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

Risk factors for disease severity, unimprovement, and mortality in COVID-19 patients in Wuhan, China

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ABSTRACT

Objective: In December 2019, coronavirus disease (COVID-19) emerged in Wuhan. However, the characteristics and risk factors associated with disease severity, unimprovement and mortality are unclear and our objective is to throw some light on these.

Methods: All consecutive patients diagnosed with COVID-19 admitted to the Renmin Hospital of Wuhan University from January 11 to February 6, 2020, were enrolled in this retrospective cohort study.

Results: A total of 663 COVID-19 patients were included in this study. Among these, 247 (37.3%) had at least one kind of chronic disease; 0.5% of the patients ($n = 3$) were diagnosed with mild COVID-19, while 37.8% (251/663), 47.5% (315/663), and 14.2% (94/663) were in moderate, severe, and critical conditions, respectively. In our hospital, during follow-up 251 of 663 patients (37.9%) improved and 25 patients died, a mortality rate of 3.77%. Older patients (>60 years old) and those with chronic diseases were prone to have a severe to critical COVID-19 condition, to show unimprovement, and to die (p <0.001, <0.001). Multivariate logistic regression analysis identified being male (OR = 0.486, 95%CI 0.311–0.758; p 0.001), having a severe COVID-19 condition (OR = 0.129, 95%CI 0.082–0.201; p <0.001), expectoration (OR = 1.796, 95%CI 1.062–3.036; p 0.029), muscle ache (OR = 0.309, 95%CI 0.153–0.626; p 0.001), and decreased albumin (OR = 1.929, 95%CI 1.199–3.104; p 0.007) as being associated with unimprovement in COVID-19 patients.

Conclusion: Male sex, a severe COVID-19 condition, expectoration, muscle ache, and decreased albumin were independent risk factors which influence the improvement of COVID-19 patients. **J. Zhang, Clin Microbiol Infect 2020;26:767**

Introduction

In modern human history, infectious diseases have posed a threat to public health several times. Coronavirus, which usually causes respiratory tract infections in humans, has been linked to several infectious diseases and subsequent global challenges [1,2]. In December 2019, clusters of patients with viral pneumonia were

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confirmed to be infected with a novel coronavirus. The infection caused by the novel coronavirus was named Coronavirus Disease 2019 (COVID-19), and this coronavirus was named as severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) by the World Health Organization and International Committee on Taxonomy of Viruses [3]. As of March 31st, 2020, SARS-CoV-2 has caused 81 554 infections and 3312 deaths in China [4], which far exceeds those caused by both SARS-CoV and MERS-CoV worldwide. An increasing number of studies have suggested that people of all ages are susceptible to SARS-CoV-2 infection, which can result in severe and even fatal respiratory diseases. Moreover, human-to-human hospital-associated transmission of SARS-CoV-2 has been shown to be possible [5,6].

This study aimed to provide additional data regarding the clinical features of patients diagnosed with COVID-19 and specifically to analyse the factors associated with disease severity, unimprovement, and mortality.

Methods

Study design and participants

All consecutive patients diagnosed with COVID-19 admitted to the Renmin Hospital of Wuhan University from January 11th to February 6th, 2020, were enrolled in this retrospective cohort study. We obtained oral informed consent from all patients enrolled in the study. A confirmed COVID-19 case was defined as a positive result on real-time RT-PCR for the presence of SARS-CoV-2 in both nasal and pharyngeal swab specimens. Open reading frame 1ab (ORF1ab) and nucleocapsid protein (N) were simultaneously amplified and tested during the real-time RT-PCR assay. The assay was performed using a SARS-CoV-2 nucleic acid detection kit, according to the manufacturer's protocol (Shanghai bio-germ Medical Technology Co Ltd, China).

This study was approved by the Ethics Committee of the Renmin Hospital of Wuhan University.

Diagnostic and grading criteria for COVID-19

Our primary outcomes included disease severity at admission and unimprovement and mortality during follow-up. The disease severity and improvement were defined according to the interim guidelines from the World Health Organization and the National Health Commission of China [7,8]. According to the patients' symptoms, laboratory results and imaging findings at admission, the disease severity of COVID-19 patients can be divided into four types: mild, moderate, severe, and critical. When patients have slight clinical symptoms without imaging findings of pneumonia they are treated as having a mild condition. When patients have fever or respiratory symptoms, they are identified as having a moderate condition. Patients are considered as having a severe condition if they have the following: respiratory distress and a respiratory rate >30 times per minute, fingertip blood oxygen saturation <93% at rest, and partial arterial oxygen pressure (PaO_2)/fraction of inspiration oxygen (FiO_2) $\leq$300 mmHg. Patients are regarded as having a critical condition if they have one of the following: respiratory failure requiring mechanical ventilation, shock, and other organ failure requiring ICU treatment. Acute kidney injury was diagnosed according to the KDIGO (Kidney Disease: Improving Global Outcomes) clinical practice guidelines [9]. Acute respiratory distress syndrome (ARDS) was diagnosed according to the Berlin definition [10]. Meanwhile, patients exhibiting one of the following situations during follow-up were considered to show improvement: continuously decreased temperature or normal temperature (<37.3°C), improved respiratory symptoms (disappeared or obviously relieved), gradual reduction in pulmonary inflammation on imaging analysis (obviously reduced shadow area), and negative results of SARS-CoV-2 real-time RT-PCR detection. Otherwise, they were considered to show unimprovement.

Data collection

Three physicians collected and reviewed the data. The epidemiological data, medical history, underlying comorbidities, symptoms and signs both at admission and during follow-up, laboratory findings, chest computed tomographic (CT) scans, real-time RT-PCR detection results, and survival data were obtained from patients' electronic medical records. The date of disease onset was defined as the day when the symptoms were noticed. Laboratory values and chest CT scans were collected at admission. Symptoms and signs at admission and during the hospital stay were also collected. The clinical outcomes were followed up until February 9th, 2020.

Statistical analysis

Categorical variables were reported as percentages and compared using the χ^2 test. Fisher's exact test was also used to estimate continuous variables if one set contained fewer than five expected subjects. When continuous measurements were normally distributed, they were presented as means ± standard deviations (SDs) and an independent group t-test was used. Otherwise, the interquartile range (IQR) values and the Mann–Whitney U test were used. A value of $p < 0.05$ was considered statistically significant.

A logistic regression was used to explore the risk factors associated with the primary outcomes. All variables associated with the primary outcomes were included in the univariate regression model. Variables with $p < 0.05$ in previous analyses were entered into logistic multivariate regression models. Continuous variable was dichotomized. The variables included in the final model were selected by an automatic procedure. We tested in the model interactions that were significant on a stratified analysis odds ratio (OR) presented with 95% confidence intervals (95%CI). Statistical analyses were conducted using the SPSS software (version 19.0).

Results

Baseline characteristics

A total of 663 COVID-19 patients, confirmed via PCR detection of SARS-CoV-2, were included in this study. The median age was 55.6 years (IQR 44–69; range 16–95 years). Among these patients, 321 (48.4%) were men with a median age of 57.8 years (IQR 46–70; range 23–95 years), and 342 (51.6%) were women with a median age of 57.8 years (IQR 42–67; range 16–90 years) (Table 1). Most of the patients were either retirees (227, 34.2%) or employees (211, 31.8%). Of the 663 COVID-19 patients, 247 (37.3%) had at least one coexisting chronic disease; the three most common among the included patients were cardiovascular disease (21.1%), endocrine system disease (10.1%), and respiratory system disease (7.9%).

Disease severity and associated risk factors

Among the 663 patients, 0.5% ($n = 3$) were classified as having a mild COVID-19 condition at admission, while 37.8% (251/663), 47.5% (315/663), and 14.2% (94/663) were classified as moderate, severe, and critical, respectively (Table 1). The median ages of patients with mild to moderate, severe, and critical COVID-19 were 49.1 (IQR 36–61), 61.3 (IQR 49–70), and 67.0 (IQR 58.3–76.8) years, respectively, differences that were significant ($p < 0.001$). Older

Table 1
Baseline characteristics of the 663 COVID-19 patients

	Total (n = 663)	Disease severity				Improvement during follow-up			In-hospital death		
		Mild to moderate	Severe	Critical	p value	Yes	No	p value	Survival	Non-survival	p value
Age, mean (IQR)	55.6 (44–69)	49.1 (36–61)	59.6 (49–70)	67.1 (58.3–76.8)	<0.001	45.7 (35.3–56.8)	61.9 (52–72)	<0.001	59.1 (43–68)	67.1 (61–78)	<0.001
≤60	348(52.5)	185(72.8)	136(43.2)	27(28.7)	<0.001	186(74.1)	162(39.3)	<0.001	342(53.6)	6(24.0)	0.004
>60	315(47.5)	69(27.2)	179(56.9)	67(71.3)		65(25.9)	250(60.7)		296(46.4)	19(76.0)	
Gender											
Male	321(48.4)	116(45.7)	149(47.3)	56(59.6)	0.060	103(41.0)	218(52.9)	0.003	306(48.0)	15(60.0)	0.237
Female	342(51.6)	138(54.3)	166(52.7)	38(40.4)		148(59.0)	194(47.1)		332(52.0)	10(40.0)	
Occupation											
Retired	227(34.2)	46(18.1)	135(42.9)	46(48.9)	<0.001	45(17.9)	182(44.2)	<0.001	211(33.1)	16(64.0)	0.016
Employee	211(31.8)	119(46.9)	77(24.4)	15(16.0)		130(51.8)	81(19.7)		209(32.8)	2(8.0)	
Self-employed	12(1.8)	7(2.8)	4(1.3)	1(1.1)		6(2.4)	6(1.5)		12(1.9)	0(0)	
Agricultural worker	8(1.2)	7(1.8)	1(0.3)	0(0.0)		4(1.6)	4(1.0)		8(1.3)	0(0)	
Others	205(30.9)	75(29.5)	98(31.1)	32(34.0)		66(26.3)	139(33.7)		198(31.0)	7(28.0)	
Comorbidities											
Respiratory disease	51(7.7)	13(5.12)	23(7.3)	15(16.0)	0.003	12(4.8)	39(9.5)	0.028	46(7.2)	5(20.0)	0.019
Cardiovascular disease	164(24.7)	33(13.0)	82(26.0)	49(52.1)	<0.001	29(11.6)	135(32.8)	0.000	148(23.2)	16(64.0)	<0.001
Gastrointestinal disease	31(4.7)	9(3.5)	16(5.1)	6(6.4)	0.482	11(4.4)	20(4.9)	0.780	30(4.7)	1(4.0)	0.749
Endocrine system disease	67(10.1)	14(5.5)	39(12.4)	14(14.9)	0.007	16(6.4)	51(12.4)	0.013	64(10.0)	3(12.00)	0.986
Urinary system disease	21(3.2)	5(1.97)	10(3.2)	6(6.4)	0.113	3(1.2)	18(4.4)	0.042	21(3.3)	0(0)	1.000
Inflammatory disease	6(0.9)	0(0.0)	3(1.0)	3(3.2)	0.020	0(0)	6(1.5)	0.088	5(0.8)	1(4.0)	0.556
Malignant tumour	14(2.1)	3(1.2)	9(2.9)	2(2.1)	0.385	3(1.2)	11(2.7)	0.316	13(2.0)	1(4.0)	0.968

Data are n (%), n/N (%), mean (SD), and median (IQR).
P <0.05 was considered statistically significant.

patients (>60 years) were more likely to exhibit severe and critical COVID-19 conditions than others (≤60 years old, p <0.001). Among the mild, moderate, severe, and critical patients, 100% (3/3), 76.5% (192/251), 60.0% (189/315), and 34.0% (32/94), respectively, had no coexisting chronic disease, which indicated that patients with chronic disease are more prone to severe forms of COVID-19 (p <0.001). Moreover, previously diagnosed respiratory (p 0.003), cardiovascular (p 0.000), endocrine system (p 0.007), and inflammatory diseases (p 0.020) were associated with disease severity (Table 1).

Regarding the symptoms, dyspnoea (p <0.001), chest tightness (p <0.001), diarrhoea (p 0.003), fatigue (p 0.015), dizziness (p 0.009), muscle ache (p 0.028), and unconsciousness (p 0.020) were significantly linked to severe COVID-19 cases (Table 2). Moreover, increased white blood cell (p <0.001) and neutrophil counts (p <0.001), decreased lymphocyte counts (p <0.001), decreased haemoglobin (p <0.001), increased alanine aminotransferase (ALT) (p 0.015) and/or aspartate aminotransferase (AST) (p <0.001), increased serum creatinine and/or decreased glomerular filtration rate (p <0.001), increased C-reactive protein (CRP) (p <0.001), decreased albumin (p <0.001), and increased lactate dehydrogenase (LDH) (p <0.001) at admission were significantly associated with severe and critical disease conditions (Table 3).

Unimprovement during follow-up and associated risk factors

A total of 251 patients (37.9%) improved in hospital during follow-up (Table 1). The median age of these patients was 48.1 years (IQR 34–60; range 22–85 years) which was younger than patients without improvement (median age 61.9; IQR 52–72; range 16–95 years, p <0.001). Older patients (>60 years) were more prone to have no improvement than others (≤60 years old, p <0.001). Among the patients with improvement, 103 (41.0%) were men and most of them (130, 51.8%) were employees. Moreover, 198 patients with improvement (251, 78.9%) had no coexisting chronic disease (Table 1), which is significantly higher than patients without improvement (219, 53.2%; p <0.001).

With respect to the systemic symptoms at admission, fever (p 0.007), dizziness (p 0.023), and muscle ache (p <0.001) were found to influence patients' improvement in hospital (Table 2). The patients who exhibited expectoration, dyspnoea, and chest tightness at admission were more likely to respond to therapy and had better overall outcomes (p <0.001, <0.001, <0.001, respectively). However, digestive symptoms had no effect on patients' improvement.

At admission, increased white blood cell counts were significantly associated with patients who responded to treatment (p 0.011). Moreover, when patients had neutrophil counts above the normal range, they were more likely to exhibit improvement in symptoms during follow-up (p <0.001). Patients with improvement were also found to have lymphocyte counts below the normal range (p <0.001). Additionally, decreased haemoglobin (p 0.006), increased ALT (p 0.001) and/or AST (p <0.001), increased serum creatinine and/or decreased glomerular filtration rate (p <0.001), increased CRP (p <0.001), decreased albumin (p <0.001), and increased LDH (p <0.001) were also shown to be associated with COVID-19 improvement. Furthermore, patients with unilateral pneumonia as diagnosed by CT scans were more likely to improve (p <0.001, Table 3).

In univariate analysis, being male, having a severe or critical condition, expectoration, muscle ache, decreased albumin, decreased lymphocytes, age >60 years, occupation, cardiovascular disease, dyspnoea, chest tightness, fever, bilateral pneumonia, reduced haemoglobin, increased ALT, increased AST, increased LDH, damaged kidney function and increased CRP were associated with unimprovement in hospital. In multivariate analysis, being male

Table 2
Clinical characteristics of the 663 COVID-19 patients

	Total ($n = 663$)	Disease severity				Improvement during follow-up			In-hospital death		
		Mild to moderate	Severe	Critical	p value	Yes	No	p value	Survival	Non-survival	p value
Respiratory symptoms											
Dry cough	410 (61.8)	155 (61.0)	202 (64.1)	53 (56.4)	0.376	150 (59.8)	260 (63.1)	0.390	394 (61.8)	16 (64.0)	0.821
Expectoration	166 (25.0)	52 (20.5)	89 (28.3)	25 (26.6)	0.096	42 (16.7)	124 (30.1)	<0.001	157 (24.6)	9 (36.0)	0.197
Dyspnoea	161 (24.3)	37 (14.6)	94 (29.8)	30 (31.9)	<0.001	36 (14.3)	125 (30.3)	<0.001	150 (23.5)	11 (44.0)	0.019
Chest tightness	154 (23.2)	37 (14.6)	91 (28.9)	26 (27.7)	<0.001	36 (14.3)	118 (28.6)	<0.001	148 (23.2)	6 (24.0)	0.926
Digestive symptoms											
Abdominal pain	5 (0.8)	2 (0.8)	3 (1.0)	0 (0)	0.643	2 (0.8)	3 (0.7)	0.716	5 (0.8)	0 (0)	1.000
Diarrhoea	61 (9.2)	25 (9.8)	36 (11.4)	0 (0)	0.003	22 (8.8)	39 (9.5)	0.762	61 (9.6)	0 (0)	0.259
Nausea	31 (4.7)	11 (4.3)	15 (4.8)	5 (5.32)	0.923	9 (3.6)	22 (5.3)	0.299	30 (4.7)	1 (4.0)	0.714
Vomiting	17 (2.6)	6 (2.4)	9 (2.9)	2 (2.13)	0.895	6 (2.4)	11 (2.7)	0.825	16 (2.5)	1 (4.0)	0.865
Bloating	8 (1.2)	4 (1.6)	4 (1.3)	0 (0)	0.485	5 (2.0)	3 (0.7)	0.281	8 (1.3)	0 (0)	1.000
Systemic symptoms											
Fever	527 (79.5)	198 (78.0)	257 (81.6)	72 (76.7)	0.427	186 (74.1)	341 (82.8)	0.007	508 (79.6)	19 (76.0)	0.660
Fatigue	208 (31.4)	63 (24.8)	110 (34.9)	35 (37.2)	0.015	67 (26.7)	141 (34.2)	0.043	199 (31.2)	9 (36.0)	0.611
Dizziness	23 (3.5)	2 (0.8)	15 (4.8)	6 (6.9)	0.009	3 (1.2)	20 (4.9)	0.023	22 (3.5)	1 (4.0)	0.682
Headache	20 (3.0)	7 (2.8)	11 (3.5)	2 (2.1)	0.757	7 (2.8)	13 (3.2)	0.789	20 (3.1)	0 (0)	1.000
Muscle ache	63 (9.5)	33 (13.0)	26 (8.3)	4 (4.3)	0.028	39 (15.5)	24 (5.8)	<0.001	63 (9.9)	0 (0)	0.157
Neurological symptoms											
Unconsciousness	10 (1.5)	1 (0.4)	0 (0)	9 (9.6)	<0.001	0 (0)	10 ()	0.031	7 (1.1)	3 (12.0)	<0.001

Data are n (%) unless specified otherwise.
P <0.05 was considered statistically significant.

(OR = 0.486, 95%CI 0.311–0.758; p 0.001), having a severe COVID-19 condition (OR = 0.129, 95%CI 0.082–0.201; p <0.001), expectoration (OR = 1.796, 95%CI 1.062–3.036; p 0.029), muscle ache (OR = 0.309, 95%CI 0.153–0.626; p 0.001), and decreased albumin (OR = 1.929, 95%CI 1.199–3.104; p 0.007) at admission were independent risk factors associated with unimprovement during follow-up (Table 4).

Mortality and associated risk factors

A total of 25 patients included in the study died, a mortality rate of 3.77% (Table 1). The median age of the deceased patients was 69.3 years (IQR 61–78; range 34–90 years), which is significantly higher than that of the surviving patients (median age 56.1; IQR 43–68; range 16–95 years; p <0.001). And older patients (>60 years) were significantly more likely to die in hospital than those ≤60 years old (p 0.004). Eight of the patients who died (32.0%) had no chronic disease (Table 2). When comparing the dead and surviving patient populations, the only two symptoms which exhibited significant difference were dyspnoea (p 0.019) and unconsciousness (p <0.001).

Compared to other patients, the proportion of patients with increased white blood cell counts (p <0.001), neutrophil counts above the normal range (p 0.001), lymphocyte counts below the normal range (p 0.006), increased ALT (p 0.011) and/or AST (p 0.001), increased serum creatinine and/or decreased glomerular

Table 3
Laboratory results and imaging finding of the 663 COVID-19 patients

	Total ($n = 663$)	Disease severity				Improvement during follow-up			In-hospital death		
		Mild to moderate	Severe	Critical	p value	Yes	No	p value	Survival	Non-survival	p value
Blood routine											
White blood cell											
Increased	80 (12.1)	18 (8.2)	29 (9.3)	33 (38.4)	<0.001	18 (8.3)	62 (15.5)	0.011	70 (11.7)	10 (55.6)	<0.001
Neutrophil											
Increased	189 (28.5)	35 (15.8)	98 (31.4)	56 (65.1)	<0.001	46 (21.1)	143 (35.7)	<0.001	177 (29.5)	12 (66.7)	0.001
Lymphocyte											
Decreased	338 (51.0)	77 (34.8)	186 (49.6)	75 (87.2)	<0.001	78 (35.8)	260 (64.8)	<0.001	322 (53.6)	16 (88.9)	0.006
Haemoglobin											
Decreased	219 (33.0)	51 (23.1)	136 (43.6)	32 (37.2)	<0.001	60 (27.5)	159 (39.7)	0.006	211 (35.1)	8 (44.4)	0.414
liver function											
Increased ALT	151 (22.8)	41 (18.6)	81 (26.1)	29 (33.7)	0.015	37 (17.0)	114 (28.6)	0.001	142 (23.7)	9 (50.0)	0.011
Increased AST	171 (25.8)	40 (18.2)	91 (29.3)	40 (46.5)	<0.001	40 (18.4)	131 (32.8)	<0.001	160 (26.7)	11 (61.1)	0.001
Kidney function											
Damage	68 (10.3)	12 (5.5)	32 (10.3)	24 (27.9)	<0.001	6 (2.8)	62 (15.5)	<0.001	63 (10.5)	5 (27.8)	0.021
Infection-related Biomarkers											
Increased CRP	388 (58.5)	94 (50.5)	255 (79.2)	69 (92.0)	<0.001	93 (49.5)	295 (82.6)	<0.001	374 (70.4)	14 (100)	0.014
Other markers											
Decreased Albumin	444(67.0)	134 (61.8)	233 (74.9)	77 (89.5)	<0.001	130 (60.2)	314 (78.7)	<0.001	426 (71.4)	18 (100)	0.005
Increased LDH	320(48.3)	67 (30.5)	179 (57.6)	74 (86.1)	<0.001	65 (29.8)	255 (63.9)	<0.001	306 (51.1)	14 (77.8)	0.046
CT											
Bilateral pneumonia	550 (83.0)	195 (86.7)	271 (95.4)	84 (98.8)	<0.001	191 (58.7)	359 (96.8)	<0.001	530 (92.3)	20 (100)	0.388

Data are n (%) unless specified otherwise.
ALT, alanine aminotransferase; AST, aspartate aminotransferase; Cr, creatinine; GFR, glomerular filtration rate; CRP, C-reactive protein; LDH, lactate dehydrogenase; CT, computed tomography.
P <0.05 was considered statistically significant.

Table 4
Logistic regression modelling evaluating risk factors for unimprovement during follow-up of COVID-19 patients

Item	Univariate logistic regression			Multivariate logistic regression		
	OR	95%CI	P Value	OR	95%CI	P Value
Male	0.520	0.355–0.761	0.001	0.486	0.311–0.758	0.001
Severe and critical condition	0.118	0.077–0.181	0.000	0.129	0.082–0.201	<0.001
Expectoration	1.899	1.205–2.992	0.006	1.796	1.062–3.036	0.029
Muscle ache	0.304	0.166–0.557	0.000	0.309	0.153–0.626	0.001
Decreased albumin	2.377	1.576–3.587	0.000	1.929	1.199–3.104	0.007
Decreased lymphocytes	3.828	2.579–5.680	0.000	—	—	—
Age >60	4.791	3.018–7.606	0.000	—	—	—
Occupation	0.187	0.124–0.281	0.000	—	—	—
Cardiovascular disease	2.436	1.503–3.948	0.000	—	—	—
Dyspnoea	2.361	1.455–3.830	0.001	—	—	—
Chest tightness	2.266	1.413–3.633	0.001	—	—	—
Fever	1.740	1.102–2.747	0.018	—	—	—
Bilateral pneumonia	4.942	2.386–10.240	0.000	—	—	—
Reduced haemoglobin	1.731	1.156–2.591	0.008	—	—	—
Increased ALT	1.699	1.075–2.686	0.023	—	—	—
Increased AST	2.081	1.324–3.271	0.002	—	—	—
Increased LDH	4.381	2.932–6.545	0.000	—	—	—
Damaged kidney function	5.957	2.320–15.296	0.000	—	—	—
Increased CRP	4.693	3.099–7.107	0.000	—	—	—

ALT, alanine aminotransferase; AST, aspartate aminotransferase; Cr, creatinine; GFR, glomerular filtration rate; CRP, C-reactive protein; LDH, lactate dehydrogenase; CT, computed tomography.
$P < 0.05$ was considered statistically significant.

filtration rate (p 0.021), increased CRP (p 0.014), decreased albumin (p 0.005), and increased LDH (p 0.046) at admission was higher among the deceased patient population (Table 3).

Discussion

In our study population there were 247 patients who had at least one kind of coexisting chronic disease. Cardiovascular disease, endocrine system disease, and respiratory system disease were the three most common coexisting chronic diseases. There were 91 patients who had no fever at admission. Additionally, 22 of the included COVID-19 patients did not exhibit any symptoms and were found to be positive only via the results of the SARS-CoV-2 PCR test. Most patients had systemic, respiratory, and digestive symptoms. Fever, dry cough, and fatigue were the three most common symptoms. On admission, most patients had white blood cell and neutrophil counts in the normal range and lymphocyte counts below the normal range. About a quarter of the COVID-19 patients had differing degrees of hepatic function abnormality, and one in ten patients had kidney function abnormality. Most patients had increased CRP, decreased albumin, and increased LDH. The vast majority of patients also had bilateral pneumonia on CT imaging.

One third of the patients improved in hospital during follow-up. Twenty-five patients died, a mortality rate of 3.77%. The mortality rate in our study was lower than that indicated in a previous report but higher than that reported in another study [5,11]. This heterogeneity is probably due to differences in the case inclusion criteria. However, our results were closer to the mortality rate indicated by official national statistics, which is 3.97%. Cumulative studies confirmed that older age was associated with poor outcomes in COVID-19 patients. In our study, older patients were prone to have severe COVID-19 symptoms and unimprovement, and were more likely to die in hospital. In previous findings in animal studies, older animals were shown to have stronger host innate immune responses to SARS-CoV infection [12]. The unsatisfactory control of viral replication and more prolonged proinflammatory responses in older individuals due to age-dependent defects was found to lead to a marked decline in cell-mediated immune function and reduced humoral immune function, which potentially leads to poor outcomes [13,14].

Fever, dizziness, muscle ache, expectoration, dyspnoea, and chest tightness at admission were also found to influence patients' improvement in hospital. Dyspnoea and unconsciousness were the only two symptoms which were associated with mortality.

A recent study reported the presence of SARS-CoV-2 nucleic acid fragments in the stool samples of patients with abdominal symptoms and suggested that SARS-CoV-2 might also be transmitted via the faecal–oral route [15]. In our study, approximately one in six COVID-19 patients had digestive symptoms, especially diarrhoea, which is more than was reported in a previous study [11]. The digestive symptoms of most COVID-19 patients were mild, which seemed to be inconsistent with the pathogenicity of SARS-CoV-2. A possible explanation is that SARS-CoV-2 in the sputum of COVID-19 patients is transmitted to the digestive tract through swallowing. There, under the action of various digestive enzymes, the virulence of SARS-CoV-2 in the digestive tract is weakened and the virus is degraded into fragments that cause only mild digestive symptoms but not serious gastrointestinal damage.

In conclusion, being male, as well as having severe COVID-19 symptoms, expectoration, muscle ache, and decreased albumin were shown to be independent risk factors which influence patients' improvement during follow-up. Older age was associated with poor condition and outcome in COVID-19 patients.

Author contributions

All authors have made substantial contributions to this work and have approved the final manuscript. JZ and XW contributed equally to this work. Concept and design: JZ, XW, YX and WD. Acquisition, analysis, or interpretation of data: JL, XJ, KH, JW, ZG, CZ, YH. Resources: HL, FC, BZ. Writing original draft: JZ, XW and YX. Writing review and editing: GW and WD. Supervision: YX, GW and WD.

Transparency declaration

The authors declare no competing interests.

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