2, several countries have developed strict regulations, including isolation, quarantine and advocating for social distancing, as an attempt to minimize the disease spread. Until now there is no effective treatment for COVID-19 [4].

The initial manifestations of COVID-19 are common with other respiratory infections such as, fever, cough which might resolve or progress to shortness of breath (SOB), dyspnoea, and pneumonia, resulting in acute respiratory distress syndrome (ARDS), renal failure, coagulation dysfunction, multiple organ failure and death [5–9]. The severity of the disease varies based on demographic features, comorbidities, and immune system responses between different populations [5–9]. Several studies reported changes in white blood cell count in COVID-19 patients such as leukopenia, leukocytosis, and lymphopenia and their association with severity of COVID-19 [7].

It is crucial to understand clinical characteristics and factor associated with severity of COVID-19. Since identification of these factors will support early recognition of patients with high risk for sever or critically COVID-19 presentation, thus, reducing mortality and guiding future management. Therefore, this study aims to describe the demographic data, clinical characteristics, comorbidities and outcomes of COVID-19 patients in Saudi Arabia.

Methods

Study design and population

All confirmed COVID-19 cases that were recorded by the Saudi Ministry of Health to WHO from March 1, 2020, to July 30, 2020, in the Riyadh region were investigated. The study protocol and study methodology were approved by the Ministry of Health's Institutional Review Board (IRB-20222E). The study was authorized and conducted as per the hospital management guidelines and the Ministry of Health (MoH).

Data measures

Patient's charts were reviewed to obtain demographic information, clinical presentations, comorbidities, severity and outcome of COVID-19. The diagnosis of COVID-19 based on the results obtained from nucleic acid test (real-time reverse transcriptase–polymerase chain reaction assay, RT-PCR, for SARS-CoV-2) of nasopharyngeal samples which tested at the National Health Laboratory according to the protocol established by the World Health Organization [10]. Patients were categorized into different groups depending on the disease severity into three pools: asymptomatic or mild, moderate, and severe or critical illness. Asymptomatic infections were characterized by the absence of clinical symptoms of the Covid-19 with a positive RT-PCR. Mild COVID-19 disease was described as the presence of mild clinical symptoms and absence of both respiratory distress and the imaging manifestations of pneumonia. Moderate disease was defined as the presence of fever, with respiratory symptoms and an image of pneumonia in CT scans. Severe disease was defined as the presence of at least one of the three conditions: respiratory distress, a respiratory rate $\geq$30 beats/min; oxygen saturation in resting state $\leq$93%; or an arterial blood oxygen partial pressure/oxygen concentration $\leq$300 mmHg (1 mmHg = 0.133 kPa). Critical illness was defined as having respiratory failure requiring mechanical ventilation, shock or combined organ failure requiring intensive care unit (ICU) monitoring and treatment.

Statistical analysis

Descriptive statistics frequency, data presentation, mean and standard deviation were expanded. Significance was assessed using chi-square test and parametric or non-parametric binomial tests where appropriate, Furthermore, stepwise Multivariate Binary logistic regression was used to determine the risk factors for sever or critical COVID-19 patients disease. Statistical analyses were performed using IBM-SPSS, version 25 software (IBM Corp., Armonk, NY, USA).l Also, level of significance set at 0.05 for any test ($p < 0.05$) and that was the criterion to consider the statistically significant results.

Results

Demographic and clinical characteristics

From the 1st of March 2020 to 30th of July 2020, 1026 patients and 30 health care workers (HCW) were diagnostically confirmed positive for COVID-19 in Riyadh, Saudi Arabia. The demographic and clinical characteristics of the patients are shown in Table 1. Of 1026 patients, male accounted for 69% (709) of cases and 54% (559) were Saudi. Most of patients were mild 697 (68%), 164 (16%) were moderate, 103 (10%) were severe and 62 (6%) were critically ill. Sever and critical cases were significantly higher in non-Saudi ($p < 0.005$). Patients aged from 21 to 60 represented 73.5% (754) of cases, in which older patients were significantly had sever disease comparing with younger ones ($p < 0.005$). During the same period, 30 cases of HCW were diagnosed with COVID-19, 18 (60%) were male, and 76.7% were non-Saudi, and 97% admitted in the general ward.

Fever, cough, sore throat, and shortness of breath were most common symptoms among patients with COVID-19 (Table 2). Asymptomatic represented 2.8% of cases. While cough, fever, and shortness of breath were the most frequent signs and symptoms among HCW diagnosed with COVID-19.

Among the studied comorbidities appeared in COVID-19 patients, diabetes mellitus occurred in 14.4%, hypertension in 8.9%, immunocompromised disease in 5.4%, chronic kidney disease in 4.1%, asthma in 3.6%, coronary heart disease in 2.7%, and heart failure in 2.1%. of the cases (Table 3). In HCW, diabetes mellitus was in 20% of the cases, hypertension in 16.7%, and asthma in 13.3% (Table 3).

History of travel abroad prior acquiring the infection was reported in 2.5% of the cases and 1% of patients and H.C.W., respectively. Patients with no history of travelling abroad were considered endogenous cases while patients who travelled abroad before acquiring the infection were considered exogenous cases (Table 4). Cases were significantly mild and moderate in co-patients, representing 16.4% and 60% of patients and H.C.W. (Table 4).

As shown in Table 5, antibiotics and bronchodilators were given to 67% and 61.2% of mild and moderate cases, respectively. As expected, most severe and critical cases were more likely to use antimalaria, corticosteroids, and vitamins (Table 5). Symptoms improved in 39.3% and 93.3% of patients, and HCW. 13 of 1026 patients died from COVI-19, one case from moderate, two from

Table 1
Demographic characteristics of patients and HCW with COVID-19 between 1st of March 2020 to 30th of July 2020.

		Patients					
		Disease severity				Total	p-Value
		Mild	Moderate	Severe	Critical		
Gender	Male	439 (61.9%)	133 (18.8%)	81 (11.4%)	56 (7.9%)	709 (69.1%)	0.000
	Female	258 (81.4%)	31 (9.8%)	22 (6.9%)	6 (1.9%)	317 (30.9%)	
Nationality	Saudi	447 (80%)	56 (10%)	39 (7%)	17 (3%)	559 (54.5%)	0.000
	Non-Saudi	250 (53.5%)	108 (23.1%)	64 (13.7%)	45 (9.6%)	467 (45.5%)	
Age	0–2.5y	16 (80%)	2 (10%)	1 (5%)	1 (5%)	20 (18.9%)	0.000
	2.6–5y	18 (100%)	0 (0%)	0 (0%)	0 (0%)	18 (17%)	
	6–20 y	102 (96.2%)	4 (3.8%)	0 (0%)	0 (0%)	106 (31.2%)	
	21–40 y	327 (79%)	51 (12.3%)	25 (6%)	11 (2.7%)	414 (40.3%)	
	41–60 y	184 (54.1%)	78 (22.9%)	46 (13.5%)	32 (9.4%)	340 (33.2%)	
	>61 y	51 (40%)	29 (28%)	31 (24.2%)	17 (16.5%)	128 (12.5%)	
Site of admission	ICU	0 (0%)	1 (1.7%)	14 (23.7%)	44 (74.6%)	59 (5.7%)	0.000
	General Ward	277 (56%)	150 (30.3%)	61 (12.3%)	7 (1.4%)	495 (48%)	
	unknown	420 (87%)	13 (3%)	28 (7.7%)	11 (2.3%)	472(46%)	
HCW							
Gender	Male	9 (50%)	6 (33.3%)	2 (11.1%)	1 (5.6%)	18 (60%)	0.502
	Female	8 (66.7%)	4 (33.3%)	0 (0%)	0 (0%)	12 (40%)	
Nationality	Saudi	4 (57.1%)	3 (42.9%)	0 (0%)	0 (0%)	7 (23.3%)	0.762
	Non-Saudi	13 (56.5%)	7 (30.4%)	2 (8.7%)	1 (4.3%)	23 (76.7%)	
Age	21–40 y	14 (73.7%)	4 (21.1%)	1 (5.3%)	0 (0%)	19 (380%)	0.053
	41–60 y	2 (33.3%)	4 (66.7%)	0 (0%)	0 (0%)	6 (120%)	
	>61 y	1 (20%)	2 (40%)	1 (20%)	1 (20%)	5 (16.7%)	
Site of admission	ICU	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1 (3.3%)	0.000
	General Ward	15 (50%)	12 (40%)	2 (6.7%)	0 (0%)	29 (96.6%)	

Table 2
Symptoms associated with COVID-19 confirmed cases.

Patients						
Symptoms	Disease severity				Total	p-Value
	Mild	Moderate	Severe	Critical		
Cough	81 (29.7%)	108 (39.6%)	49 (17.9%)	35 (12.8%)	273 (27.4%)	0.005
Fever	96 (34.8%)	92 (33.3%)	54 (19.6%)	34 (12.3%)	276 (27.7%)	0.005
Sore throat	12 (42.9%)	9 (32.1%)	4 (14.3%)	3 (10.7%)	28 (2.8%)	0.041
Shortness of breath	52 (28%)	69 (37.1%)	39 (21%)	26 (14%)	186 (18.7%)	0.005
Diarrhoea	21 (50%)	11 (26.2%)	6 (14.3%)	4 (9.5%)	42 (4.2%)	0.116
Vomiting	3 (33.3%)	4 (44.4%)	1 (11.1%)	1 (11.1%)	9 (0.9%)	0.101
Nausea	4 (33.3%)	5 (41.7%)	2 (16.7%)	1 (8.3%)	12 (1.2%)	0.063
Asymptomatic	18 (64.3%)	7 (25%)	2 (7.1%)	1 (3.6%)	28 (2.8%)	0.594
HCW						
Cough	10 (50%)	8 (40%)	1 (5%)	1 (5%)	20 (66.7%)	0.568
Fever	10 (62.5%)	4 (25%)	2 (12.5%)	0 (0%)	16 (53.3%)	0.282
Sore throat	2 (66.7%)	1 (33.3%)	0 (0%)	0 (0%)	3 (10%)	0.942
Shortness of breath	3 (42.9%)	2 (28.6%)	1 (14.3%)	1 (14.3%)	7 (23.3%)	0.217
Diarrhoea	4 (80%)	1 (20%)	0 (0%)	0 (0%)	5 (16.7%)	0.683
Vomiting	0 (0%)	1 (100%)	0 (0%)	0 (0%)	1 (3.3%)	0.558
Nausea	0 (0%)	1 (100%)	0 (0%)	0 (0%)	1 (3.3%)	0.558
Asymptomatic	3 (75%)	1 (25%)	0 (0%)	0 (0%)	4 (13.3%)	0.842

sever, and ten from critical cases (Table 5). The case fatality rate was 1.3%.

The results from the bivariate logistic regression analysis are presented in Table 6. Factors associated with severe or critical illness included age (41–60 and <60 year) (OR 6.38 with 95% CI (1.491–127.369), and OR 14.741 with 95% CI (3.354–64.7880)), diabetes mellitus (OR 2.01 with 95% CI (1.218–3.323)), asthma (OR 3.50 with 95% CI (1.555–7.918)), smoking (OR 11.55 with 95% CI (4.538–29.440)), and fever (OR 1.97 with 95% CI (1.273–3.061).

Discussion

This study describes the demographic and clinical characteristics of COVID-19 patients in Riyadh, Saudi Arabia, and the risk factors associated with severe infection. Out of 1026 patients, 103 (10%) and 62 (6%) were sever and critically sick, respectively which was similar to result of study reported from Wuhan, China [11]. In comparison to reports from China [12], Italy [13], and the United States [8], this study found that COVID-19 had a milder clinical presentation. The study also revealed that, male patients with COVID-19 were higher than female patients; this is consistent with previous studies that showed that male were more prevalent among patients infected with COVID-19 [5,8].This might be due to behavioural habits such as smoking or sex-based immunological variations or high prevalent comorbidities in men [14], which necessitates further research aims to investigate clinical outcomes in different gender.

Among 1026 patients, asymptomatic ones represented 2.8% of cases, a higher percentage was observed in HCW in which asymptomatic accounted for 13.3% of cases. These findings were comparable with a national study conducted in Saudi Arabia [15], revealing a significant higher risk for disease transmission

Table 3
Comorbidities in COVID-19 confirmed cases.

Patients						
Comorbidities	Disease severity					
	Mild	Moderate	Severe	Critical	Total	p Value
Hypertension	18 (20.2%)	30 (33.7%)	23 (25.8%)	18 (20.2%)	89 (8.9%)	0.000
Diabetes mellitus	33 (22.9%)	47 (32.6%)	34 (23.6%)	30 (20.8%)	144 (14.4%)	0.000
Asthma	13 (36.1%)	6 (16.7%)	10 (27.8%)	7 (19.4%)	36 (3.6%)	0.000
COPD	8 (57.1%)	2 (14.3%)	3 (21.4%)	1 (7.1%)	14 (1.4%)	0.577
Coronary heart disease	11 (40.7%)	8 (29.6%)	4 (14.8%)	4 (14.8%)	27 (2.7%)	0.021
Heart failure	5 (23.8%)	6 (28.6%)	5 (23.8%)	5 (23.8%)	21 (2.1%)	0.000
Stroke	5 (38.5%)	4 (30.8%)	2 (15.4%)	2 (15.4%)	13 (1.3%)	0.145
Malignancy	7 (43.8%)	6 (37.5%)	3 (18.8%)	0 (0%)	16 (1.6%)	0.049
Chronic Kidney disease	15 (44.1%)	11 (32.4%)	2 (5.9%)	6 (17.6%)	34 (4.1%)	0.007
Chronic liver disease	9 (75%)	0 (0%)	2 (16.7%)	1 (8.3%)	12 (1.8%)	0.284
Immunocompromised disease	10 (29.4%)	13 (38.2%)	5 (14.7%)	6 (17.6%)	34 (5.4%)	0.013
Organ transplant	0 (0%)	0 (0%)	0 (0%)	1 (100%)	1 (0.1%)	0.002
Current use of NSAIDs	0 (0%)	2 (33.3%)	1 (16.7%)	3 (50%)	6 (1.3%)	0.007
Smoking	7 (29.2%)	3 (12.5%)	4 (16.7%)	10 (41.7%)	24 (2.4%)	0.000
HCW						
Hypertension	1 (20%)	2 (40%)	1 (20%)	1 (20%)	5 (16.7%)	0.044
Diabetes mellitus	1 (16.7%)	4 (66.7%)	1 (16.7%)	0 (0%)	6 (20%)	0.112
Asthma	1 (25%)	3 (75%)	0 (0%)	0 (0%)	4 (13.3%)	0.298
COPD	–	–	–	–	–	–
Coronary heart disease	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (3.3%)	0.852
Heart failure	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (3.3%)	0.852
Stroke	–	–	–	–	–	–
Malignancy	–	–	–	–	–	–
Chronic Kidney disease	–	–	–	–	–	–
Chronic liver disease	–	–	–	–	–	–
Immunocompromised disease	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (3.3%)	0.852
Organ transplant	–	–	–	–	–	–
Current use of NSAIDs	–	–	–	–	–	–
Smoking	–	–	–	–	–	–

Table 4
Route of infection in COVID-19 patients.

Mode of infection	Level	Spectrum of illness severity				Total	p Value
		Mild	Moderate	Severe	Critical		
Exogenous cases	Patients	14 (56%)	5 (20%)	5 (20%)	1 (4%)	208 (2.5%)	0.352
	HCW	0 (0%)	1 (100%)	0 (0%)	0 (0%)	1 (0%)	0.579
Contact with positive case (co-patients)	Patients	77 (48.1%)	53 (33.1%)	22 (13.8%)	8 (5%)	160 (16.4%)	0.000
	HCW	15 (83.3%)	3 (16.7%)	0 (0%)	0 (0%)	18 (60%)	0.003

Table 5
Outcome of Clinical management in COVID-19 patients.

		Disease severity HCW				All patients	p-Value
Category		Mild	Moderate	Sever	Critical	N (%)	
Medications							
Antibiotics	Patients	69 (23.1%)	131 (43.8%)	60 (20.1%)	39 (13%)	299 (29.14%)	0.000
	HCW	3 (25%)	6 (50%)	2 (16.7%)	1 (8.3%)	12 (100%)	
Antimalaria	Patients	2 (3.2%)	23 (36.5%)	17 (27%)	21 (33.3%)	63 (6.14%)	0.000
	HCW	1 (100%)	1 (100%)	0 (0%)	0 (0%)	1 (100%)	
Vitamins	Patients	10 (9.1%)	32 (29.1%)	33 (30%)	35 (31.8%)	110 (10.72%)	0.000
	HCW	2 (28.6%)	3 (42.9%)	1 (14.3%)	1 (14.3%)	7 (100%)	
Bronchodilator	Patients	20 (20.4%)	40 (40.8%)	21 (21.4%)	17 (17.3%)	98 (9.6%)	0.000
	HCW	3 (75%)	1 (25%)	4 (100%)	(0%)	4 (100%)	
Corticosteroid	Patients	3 (0.3%)	5 (0.5%)	14 (1.4%)	22 (2.1%)	44 (4.3%)	0.000
	HCW	2 (100%)	2 (100%)	(0%)	(0%)	2 (100%)	0.000
Response to medications							
Symptoms improving	Patients	154 (38.2%)	146 (36.2%)	67 (16.6%)	36 (8.9%)	403 (39.3%)	0.000
	HCW	16 (57.1%)	10 (35.7%)	2 (7.1%)	0 (0%)	28 (93.3%)	0.000
Clinical outcome							
Death	Patients	0	1 (0.6%)	2 (2%)	10 (16.13%)	13 (1.3%)	0.000
	HCW	0	0	0	0	0	
Hospital admission period in days (Mean ± SD)	Patients	6.18 ± 2.993	10.374 ± 4.157	14.885 ± 4.914	18.226 ± 8.632	10.07 ± 5.903	0.000
	HCW	6.375 ± 5.236	10.375 ± 5.125	20 ± 0	0 ± 0	10.07 ± 5.903	0.056

Table 6
Factors associated with sever/ critical COVID-19 cases.

Risk Factor		B	S.E.	Wald	df	p Value	Exp(B)	95% C.I. for EXP(B)	
								Lower	Upper
Diabetes mellitus		0.699	0.256	7.444	1.000	0.006	2.011	1.218	3.323
Asthma		1.255	0.415	9.137	1.000	0.003	3.509	1.555	7.918
Smoking		2.447	0.477	26.323	1.000	0.000	11.558	4.538	29.440
Fever		0.680	0.224	9.241	1.000	0.002	1.974	1.273	3.061
Antimalaria		0.784	0.358	4.786	1.000	0.029	2.189	1.085	4.417
Corticosteroid		1.986	0.722	7.574	1.000	0.006	7.288	1.771	29.986
Vitaminsupplements		1.742	0.267	42.705	1.000	0.000	5.711	3.386	9.630
Age	21–40	1.196	0.749	2.554	1.000	0.110	3.308	0.763	14.346
	41–60	1.854	0.742	6.238	1.000	0.013	6.387	1.491	27.369
	>60	2.691	0.755	12.688	1.000	0.000	14.741	3.354	64.788

from asymptomatic carriers. Our findings support the observations of previous studies [7,8,15,16], which reported fever, cough, and shortness of breath as the most common symptoms among patients. In accordance with the earlier reports [15,17], gastrointestinal symptoms including vomiting, nausea, and diarrhoea were less common. In agreements with earlier studies high percentage of cases in current study had pre = existing comorbidities, in which diabetes mellitus (14.4%), hypertension (8.9%), and asthma (3.6%) were the most common disease manifestations. These results match those observed in earlier studies [15,18]. Of note, diabetes mellitus, asthma, and smoking were significantly associated with sever and critical disease on bivariate analysis. In this regard, it is well known that patients with diabetes have a higher risk of COVID-19 complications, such as acute respiratory distress syndrome (ARDS) as reported by previous studies [19] due to their immune deficiency. Smoking also associated with severe COVID-19 [20]. In this regard, a study reported by Huang et al., patients with asthma and COPD, on the other hand, had an elevated risk of severe COVID-19 disease and hospitalization [21], which was in agreement with our study.

Findings of this study provide a scientific evidence to predict the complications and severity of the disease among the confirmed cases. This will assist the decision makers to allocate the available facilities towards the high risked patients.

Limitations

There might be subtle neglected factors such as pregnancy and occupation that might be subjected to uncontrolled confounders, which might affect the study results. Some uncontrolled confounders might also affect the outcome of associated factors. Finally, retrospective observational study always proves to present biased data due to various reasons such as the data sources.

Conclusion

In summary, throughout the study, it is clear that various risk factors directly affect the severity of COVID-19 infection. People with higher possibility to expose to risk factors are more likely to develop the disease and suffer from severe or critical Covid-19 complications. Covid-19 severity is linked to demographic and clinical characteristics, and comorbidities.

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Competing interests

None declared.

Ethical approval

Not required.

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References

[1] Del Rio C, Malani PN. COVID-19—new insights on a rapidly changing epidemic. JAMA 2020;323(14):1339–40.
[2] John Hopkins Coronavirus Resource Center [Accessed 17 November 2020]; Available from: COVID-19 map; 2020 https://coronavirus.jhu.edu/map.html.
[3] Lau S, Luk H, Wong A, Li K, Zhu L, He Z, et al. Possible bat origin of severe acute respiratory syndrome coronavirus 2. Emerg Infect Dis 2020;26(7):1542–7.
[4] Lai S, Bogoch I, Ruktanonchai N, Watts A, Lu X, Yang W, Yu H, Khan K, Tatem AJ. Assessing spread risk of Wuhan novel coronavirus within and beyond China, January–April 2020: a travel network-based modelling study. medRxiv 2020 [Preprint]. Feb 5:2020.02.04.20020479.
[5] Guan W-J, Ni Z-Y, Hu Y, Liang W-H, Ou C-Q, He J-X, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020;382(18):1708–20.
[6] Jiang F, Deng L, Zhang L, Cai Y, Cheung CW, Xia Z. Review of the clinical characteristics of coronavirus disease 2019 (COVID-19). J Gen Intern Med 2020;35(5):1545–9.
[7] Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA 2020;323(11):1061–9.
[8] Goyal P, Choi JJ, Pinheiro LC, Schenck EJ, Chen R, Jabri A, et al. Clinical characteristics of Covid-19 in New York City. N Engl J Med 2020;382(24):2372–4.
[9] Mitra AR, Fergusson NA, Lloyd-Smith E, Wormsbecker A, Foster D, Karpov A, et al. Baseline characteristics and outcomes of patients with COVID-19 admitted to intensive care units in Vancouver, Canada: a case series. CMAJ 2020;192(26):E694–701.
[10] Organization WH. Coronavirus disease (COVID-19) technical guidance: laboratory testing for 2019-nCoV in humans; 2020.
[11] Epidemiology Working Group for Ncip Epidemic Response, C.C.f.D.C.P. The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China. Zhonghua Liu Xing Bing Xue Za Zhi 2020;41(2):145–51.
[12] Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72314 cases from the chinese center for disease control and prevention. JAMA 2020;323(13):1239–42.
[13] Livingston E, Bucher K. Coronavirus disease 2019 (COVID-19) in Italy. JAMA 2020;323(14):1335.
[14] Wenham C, Smith J, Morgan R, Gender, Group C-W. COVID-19: the gendered impacts of the outbreak. Lancet 2020;395(10227):846–8.
[15] Alsofayan YM, Althunayyan SM, Khan AA, Hakawi AM, Assiri AM. Clinical characteristics of COVID-19 in Saudi Arabia: a national retrospective study. J Infect Public Health 2020;13(7):920–5.
[16] Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. N Engl J Med 2020;382(13):1199–207.
[17] Pan L, Mu M, Yang P, Sun Y, Wang R, Yan J, et al. Clinical characteristics of COVID-19 patients with digestive symptoms in Hubei, China: a descriptive, cross-sectional, multicenter study. Am J Gastroenterol 2020;115(5):766–73.
[18] Hu Z, Song C, Xu C, Jin G, Chen Y, Xu X, et al. Clinical characteristics of 24 asymptomatic infections with COVID-19 screened among close contacts in Nanjing, China. Sci China Life Sci 2020;63(5):706–11.

[19] Wu J, Zhang J, Sun X, Wang L, Xu Y, Zhang Y, et al. Influence of diabetes mellitus on the severity and fatality of SARS-CoV-2 (COVID-19) infection. Diabetes Obes Metab 2020;22(10):1907–14.
[20] Gulsen A, Yigitbas BA, Uslu B, Dromann D, Kilinc O. The effect of smoking on COVID-19 symptom severity: systematic review and meta-analysis. Pulm Med 2020;2020:7590207.
[21] Huang B, Chen Z, Sidell M, Eckel S, Martinez M, Lurmann F, et al. Associations of asthma, COPD and medication history with the risk of severe COVID-19. J Allergy Clin Immunol 2021;147:AB247.