Association between blood groups and COVID-19 outcome in Iranian patients

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Aim: Many factors have been speculated to explain the COVID-19 complex clinical phenotype. Due to the inconsistent data published on blood groups and COVID-19, we conducted a study on Iranian patients to further assess this association. Materials & methods: This retrospective study was conducted on data collected from confirmed COVID-19 hospitalized patients during March and December 2020 in a referral hospital for COVID-19, 5 Azar Hospital, Gorgan, north of Iran. A total of 1554 confirmed COVID-19 cases were enrolled in the study with blood group (ABO and Rh), demographic, and clinical data available. Results: Of 1554 patients, 1267 and 287 cases had recovered and deceased (due to COVID-19) outcomes, respectively. Most of the cases had O+ (29.6%), the least number had AB- (0.5%), and most of the deceased cases had O+ blood types (31.4%). Logistic regression analysis revealed that groups A- and B- had higher and groups B+, A B+, O+ and O- had lower odds of death than the A+ group. Conclusion: This study indicates that blood types may be related to the clinical outcome of COVID-19. Further studies with a large cohort for multiple people are required to validate this association.

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COVID-19, an infectious disease caused by SARS-CoV-2, emerged in late November 2019 in Wuhan, China, and has become a pandemic disease. The WHO has identified the disease as a public health priority of international concern [1]. As an emerging virus, all people may be susceptible to SARS-CoV-2 infection, but the clinical course and outcome of COVID-19 vary significantly among individuals. While most infected cases present asymptomatic or mild symptoms, a small number are severely affected by COVID-19 [2]. It is unclear why severe disease and death occur only in a small subset of COVID-19 patients [3]. Despite efforts to elucidate mechanisms for differential clinical responses to SARS-CoV-2 infection, they remain largely elusive.

Although older patients with predisposing risk factors are more susceptible to severe forms of COVID-19, several cases of severe infection occur among previously healthy individuals [4]. Many factors (related to host, virus and environment) have been speculated to explain the COVID-19 complex clinical phenotype, but the exact contributions of each factor remain contentious [3]. It is well accepted that host differences (mainly genetic makeup) could dictate any viral infection’s clinical course and outcome [3,5]. People are different in many aspects, and we are in the preliminary stage to characterize stimulating factors for this complex disease. Since we have to live with SARS-CoV-2 for a long time, finding specific factors associated with the complicated disease outcome is very important.
Table 1. Demographic, sex, age, blood group and hospitalization wards of all, recovered and deceased cases.

| Variables             | All cases (%) | Recovered (%) | Deceased (%) | p-value |
|-----------------------|---------------|---------------|--------------|---------|
| **Sex**               |               |               |              |         |
| Female                | 740 (47.6)    | 606 (47.8)    | 134 (46.7)   |         |
| Male                  | 814 (52.4)    | 661 (52.2)    | 153 (53.3)   |         |
| Total                 | 1554 (100)    | 1267 (81.5)   | 287 (18.5)   | 0.354   |
| **Age (years)**       |               |               |              |         |
| 1–29                  | 92 (5.92)     | 85 (6.71)     | 7 (2.44)     |         |
| 30–39                 | 174 (11.20)   | 159 (12.55)   | 15 (5.23)    |         |
| 40–49                 | 279 (17.95)   | 254 (20.05)   | 25 (8.71)    |         |
| 50–59                 | 314 (20.21)   | 271 (21.39)   | 43 (14.98)   |         |
| ≥60                   | 695 (44.72)   | 498 (39.31)   | 197 (68.64)  | <0.001  |
| **Blood group**       |               |               |              |         |
| A+                    | 427 (27.5)    | 342 (27)      | 85 (29.6)    |         |
| A-                    | 45 (2.9)      | 31 (2.4)      | 14 (4.9)     |         |
| B+                    | 401 (25.8)    | 353 (27.9)    | 48 (16.7)    |         |
| B-                    | 35 (2.3)      | 18 (1.4)      | 17 (5.9)     |         |
| AB+                   | 105 (6.8)     | 86 (6.8)      | 19 (6.6)     |         |
| AB-                   | 7 (0.5)       | 7 (0.6)       | 0 (0.0)      |         |
| O+                    | 460 (29.6)    | 370 (29.2)    | 90 (31.4)    |         |
| O-                    | 74 (4.8)      | 60 (4.7)      | 14 (4.9)     | <0.001  |
| **Hospitalization wards** |           |               |              |         |
| Infectious Disease    | 1102 (70.91)  | 1078 (85.08)  | 24 (8.36)    |         |
| ICU/CCU/Emergency     | 288 (18.53)   | 52 (4.10)     | 236 (82.23)  |         |
| Post-ICU/isolated room| 74 (4.76)     | 54 (4.26)     | 20 (6.97)    |         |
| Other wards           | 90 (5.79)     | 83 (6.55)     | 7 (2.44)     | <0.001  |

CCU: Cardiac care unit; ICU: Intensive care unit.

The association between blood groups and susceptibility to some viral infections has been well established [6–11]. The blood group antigens are cell-surface glycoproteins present principally on erythrocytes that may affect infectious diseases [12]. During the current pandemic, several studies have investigated the association of blood groups and COVID-19 [13–18]. Some studies suggested that patients with blood group A are more susceptible to severe infection, but there are other controversial results [19–24]. More studies are needed to confirm the association between blood grouping and COVID-19 susceptibility and severity. Here, we investigated the association between blood groups (ABO and Rh) and COVID-19 outcomes in Iranian hospitalized patients.

Materials & methods

This retrospective study was conducted on data collected from patients hospitalized during March and December 2020 in a referral hospital for COVID-19, 5 Azar Hospital, Gorgan, north of Iran. A total of 1554 confirmed COVID-19 cases were enrolled in the study with blood group (ABO and Rh), demographic, and clinical data available. All COVID-19 patients had been confirmed by reverse transcriptase real-time PCR assay targeting the SARS-CoV-2 nucleoprotein (N) and ORF1ab genes (Pishtazteb, Iran). Data such as blood group, gender, age, hospitalized ward and disease outcome was collected from the patients’ case report forms. Because the frequency of participants in different age groups was different, the patients were classified into different age groups according to the literature. The patients were also classified into different hospitalized wards. Two outcomes, recovered and deceased (due to COVID-19), were examined in this study. All of the patients were from Golestan Province and had the same geographical origin.

Analyses were performed using SPSS version 25.0 (IBM Corp., NY, USA). Data were presented in proportions. We performed a chi-square test to compare the proportion of blood groups, age group, sex and hospitalization wards between the recovered and deceased groups. Multiple logistic regression was computed to assess the odds of death (dependent variable). Independent variables included the blood groups, age group, sex and hospitalization wards. The reported p-value is two-sided, and p-values less than 0.05 were considered statistically significant.
Table 2. Association of sex, age, blood group and hospitalization wards of COVID-19 patients with risk of death.

| Variables                  | All cases (%) | OR (CI: 95%) | p-value |
|----------------------------|---------------|--------------|---------|
| Sex                        |               |              |         |
| Female                     | 740 (47.6)    | Ref.         | 0.27    |
| Male                       | 814 (52.4)    | 1.15 (0.88–1.51) |         |
| Total                      | 1554 (100)    |              |         |
| Age (years)                |               |              |         |
| 1–29                       | 92 (5.92)     | Ref.         |         |
| 30–39                      | 174 (11.20)   | 1.16 (0.45–2.96) | 0.75    |
| 40–49                      | 279 (17.95)   | 1.22 (0.51–2.93) | 0.65    |
| 50–59                      | 314 (20.21)   | 1.97 (0.85–4.55) | 0.11    |
| ≥60                        | 695 (44.72)   | 4.95 (2.24–10.91) | <0.001  |
| Blood group                |               |              |         |
| A+                         | 427 (27.5)    | Ref.         |         |
| A-                         | 45 (2.9)      | 1.817 (0.925–3.566) | 0.083   |
| B+                         | 401 (25.8)    | 0.547 (0.372–0.803) | 0.002   |
| B-                         | 35 (2.3)      | 3.8 (1.879–7.683) | <0.001  |
| AB+                        | 105 (6.8)     | 0.888 (0.512–1.541) | 0.675   |
| AB-                        | 7 (0.5)       |              |         |
| O+                         | 460 (29.6)    | 0.978 (0.702–1.362) | 0.899   |
| O-                         | 74 (4.8)      | 0.938 (0.500–1.759) | 0.844   |
| Hospitalization wards      |               |              |         |
| Infectious disease         | 1102 (70.91)  | Ref.         |         |
| ICU/CCU/emergency          | 288 (18.53)   | 203.85 (123.178–337.362) | <0.001  |
| Post-ICU/isolated room     | 74 (4.76)     | 16.635 (8.655–31.972) | <0.001  |
| Other wards                | 90 (5.79)     | 3.788 (1.585–9.051) | 0.003   |

CCU: Cardiac care unit; ICU: Intensive care unit.

Results

Of 1554 patients, 1267 and 287 cases had recovered and deceased outcomes, respectively. Of all cases, 814 (52.4%) and 740 (47.6%) were male and female, respectively. The mean age of all patients was 56.66 ± 17.15 (median: 57 years; range: 1–101 years). The patients were distributed into five groups: 1–29 years, 30–39 years, 40–49 years, 50–59 years and ≥60 years. Hospital wards were ICU (intensive care unit)/CCU (cardiac care unit)/emergency, infectious disease, post-ICU/isolated room and other wards. Details of the distribution of the demographic, gender, age, hospitalization ward and blood groups of all, recovered and deceased cases are presented in Table 1.

In this study, there was no significant association between gender and the outcome of COVID-19. The data showed a significant association between age and the outcome of the disease. The number of COVID-19 cases and deaths gradually increased with age, so the odds of the deaths were higher in the age group over 60 years compared with the reference group. We found a significant association between hospitalization ward and outcome of the disease. The odds of death were higher in those hospitalized in the ICU/CCU/emergency wards than in the infectious disease group. Most of the COVID-19 cases in this study had O+, the least had AB- and most deaths had O+ blood types. Logistic regression analysis revealed that odds of death in group A- versus A+ were 1.81-times higher, though it was not significant. Blood type B+ had lower odds of death than A+. Patients with type B-, 3.8-times more likely for COVID-19 death than the A+ blood group. Patients with the AB+ group had lower odds of death than the A+. Finally, group O+ and O- had a lower odds of death than the A+ blood group. The details association of sex, age, blood group and hospitalization wards of COVID-19 patients with risk of death are presented in Table 2.

Discussion

This study indicates that blood types may be related to the clinical outcome of COVID-19. The main findings of this study are: no significant association between gender and outcome of COVID-19, a significant association between age and the outcome of the disease, a significant association between hospitalization ward and outcome of
## Table 3. The literature regarding the association between blood types and COVID-19.

| Study (year)          | Countries             | Sample size | Main findings                                                                                                                                                                                                 | Ref. |
|-----------------------|-----------------------|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|
| Zhang et al. (2021)   | Literature review     | 23 study    | Greatest risk for susceptibility to COVID-19 infection was found among individuals with blood type A                                                                                                           | [13] |
| Kabrah et al. (2020)  | Systematic review and meta-analysis | 16 study   | Blood group A cases were vulnerable to COVID-19 infection, and blood type AB linked to a lower risk of COVID-19 infection                                                                                  | [14] |
| Liu et al. (2020)     | Systematic review and meta-analysis | 10 study   | Individuals with blood groups A and B were more susceptible to COVID-19 infection, whereas the blood group O appeared to be protective                                                                 | [15] |
| Franchini et al. (2021) | Systematic literature review and meta-analysis | 21 study   | Blood group O individuals were less susceptible to SARS-CoV-2 infection compared with those in the non-O group. No evidence was found indicating an effect of the O type on disease severity in SARS-CoV-2 infection | [17] |
| Mahmud et al. (2021)  | Bangladesh            | 438         | Although ABO blood groups were not associated with the presentation or recovery period of COVID-19, patients with blood group A had delayed seroconversion                                                   | [18] |
| Garg et al. (2021)    | India                 | 383         | COVID-19 patients with A and B blood groups exhibit greater disease severity. There are no differences between distribution of Rh (D) +ve type and Rh (D) -ve in severe, moderate and mild patients | [19] |
| Kim et al. (2021)     | Review                | 9 study     | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2                                                                                           | [20] |
| Samra et al. (2021)   | Saudi Arabia          | 507         | The incidence, severity, and mortality of COVID-19 were common in nonblood group O, while blood group O was protected against COVID-19                                                                           | [24] |
| Zietz et al. (2020)   | United States         | 14112       | Blood type O was protective against SARS-CoV-2 infection compared with non-O blood. Blood type A patients had lower risk of intubation and death compared with blood type O patients, whereas blood type AB had higher risk of both intubation and death. The Rh- patients had a 2.7% lower risk of initial infection after adjustment, and also lower risk for both intubation and death. | [27] |
| Ray et al. (2020)     | Canada                | 225,556     | Blood type A and AB had higher risk of severe illness or death. B+ was associated with higher odds of testing positive, whereas O+ was associated with lower infection rate. The Rh+ cases had higher risk of severe illness or death. | [28] |
| Taha et al. (2020)    | Sudan                 | 557         | The O+ blood group had the lowest risk of having severe symptoms, and A+ individuals were the most vulnerable when exposed to the virus                                                                            | [29] |
| Abdollahi et al. (2020) | Iran                 | 397         | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower risk. The Rh blood group phenotype was not statistically significant in determining a patient's vulnerability. | [30] |
| Dal et al. (2021)     | Turkey                | 39,850      | ABO and Rh blood groups did not have any impact on the rate of hospital admission, hospital and ICU stay, mechanical ventilation support and case fatality rate. Blood group A was found to be related with increased rate of ICU admission. | [31] |
| Fan et al. (2020)     | China                 | 105 cases | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2                                                                                           | [32] |
| Zhao et al. (2020)    | China                 | 2173        | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2                                                                                           | [33] |
| Golinell et al. (2020) | Meta-analysis       | 7503 cases | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2                                                                                           | [34] |
| Barnkob et al. (2020) | Denmark               | 7422 cases | Blood type O was protective against SARS-CoV-2 infection compared with non-O blood type                                                                                                                        | [35] |
| Wu et al. (2020)      | Systematic review and meta-analysis | 31,100      | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2                                                                                           | [36] |
| Padhi et al. (2020)   | India                 | 277,649     | Blood type O was protective against COVID-19 death, while blood type B was more strongly correlated with death.                                                                                              | [37] |
| Li et al. (2020)      | China                 | 2153 cases | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2                                                                                           | [38] |
| Goker et al. (2020)   | Turkey                | 186         | Blood group A might have a role in increased susceptibility to the COVID-19 infection, and the blood group O might be somewhat protective                                                                     | [39] |
| Leaf et al. (2020)    | USA                   | 3239        | Type A blood may be a risk factor for COVID-19-related critical illness among White patients, and that type O blood may be protective                                                                          | [40] |
| Zeng et al. (2020)    | China                 | 97          | Blood type A individuals were more sensitive to SARS-CoV-2 infection. Blood type distribution was not a relevant factor of ARDS, AKI and mortality in COVID-19 patients                                            | [41] |
| Chegini et al. (2020) | Iran                  | 76          | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower risk of infection                                                                     | [42] |
| Zhang et al. (2020)   | China                 | 134         | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower risk of infection                                                                  | [43] |

AKI: Acute kidney injury; ARDS: Acute respiratory distress syndrome; CRRT: Continuous renal replacement therapy; ICU: Intensive care unit.
than the A blood groups. However, in this study, there was no significant association between gender and the outcome of COVID-19.

Studies also demonstrated that age could be considered as a death-associated risk factor for COVID-19 [3,26]. Most elderly cases and deaths gradually increased with age, so the odds of the deaths were higher in the age group over 60 years. This finding might be expected because elderlies tend to have a higher prevalence of comorbidities such as diabetes, heart disease, hypertension, chronic respiratory diseases and they have a reduced immune response. A significant number of COVID-19 patients died due to the increased risk of acute respiratory distress syndrome (ARDS) and multiorgan failure. Elderly patients are at higher risk of death due to respiratory failure and other complications associated with the disease.

Table 3. The literature regarding the association between blood types and COVID-19 (cont.).

| Study (year)          | Countries     | Sample size | Main findings                                                                                     | Ref. |
|----------------------|---------------|-------------|---------------------------------------------------------------------------------------------------|------|
| Roberts et al. (2020)| USA           | 2417        | Blood group A was significantly associated with a higher risk of infection                         | [44] |
| Marcos et al. (2020) | Spain         | 226         | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower mortality | [45] |
| Franchini et al. (2020)| Italy       | 447         | Blood type O may be protective against COVID-19                                                   | [46] |
| Aljanobi et al. (2020)| Saudi-Arabia | 72          | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower mortality | [47] |
| Valenti et al. (2020)| Italy/Spain   | 505         | Blood group A was associated with higher risk of severe COVID-19 than group O, while group B was not. Increased risk of severe disease was observed in carriers of the AB group | [48] |
| Holland et al. (2020)| Canada        | 95          | A greater proportion of blood group A or AB patients required mechanical ventilation and CRRT compared with blood group O or B patients | [49] |
| Wu et al. (2020)     | China         | 187         | Blood type A patients had higher risk and blood type O patients had lower risk of becoming infected with SARS-CoV-2. There is no correlation between blood type and COVID-19 severity or mortality | [50] |
| Diaz et al. (2021)   | Spain         | 854         | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower mortality | [51] |
| Ahmed et al. (2021)  | UK            | 86          | Blood group A women had a significantly higher relative risk of developing COVID-19 infection      | [52] |
| Solmaz et al. (2021) | Turkey        | 1667        | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower mortality | [53] |
| Cordero et al. (2021)| International| 9859        | Blood group A was significantly associated with a higher risk of infection and blood group O was associated with a lower mortality | [54] |
| Solhpour et al. (2020)| Iran         | 93          | Blood group type A is usually more susceptible to be involved by severe form of the COVID-19       | [55] |
| Almadhi et al. (2021)| Bahrain       | Cases: 2334 Controls: 4985 | Blood group AB was associated with a decreased risk of infection, while blood group B was associated with an increased risk. No association between blood group A and risk of COVID-19 infection was found | [22] |
| Ishaq et al. (2021)  | Pakistan      | 1067        | Hospital stay, severity of disease and mortality were associated with blood group A                | [23] |
| Niles et al. (2021)  | USA           | 34,178      | The SARS-CoV-2 positivity rate was significantly higher among type O and Rh+ patients              | [56] |
| Latz et al. (2020)   | USA           | 1289        | Blood type B and AB were associated with higher risk of testing positive for COVID-19. Blood type O was associated with lower risk of testing positive. There is no correlation between blood type and COVID-19 intubation and death. Individuals with Rh- blood type were less susceptible to infection by SARS-CoV-2 | [57] |
| Bai et al.           | Systematic review | 24 study    | There is no true relationship between ABO blood type and COVID-19 infection, severity or mortality | [16] |
| Anderson et al. (2021)| USA          | Cases: 11,468 Controls: 96,328 | No ABO associations were found with either disease susceptibility or severity | [21] |
| Levi et al. (2021)   | Brazil        | 2037        | Absence of a relationship between ABO blood type and susceptibility to SARS-CoV-2 infection       | [58] |
| Boudin et al. (2020) | France        | 1769        | Absence of a relationship between ABO blood type and susceptibility to SARS-CoV-2 infection       | [59] |
| Dzik et al. (2020)   | USA           | 957         | No association was found between ABO type and death among individuals hospitalized with COVID-19   | [60] |
| Samra et al. (2021)  | Saudi Arabia  | 507         | The severity of COVID-19 infection was common in Rh+ patients and Rh- patients                    | [24] |
| Garg et al. (2021)   | India         | 383         | There was no differences between distribution of Rh D+ve type and Rh D-ve in severe, moderate and mild patients | [19] |

AKI: Acute kidney injury; ARDS: Acute respiratory distress syndrome; CRRT: Continuous renal replacement therapy; ICU: Intensive care unit.

COVID-19 and blood groups A- and B- have higher and groups B+, AB+, O+ and O- have lower odds of death than the A+ group (Table 1 & 2).

Previous studies demonstrated that male cases have an increased risk of death compared with females [25]. However, in this study, there was no significant association between gender and the outcome of COVID-19. Studies also demonstrated that age could be considered as a death-associated risk factor for COVID-19 [3,26]. Most of the data in this context agree that the infection and death were mostly observed in cases with advanced ages. Our data showed a significant association between age and the outcome of the disease. The number of COVID-19 cases and deaths gradually increased with age, so the odds of the deaths were higher in the age group over 60 years. This finding might be expected because elderlies tend to have a higher prevalence of comorbidities such as diabetes, heart disease, hypertension, chronic respiratory diseases and they have a reduced immune response. A significant
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An association between hospitalization ward and outcome of the disease was found, and also odds of death were higher in those hospitalized in the ICU/CCU/emergency wards. This finding also might be expected because critically ill COVID-19 patients are hospitalized in these wards.

Regarding blood groups, our data showed that odds of death in the group A- versus A+ were 1.81-times higher, and patients with type B-, 3.8-times more likely for COVID-19 death than the A+ blood group. However, other blood groups such as B+, AB+, O+ and O- had a lower odds of death than the A+ blood group. It is not yet clear which blood type is most likely to be susceptible to COVID-19. Some studies considered that people with blood type A to be the most susceptible to the disease, and people with blood type O are less likely to develop the disease [13–15,17–20,24,27–55]. But other studies reported conflicting results [22,23,56,57], and some did not find a significant relationship between blood type and COVID-19 [16,21,58–60]. Moreover, studies reported that individuals with Rh- blood type had a lower risk of infection, intubation and death, and cases with Rh+ were more sensitive to COVID-19 [24,27–29,56,57]. However, a study from Iran did not find any relation between COVID-19 and Rh type [30]. Another study in Turkey also did not report a relationship between Rh blood groups and any impact on the rate of hospital admission, ICU stay, mechanical ventilation support and case fatality rate [31]. The literature studies regarding the association between blood types and COVID-19 are summarized in Table 3.

The discrepancy between studies may be due to the different sample sizes, heterogeneity of ABO between populations or geographical areas, differences in genetic background and differences in viral strains. Variation between blood group phenotypes in countries and different genetics may affect heterogeneity of COVID-19 clinical phenotypes [21,61]. Susceptibility to SARS-CoV-2 infection and ABO blood system might be for some reasons: blood group O patients had natural anti-A and anti-B antibodies that could be partially protective against SARS-CoV-2 virions, carbohydrate–carbohydrate interactions, which could maximize or minimize the virus spike protein binding to the host cell, furin levels might be reduced in blood type O individuals, so the infectivity of virus is reduced, the levels of C-reactive protein and alkaline phosphatase appear to be higher in blood group A individuals in comparison with blood group O and microbiota trigger the synthesis of anti-A and anti-B antibodies [61,62].

Conclusion
Finding high-risk groups for severe infection and death are important to manage the current pandemic disease. The results of such studies could lead to individuals with a higher risk of severe infection being vaccinated earlier or monitored more closely and treated earlier. Together, these findings suggest that the blood group may interplay with susceptibility to SARS-CoV-2 infection and clinical course of COVID-19; however, the mechanism(s) is subjected to speculations. The limitation of this study was the small sample size, and further studies with a large cohort for multiple people are required to validate this association.

Summary points
- Due to the inconsistent data published on blood groups and COVID-19, we conducted a study on Iranian patients to further assess this association.
- A total of 1554 confirmed COVID-19 cases were enrolled in the study with blood group, demographic and clinical data available.
- Of 1554 patients, 1267 and 287 cases had recovered and deceased outcomes, respectively.
- Most of the cases had O+ (29.6%), the least number had AB- (0.5%), and most of the deceased cases had O+ blood types (31.4%).
- Logistic regression analysis revealed that groups A- and B- had higher and groups B+, AB+, O+ and O- had lower odds of death than the A+ group.
- Our findings indicate that blood types may be related to the clinical outcome of COVID-19.
- Further studies with a large cohort for multiple people are required to validate this association.

Author contributions
A Tahamtan and AA Ayatollahi conceptualized and designed the study. B Aghcheli, A Amini, H Nikbakht and P Ghasemzadehpirsala collected data. A Rajabi and B Aghcheli analyzed the collected data. B Aghcheli and E Behboudi drafted the manuscript. All authors evaluated and edited the manuscript and have read and approved the final manuscript.
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Ethical conduct of research
This study was approved by the Ethics Committee of the Golestan University of Medical Sciences (IR.GOUMS.REC.1400.141).

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