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ABO Blood System Associated with Susceptibility, and Rhesus (Rh) Status Associated with Disease Severity in COVID-19 Patients, (Southeast of Iran)

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Abstract

Background: The ABO/Rh blood groups were related to susceptibility to numerous infectious and non-infectious diseases. Here, the association of ABO/Rh groups with susceptibility to COVID-19 and disease severity was investigated in a population from southeast Iran.

Material and Methods: In this descriptive study, information regarding the clinical characteristics and ABO/Rh blood groups was collected from 524 patients with COVID-19 from March to October, 2020. The data of blood groups from patients were compared with those from 7365 healthy individuals during the same period. Data was analyzed using SPSS.

Results: No significant differences were found between COVID-19 patients and the healthy group regarding the proportions of A, B, and O blood groups. However, the proportion of the AB blood group was significantly higher in COVID-19 patients than that in healthy people (11.8% versus 8.2%, P <0.004). When the A group was considered as a reference, the AB blood group was associated to a greater risk of COVID-19 [OR: 1.45 (1.06-1.98), P<0.02]. No association was found between ABO blood groups and COVID-19 severity. The proportion of the Rh-positive blood group was slightly higher in COVID-19 patients than in the other group. The proportion of Rh-negative patients was greater in severe COVID-19 than in mild and moderate forms (P<0.001). In A, AB, and O blood groups, the proportions of Rh-negative patients were greater in severe COVID-19 than those with mild and moderate disease (P=0.05, P<0.05, and P<0.001, respectively).

Conclusion: The AB blood group was associated with greater susceptibility to COVID-19, while Rh-negative status was positively associated with disease severity.

Keywords: COVID-19, SARS-CoV-2, ABO Blood System, Rh System, Susceptibility, Disease Severity

Introduction

The SARS-CoV-2-related COVID-19 disease has affected many populations in more than 212 countries and territories [1]. SARS-CoV-2 is mainly transmitted via respiratory droplets (particularly during coughing and sneezing) and near contact with a person-to-person. However, aerosols and fomites can also transmit the virus [2]. SARS-CoV-2 remains contagious in aerosols for several minutes or hours and on surfaces for several days [2].

The SARS-CoV-2-infected persons may be asymptomatic or express a range of clinical patterns, including mild, moderate, severe, and critical types [3]. The COVID-19 manifestations appear after an incubation stage (with a median of about 5 days) and include fever, breath shortness, dry cough, headache and dizziness, nausea and diarrhea, and loss of sense of smell and taste, in some cases, patients exhibit no specific clinical symptoms [3, 4].

The spike (S) protein of SARS-CoV-2 binds to the cells expressing ACE2, the main receptor of SARS-CoV-2 [5]. ACE2 is expressed in many tissues, especially the lungs, gastrointestinal tract, testis and kidneys, bladder, liver, heart, and CNS [3, 5]. Old age, diabetes complications, obesity, hypertension, coronary artery disease, and tumors are the major risk factors for COVID-19 aggravation and related fatality [3, 5]. Overall, hyper-inflammatory reactions, cytokine storm, immune dysregulation, lymphopenia, massive virus replication, excessive death of host cells, coagulopathy, and lung fibrosis are among the mechanisms playing crucial roles in COVID-19 pathogenesis [6].

ABH antigens are present on the membrane of erythrocytes and many other cells, including white blood cells, platelets, and vascular endothelial cells [7]. ABO blood groups have been reported to be associated with many infectious diseases, including bacterial and parasitic infections such as Helicobacter pylori, malaria, and schistosomiasis. [8-10]. ABO blood groups have also been shown to be associated with susceptibility to major viral diseases, including enteroviruses, Ebola, influenza, and SARS [11-13]. Blood group antigens may directly act as receptors or co-receptors for viruses, bacteria, and parasites [8].

Furthermore, some blood group-related antigens can support attachment, intracellular uptake, or signal transduction during infectious diseases [10, 14-16]. Furthermore, the presence of the performed natural antibodies of blood groups may contribute to the anti-virus innate immune response [17]. Nevertheless, the precise role of ABO/Rh blood group antigens during the SARS-CoV-2 infection has not yet been elucidated.

Although there are some studies concerning the association of the ABO blood types and COVID-19, this association has not been evaluated in the southeast of Iran. Therefore, this study was conducted to investigate the association of the ABO/Rh blood groups with susceptibility to COVID-19 or disease severity in Rafsanjan City (a city located in the southeast of Iran, Kerman province, Iran) to clarify possible association.

Materials and Methods

Totally, a total of 524 patients with COVID-19 were enrolled in this descriptive study and referred to Ali-iben-e Abitaleb Hospital, affiliated with the Rafsanjan University of Medical Sciences (Rafsanjan, Iran). Patients with COVID-19 infection were enrolled during March- to October of 2020. The SARS-CoV-2 infection was considered positive according to the results obtained from the real-time PCR test performed on a sample collected from the nasopharyngeal region of patients. The adult COVID-19 patients (age >18 years) with a documented ABO/Rh blood type were enrolled in the hospital records. The patients without documented ABO/Rh blood types were excluded from the study. History of hypertension, diabetes, hyperlipidemia, cardiovascular disease, gastrointestinal disease, liver and kidney diseases, respiratory diseases, thyroid disease, and other diseases were screened for underlying disease.

According to the WHO guidelines, COVID-19 patients were classified into mild, moderate, and severe subgroups based on their clinical exhibitions. The mild form of COVID-19 was defined as symptoms such as mild fever, headache, dry cough, sore throat, nasal congestion, malaise, muscle pain, and anosmia. Moderate type of COVID-19 was characterized by respiratory symptoms, especially cough, and shortness of breath without signs of severe pneumonia. Severe COVID-19 was defined as serious dyspnea, hypoxia, and tachypnea [18].

To determine the normal distribution of ABO/Rh blood group types in the general population of Rafsanjan, the blood types of 7365 healthy individuals who were referred to the local blood transfusion center (for a donation of whole blood or platelets) during the same period were collected and analyzed. This investigation was evaluated and approved by a local ethical committee affiliated with the Rafsanjan University of Medical Sciences and registered with an ethics code of IR.RUMS.REC.1399.191. Moreover, informed written consent was obtained from all patients.

Differences in variables were analyzed using appropriate statistical tests, including $\chi 2$ and student t-test, and the P-values less than 0.05 were considered significant. ORs with 95% CIs for ABO/Rh blood types in COVID-19 patients were determined using logistic regression. The data were analyzed by a statistical SPSS software (version 22, Chicago, IL, USA).

Table 1. Major clinical symptoms in patients with COVID-19

Clinical symptoms of COVID-19	Number (%) of Patients (n=524)
Body pain	289 (55.2%)
Headache	224(46.6%)
Weakness and fatigue	232 (44.3%)
Coughing	228 (43.5)
Fever	214 (40.8%)
Decreased sense of smell	185 (35.3%)
Decreased sense of taste	166 (31.7%)
Shortness of breath	113 (21.6%)
Gastrointestinal symptoms	113 (21.6%)
Body Trembling	110 (21%)
Sore throat	47 (9%)

Results

Clinical symptoms of COVID-19 patients: As demonstrated in Table 1, the most common clinical symptoms in COVID-19 patients were body pain (55.2%), headache (46.6%), weakness and fatigue (44.3%), coughing (43.5%), fever (40.8%), decreased sense of smell (35.3%), decreased sense of taste (31.7%), shortness of breath (21.6%), gastrointestinal symptoms (21.6%), body trembling (21.0%) and sore throat (9.0%).

Occupational status and previous contact of COVID-19 patients with an infected person: The occupational status including official employee, unemployed / housekeeper, self - employed, emeritus, and student were reported in 371 (70.8%), 60 (11.45%), 55 (10.49%), 30 (5.72%) and 8 (1.52%) of COVID-19 patients, respectively (Table 2). Concerning previous exposure to SARS-CoV-2, 225 (42.9%) of patients reported close contact with a COVID-19 patient, while 114 (21.8%) had a SARS-CoV-2-infected member in their family (Table 2).

Table 2. Occupational status and history of exposure to a SARS-CoV-2-infected person in patients with COVID-19

Environmental parameters	Situations	Patients (n=524)
Occupational status	Unemployed/Housekeeper	60 (11.4%)
	Student	8 (1.5%)
	Employee	371 (70.8%)
	Emeritus	30 (5.7%)
	Self-employed	55 (10.5%)
History of exposure to a patient with COVID-19	The presence of an infected member in the family	114 (21.8%)
	Contact with a COVID-19 patient	225 (42.9%)
	As the first infected person in the family	100 (19.1%)
	Roommate	6 (1.1%)
	Colleague	70 (13.4%)
	No answer	9 (1.7%)

Disease severity and related parameters in COVID-19 patients: According to disease severity, the mild, moderate, and severe forms of COVID-19 were exhibited in 288 (55.5%), 143 (27.3%), and 93 (17.7%) of the SARS-CoV-2-infected patients, respectively. The presence of underlying diseases in patients with COVID-19 was as follows: hypertension in 52 (9.9%), diabetes in 45 (8.6%), hyperlipidemia in 27 (5.2%), cardiovascular diseases in 26 (5%), respiratory diseases in 25 (4.8%), thyroid diseases in 25 (4.8%), liver and kidney diseases in 22 (4.2%), gastrointestinal diseases in 10 (1.9%) and other diseases in 24 (4.6%) (Table 3). As indicated in Table 3, hypertension, hyperlipidemia, diabetes, cardiovascular disease, respiratory diseases, and liver and kidney diseases showed significant association with COVID-19 severity. However, no significant association was found between the presence of the thyroid and gastrointestinal diseases with COVID-19 severity (Table 3).

Table 3. The presence and association of a history of underlying diseases with the COVID-19 severity

Underlying diseases	COVID-19 severity			Total patients (n=524)	P- value
	Mild (n=288)	Moderate (n=143)	Severe (n=93)		
Hypertension	13 (4.5%)	17 (11.9%)	22 (23.7%)	52 (9.9%)	0.001
Diabetes	18 (6.2%)	11 (7.7%)	16 (17.2%)	45 (8.6%)	0.010
Hyperlipidemia	5 (1.7%)	9 (6.3%)	13 (14.0%)	27 (5.2%)	0.000
Cardiovascular diseases	11 (3.8%)	6 (4.2%)	10 (10.8%)	26 (5%)	0.039
Respiratory diseases	7 (2.4%)	10 (7.0%)	9 (9.7%)	25 (4.8%)	0.011
Thyroid diseases	13 (4.5%)	5 (3.5%)	7 (7.5%)	25 (4.8%)	0.392
Liver and kidney diseases	5 (1.7%)	8 (5.6%)	9 (9.7%)	22 (4.2%)	0.007
Gastrointestinal diseases	3 (1.04%)	4 (2.8%)	3 (3.2%)	10 (1.9%)	0.444
Other diseases	12 (4.2%)	7 (4.9%)	5 (5.4%)	24 (4.6%)	0.728

Distribution of ABO/Rh blood group types in COVID-19 and healthy groups: The distribution of the ABO/Rh blood group types in COVID-19 patients and healthy group was summarized in Table 4. The proportion of A blood group was similarly expressed in COVID-19 patients and healthy group (26.1% versus 26.2%, P=0.99). There was no significant differences between COVID-19 patients and the healthy healthy group regarding the frequencies of B and O blood group types (Table 4). The AB blood group type frequency was significantly greater in COVID-19 patients than in the healthy healthy group (11.8% versus 8.2%, P <0.004). When the A blood group was considered as a reference, the AB blood group type was related to the greater risk of COVID-19 [OR: 1.45 (1.06-1.98), P<0.02] (Table 4). The frequency of the Rh-positive blood group type was slightly higher, while the frequency Rh-negative blood group was slightly lower in COVID-19 patients in comparison with those in the healthy healthy group (Table 4).

Table 4. Distribution of the ABO/Rh blood group types in patients with COVID-19 and healthy group.

ABO/Rh blood group types	Healthys (n=7365)	Patients (n=524)	P value	OR (95% CI)	P-value
A	1927 (26.2%)	137 (26.1%)	0.99	Reference	---
B	2117 (28.7%)	140 (26.8%)	0.32	0.93 (0.73-1.18)	0.93
AB	602 (8.2%)	62 (11.8%)	0.004*	1.45 (1.06-1.98)	0.02
O	2719 (36.9%)	185 (35.3%)	0.46	0.95 (0.76-1.20)	0.70
Rh positive	6474(87.9%)	464 (88.5%)	0.66	Reference	0.66
Rh negative	891(12.1%)	60 (11.5%)	0.66	1.064 (0.81-1.4)	

The distribution of the ABO blood group types in COVID-19 patients and healthy group according to their Rh status was summarized in Table 5. Considering Rh status in all A, B, AB, and O blood group types, there was no significant differences between COVID-19 patients and the healthy group regarding the proportion of Rh-positive or Rh-negative individuals (Table 5).

Table 5. Distribution of the ABO blood group types in patients with COVID-19 and healthy group according to their Rh status

ABO blood group type	Rh status	Healthy people (n=7365)	Patients (n=524)	P-value
A	A+	1685 (87.4%)	121 (88.3%)	0.76
	A-	242 (12.6%)	16 (11.7%)	
	Total	1927 (100.0%)	137 (100.0%)	
B	B+	1897 (89.6%)	124 (88.6%)	0.69
	B-	220 (10.4%)	16 (11.4)	
	Total	2117 (100.0%)	140 (100.0%)	
AB	AB+	528 (87.7%)	54 (87.1%)	0.88
	AB-	74 (12.3%)	8 (12.9%)	
	Total	602 (100.0%)	62 (100.0%)	
O	O+	2364 (86.9%)	165 (89.2%)	0.37
	O-	355 (13.1%)	20 (10.8%)	
	Total	2719 (100.0%)	185 (100.0%)	

The distribution of the ABO/Rh blood group types in COVID-19 patients and the healthy group according to their gender was summarized in Table 6. Considering gender status in A, B, and O blood group types, there was no significant differences between the COVID-19 patients and healthy group regarding the frequencies of men or women. In the AB blood group type, the frequencies of the men and women in the COVID-19 patients were markedly greater than those in the healthy group. However, the differences did not show a significant level (P=0.06 and P=0.08, respectively) (Table 6). Considering gender status in Rh-positive and Rh-negative blood group types, no significant differences were detected between the COVID-19 and healthy groups regarding the frequencies of men or women (Table 6).

Table 6. Distribution of the ABO/Rh blood group types in COVID-19 patients and healthy group according to their gender

ABO/Rh blood group type		Healthy (n=7365)	Patients (n=524)	P-value
A	Men	1870 (26.2%)	66 (27.3%)	0.72
	Women	57 (23.7%)	71 (25.2%)	0.68
	Total	1927 (26.2%)	137 (26.1%)	0.99
B	Men	2046 (28.7%)	65 (26.9%)	0.53
	Women	71 (29.5%)	75 (26.6)	0.46
	Total	2117 (28.7%)	140 (26.8%)	0.32
AB	Men	584 (8.2%)	28 (11.6%)	0.06
	Women	18 (7.5%)	34 (12.1%)	0.08
	Total	602 (8.2%)	62 (11.8%)	0.004
O	Men	2624 (36.8%)	83 (34.3%)	0.42
	Women	95 (39.4%)	102 (36.2%)	0.44
	Total	2719 (36.9%)	185 (35.3%)	0.46
Rh positive	Men	6264 (87.9%)	216 (89.3%)	0.53
	Women	210 (87.1%)	248 (87.9%)	0.78
	Total	6474 (87.9%)	464 (88.5%)	0.66
Rh negative	Men	860 (12.1%)	26 (10.7%)	0.53
	Women	31 (12.9%)	34 (12.1%)	0.78
	Total	891(12.1%)	60 (11.5%)	0.66

Association of ABO/Rh blood group types and COVID-19 severity: Distribution of the ABO blood group types in patients with COVID-19 according to their disease severity was summarized in Table 7. Within the A, B, AB, or O blood group types, there was no significant difference between mild, moderate, and severe types of COVID-19 regarding the frequency of a particular blood group (Table 7).

Table 7. Distribution of the ABO blood group types in COVID-19 patients according to their disease severity

ABO blood group types	COVID-19 Severity				P-value
	Mild	Moderate	Severe	Total	
A	77 (26.7%)	36 (25.2%)	24 (25.8%)	137 (26.1%)	0.93
B	71 (24.7%)	41 (28.7%)	28 (30.1%)	140 (26.8%)	0.62
AB	36 (12.5%)	15 (10.5%)	11 (11.8%)	62 (11.8%)	0.83
O	104 (36.1%)	51 (35.7%)	30 (32.3%)	185 (35.3%)	0.79
Total	288 (55.0%)	143 (27.3%)	93 (17.7%)	524 (100.0%)	---

The distribution of the Rh status in patients with COVID-19 according to their disease severity was summarized in Table 8. There were significant differences between mild, moderate, and severe types of COVID-19 regarding the frequency of Rh-positive or Rh-negative patients. The frequency of Rh-positive patients was significantly lower, while the frequency of Rh-negative patients was significantly greater in the severe form of the disease than those with the mild and moderate forms of COVID-19 (P<0.001) (Table 8).

Table 8. Distribution of Rh blood group types in COVID-19 patients according to their disease severity

Rh blood group types	COVID-19 Severity				P-value
	Mild	Moderate	Severe	Total	
Rh positive	262 (91.0%)	130 (90.9%)	72 (77.4%)	464 (88.5%)	0.001
Rh negative	26 (9.0%)	13 (9.1%)	21 (22.6%)	60 (11.5%)	
Total	288 (55.0%)	143 (27.3%)	93 (17.7)	524 (100%)	---

Distribution of the ABO blood group types in patients with mild, moderate, and severe forms of COVID-19 according to their Rh status was summarized in Table 9. In the patients with A, AB, and O blood group types, there were significant differences between mild, moderate, and severe types of COVID-19 regarding the frequency of Rh-positive or Rh-negative patients. In the patients with A, AB, and O blood group types, the frequency of Rh-positive patients was lower, while the frequency of Rh-negative patients was greater in the severe form of COVID-19 than those in the mild and moderate forms (P=0.05, P<0.05, and P<0.001, respectively). In the patients with B blood group type, there was no significant differences between the mild, moderate, and severe forms of COVID-19 regarding the distribution of Rh-positive or Rh-negative patients (Table 9).

Table 9. Distribution of the ABO blood group types in patients with mild, moderate, and severe forms of COVID-19 according to their Rh status

Blood group types	COVID-19 severity				P-value
	Mild	Moderate	Severe	Total	
A+	72 (93.5%)	28 (77.8%)	21 (77.5%)	121 (88.3%)	
A-	5 (6.5%)	8 (22.2%)	3 (12.5%)	16 (11.7%)	0.05
Total A	77 (100.0%)	36 (100.0%)	24 (100.0%)	137 (100.0%)	
B+	63 (88.7%)	38 (92.7%)	23 (82.1%)	124 (88.6%)	
B-	8 (11.3%)	3 (7.3%)	5 (17.9%)	16 (11.4)	0.40
Total B	71 (100.0%)	41 (100.0%)	28 (100.0%)	140 (100.0%)	
AB+	32 (88.9%)	15 (100.0%)	7 (63.6%)	54 (87.1%)	
AB-	4 (11.1)	0 (0.0%)	4 (34.6%)	8 (12.9%)	0.05
Total AB	36 (100.0%)	15 (100.0%)	11 (11.8%)	62 (100.0%)	
O+	95 (91.3%)	49 (96.1%)	21 (70.0%)	165 (89.2%)	
O-	9 (8.7%)	2 (3.9%)	9 (30.0%)	20 (10.8%)	0.001
Total O	104 (100.0%)	51 (100.0%)	30 (100.0%)	185 (100.0%)	

Discussion

In this study, the most common clinical symptoms in COVID-19 patients were body pain, headache, weakness and fatigue, coughing, fever, decreased sense of smell, decreased sense of taste, shortness of breath, gastrointestinal symptoms, body trembling, and sore throat. The patterns of the clinical signs observed in the present study were similar to those found in other investigations [19-21]. Here, a remarkable proportion of patients reported close contact with a COVID-19 patient or had a SARS-CoV-2-infected member in their family. The mild, moderate, and severe forms of COVID-19 were exhibited in 55.5%, 27.3%, and 17.7% of the patients, respectively. The results from a large cohort from China indicated that mild or moderate forms of COVID-19 were observed in more than 80.0% of SARS-CoV-2-infected patients [22]. The presence of underlying diseases in COVID-19 patients was as follows: hypertension in 9.9%, diabetes in 8.6%, hyperlipidemia in 5.2%, cardiovascular diseases in 5.0%, respiratory diseases in 4.8%, thyroid diseases in 4.8%, liver and kidney diseases in 4.2%, gastrointestinal diseases in 1.9% and other diseases in 4.6%. Similar patterns of the presence of hypertension, diabetes, hyperlipidemia, cardiovascular diseases, and respiratory disorders were reported in other studies [23, 24]. However, the results reported by Khoo et al. and Lui et al. indicated that about 15.0% of COVID-19 patients displayed thyroid dysfunction [25, 26].

Hypertension, hyperlipidemia, diabetes, cardiovascular disease, respiratory diseases, and liver and kidney diseases showed significant association with COVID-19 severity. Indeed, greater mortality rates were reported in COVID-19 patients suffering from the mentioned underlying diseases [24]. However, no significant association was found between the presence of thyroid and gastrointestinal diseases with COVID-19 severity.

In the present study, there was also no significant differences between COVID-19 patients and the healthy group regarding the frequencies of A, B, and O blood group types. The frequency of the AB blood group was significantly higher in the COVID-19 patients than in the healthy group. The AB blood group type was also related to the greater risk of COVID-19. There are controversies regarding the relationship of the ABO blood group types with COVID-19 in different populations. The results from some studies indicated no association between the ABO blood group types with COVID-19 [27, 28]. In contrast, others demonstrated a positive relation between COVID-19 with a blood group and a negative association with the O blood group type [29-32]. Latz et al. reported that the B and AB blood group types exhibited a positive association, the O blood type displayed a negative association, and the A blood group showed no

association with COVID-19 [33]. A study from Canada also indicated that the O blood group was related to a smaller risk for SARS-CoV-2 infection. At the same time, COVID-19 patients with severe illness or death express higher ratios of AB and B blood groups [34].

The lower risk of SARS-CoV-1 infection in the persons with O blood group was attributed to the anti-A antibodies in these subjects inhibiting the virus attachment to its target cells. The interaction of the viral S protein with ACE2-expressing cells was prevented by natural and monoclonal anti-A antibodies in vitro [35]. A higher risk of SARS-CoV-2infection in individuals with AB blood group confirms that anti-A antibodies (and perhaps anti-B antibodies) may provide a protective line against SARS-CoV-2 infection due to their inhibitory effects. Whether A and B antigens provide further molecular patterns for SARS-CoV-2 binding needs to be clarified in more molecular investigations.

There were no significant differences between the COVID-19 patients and the healthy group regarding the frequencies of men or women in A, B, and O blood group types. A study from the UK indicated that the risk of SARS-CoV-2 infection and COVID-19 outcomes were not associated with ABO blood groups in males or females [27]. However, we have observed that the frequencies of the men and women with AB blood group in the COVID-19 patients were markedly greater than those in the healthy group.

Within the A, B, AB, or O blood group types, there was no significant difference between mild, moderate, and severe types of COVID-19 regarding the frequency of a particular blood group. Mullins et al. and Mahmud et al. also reported that ABO blood group types of the COVID-19 patients did not affect their disease severity [28, 32].

In this study, no significant differences were found between COVID-19 patients and the healthy group regarding the Rh status of individuals. However, the frequency of the individuals with the Rh-positive blood group was slightly higher in COVID-19 patients compared with those in the healthy group. However, the frequency of Rh-positive patients was significantly lower, while the frequency of Rh-negative patients was significantly greater in the severe form of the disease than those with the mild and moderate forms of COVID-19. In the patients with A, AB, and O blood group types, the frequency of Rh-positive patients was significantly lower, while the frequency of Rh-negative patients was significantly greater in the severe form of the disease than those with the mild and moderate forms of COVID-19. Thus, it seems that the Rh status did not affect the risk of SARS-CoV-2 infection. Nonetheless, after SARS-CoV-2 infection, the Rh negativity may act as an accelerating factor for COVID-19 severity. Latz et al. reported that Rh positivity was associated with greater odds of SARS-CoV-2 infection, higher risks of intubation, and a greater fatality rate [33]. Zietz et al. also reported that Rh-negative patients exhibited a lower risk of SARS-CoV-2 infection, intubation, and death [36].

Moreover, Ray et al. found that individuals with Rh-negative blood type exhibited lower susceptibility to SARS-CoV-2 infection, especially those with O-negative blood type [34]. However, Saify et al. reported that the Rh-negative status was associated with a greater risk of COVID-19 [37]. The discrepancy observed between our findings and studies above concerning the association of Rh status with COVID-19 severity remains to be clarified in future studies.

Conclusion

In conclusion, similar patterns of clinical symptoms were observed in COVID-19 patients. Hypertension, hyperlipidemia, diabetes, cardiovascular disease, respiratory diseases, and liver and kidney diseases showed significant association with COVID-19 severity. ABO blood group types were not related to COVID-19 severity, while AB blood group type was positively associated with disease susceptibility. Rh status was not related to susceptibility to COVID-19, while Rh-negative status was positively associated with disease severity.

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