Open Access Article

The Association between ABO System and Rh Factor with COVID-19 in Basrah Province, Iraq

Rafida M. Al-Amiri[1]*, Adil G. Fadhil[2], Fateh Al-Khaqani[3]

[1] Assistant Lecturer, Department of Basic Sciences, College of Dentistry, University of Basrah, Basrah, Iraq

[2] Assistant Professor, Department of Preventive Dentistry, College of Dentistry, University of Basrah, Basrah, Iraq

[3] Assistant Professor, Department of Medicine, College of Medicine, University of Basrah, Basrah, Iraq

* Corresponding author: rafeda.abdalhussain@uobasrah.edu.iq

Abstract: The new coronavirus illness of 2019 (COVID-19) has been quickly spreading around the world and was deemed a pandemic by the World Health Organization. Numerous infectious diseases have been linked to the ABO blood group system. The novel respiratory infectious disease coronavirus disease 2019 (COVID-19) may have a connection to the ABO blood group system [1]. Our study's goal was to determine whether there was any correlation between COVID-19 infection and the ABO blood group system. ABO system and RH factor distribution in 125 patients from a private clinic in Basrah/Iraq province who had COVID-19 confirmed by PCR (polymerase chain reaction) test and lung CT scan had been assessed. We correlated the severity of COVID-19 infection with the ABO blood group of patients under study. The results of our study blood group O predominate in COVID-19 patients, Between all instances, blood group O had a smaller percentage of severe cases than mild ones (48.6 percent). There were no serious cases with blood type AB patients. In conclusion, our research demonstrates that, while having milder cases, patients with blood group O had a higher chance of COVID-19 infection.

Keywords: COVID-19, blood groups, susceptibility.

伊拉克巴士拉省ABO系统和恒河猴因素与新冠肺炎 的关联

摘要：2019年的新型冠状病毒疾病已在全球迅速蔓延，并被世界卫生组织认定为大流行病。许多传染病都与ABO血型系统有关。新型呼吸道传染病冠状病毒病2019可能与ABO血型系统有关[1]。我们研究的目标是确定新冠肺炎感染与ABO血型系统之间是否存在任何相关性。对来自巴士拉/伊拉克省一家私人诊所的125名通过聚合链反应测试和肺部计算机断层扫描确认患有新冠肺炎的患者的ABO系统和恒河猴因子分布进行了评估。我们将新冠肺炎感染的严重程度与所研究患者的ABO血型相关联。我们研究的结果是欧型血在新冠肺炎患者中占主导地位，在所有情况下，欧型血的重症病例低于轻度病例(48.6%)。AB型血患者无重症病例。总之，我们的研究表明，虽然病情较轻，但欧型血患者感染新冠肺炎的几率更高.

关键词：新冠肺炎、血型、易感性.

Al-Amiri et al. The Association between ABO System and Rh Factor with COVID-19 in Basrah Province, Iraq, Vol. 49 No. 12 December 2022

191

_____

1. Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that initially emerged in Wuhan, China, at the end of December 2019 is the cause of the 2019 coronavirus disease (COVID-19) [2]. The COVID-19 infection was deemed a pandemic by the World Health Organization on March 11, 2020 [3]. By September 2021, more than 200 countries worldwide were affected, with over 227.921.462 cases globally burdening and over 4.686.012 deaths. The coronavirus disease 2019 (COVID-19) was first noted in Iraq on February 24, 2020, in the province of Al Najaf, and it has since spread steadily throughout the nation. In Iraq, there were more than 1955000 confirmed cases as of September 2021, and 21550 of those cases resulted in fatalities. SARS-CoV-2 is a highly homologous coronavirus that is transmitted using angiotensin-converting enzyme 2 (ACE2)[4]. Age, sex, and chronic illness are risk factors for SARS-CoV-2 susceptibility [5]. The first human blood group found was the ABO blood group system in 1901. Because the ABO blood type system is innate to humans and simple to identify, research into its connection to numerous diseases has continued ever since.

Numerous chronic diseases, including vascular disease, coronary heart disease, and tumour formation are statistically or physiologically linked to specific ABO blood groups [6]. Studies on the relationship between specific viral infections and blood types have gained more and more interest recently. Determining a person's vulnerability to a virus may benefit from research on how different blood types affect viral infection. For instance, research has shown that blood group O significantly lowers the risk of hepatitis B. Rotaviral gastroenteritis is also more prevalent in blood type A individuals and less prevalent in blood type B patients [7, 8]. Additionally, it was found that individuals with blood type AB were 2.5 times more likely than those with other blood types to contract dengue hemorrhagic fever [9]. Previous studies on SARS-CoV-1 found a correlation between the blood type and the risk of infection, with those with blood group O having a low risk of infection [10].

There hasn't been several hard data showing a connection between SARS-CoV-2 and the ABO blood types up to this point. According to most studies, people with blood group A have a higher risk of contracting the SARS-CoV-2, whereas people with blood group O have a lower risk of infection and less severe consequences.[11-13]. Furthermore, there have been many studies that have looked into the connection between the two in Iraq. To study the profile of ABO blood type with patients infected with SARS-CoV-2, this investigation was carried out.

2. Materials and Methods

2.1. Study Design and Data Source

A cross-section study with 125 people was conducted in the province of Basrah from May 1 to September 1, 2020. Every subject was chosen from the community and a private clinic. All study participants had their demographics, clinical features, laboratory results, reports, and chest CT scans examined. Age, sex, diabetes and hypertension were among the demographic factors.

Clinical features involved disease manifestations such as fever, cough, dyspnea, Laboratory findings included lymphocyte count, hemoglobin value, blood type, all information was obtained and analysed with the standard Excel program. Oral consent was obtained from the patients, as seen in figure 1.
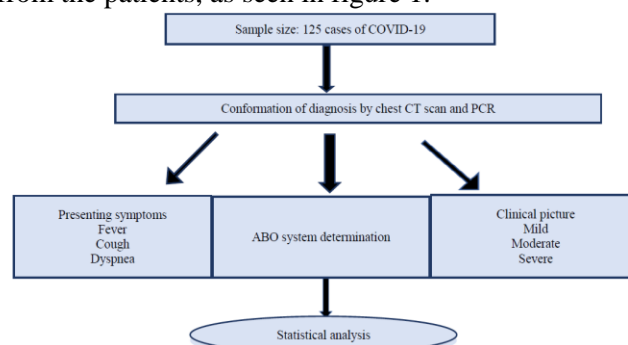

Fig. 1 Material and methods

2.2. Population Sample

The current cross-section study comprised 125 patients with COVID-19 infection carried at Basrah province from May 1, 2020 to September 1 2020, and who tested positive for SARS-CoV-2 RNA by PCR from a nasopharyngeal swab. All subjects were enrolled from private medical clinics and the community. Sociodemographic information, clinical features, such as age, gender, and Rh factor, comorbidities, and signs and symptoms of the patients were recorded.

2.3. Laboratory Data

Including complete blood count, including Hb levels and white blood cell count, lymphocyte percentage, peak C-reactive protein (CRP). The clinical signs and symptoms include the presence of fever, cough, shortness of breath, we classified COVID-19 into mild, moderate and severe types according to the degree of clinical symptoms (according to WHO guideline) [14]. Computed tomography of the chest was performed for all patient. The Institutional Ethical Review Committee (ERC) of the University of Basrah, College of Dentistry granted its approval and all

patients provided informed consent before enrolling in this study.

2.4. Statistical Analysis

SPSS version 23.0 (IBM Corp., Armonk, NY, USA) was used for the analyses. Chi-square and Fisher Exact tests were used to assess how the blood groups of the patient were distributed. Cases with a P value of less than 0.05 were considered statistically significant.

3. Results

Table 1 shows the clinical traits and results of the 125 patients who were included in the study based on their blood types. Patients ranged in age from 13 to 80, with a mean age of 47 (SD 15.831) and a 51.2% female patient population. The COVID-19 patients had detection rate of 54.4 percent for blood group O, followed by a group A detection rate of 24.8 percent, and an AB detection rate of 3.2 percent.

Almost all patients (97.6%) had positive CT chest or PCR results for COVID-19 infection. Most patients (84.8%) have a cough, and 64.8% of patients experience shortness of breath. All patients have a fever. 19.2% of patients have chronic illnesses. According to the disease's severity, most cases 60.8% were mild, followed by instances with a moderate severity 22.4% and severe cases comprised 16.8% of all cases.

ABO blood type and disease severity were correlated, with roughly 54 percent of mild cases being group O and 23.7 percent being blood type A. Blood group O had a lower proportion of severe cases than mild ones among all cases (48.6 percent). Patients with blood type AB did not have any severe cases. Although there were no significant differences, patients with blood group A experienced more severe cases than mild ones.

Regarding the correlation of type of blood group and the presenting symptoms among selected patients, about 51.4 percent of patients with COVID 19 under study cases who came with cough were blood group O, compared with 28 percent of patients with blood group A, 17.7 percent of patients with blood group B, and 2.8 percent of patients with blood group AB. Breathlessness is the primary symptom and occurs in 64.8% of cases. Additionally, 50% of these cases involved blood group O, 27% involved blood group A, and patients with blood group B had the fewest cases of dyspnea.

Table 4 shows the existence of comorbidities, including hypertension, diabetes mellitus, and other chronic diseases. Most our patients (80%) did not have chronic diseases; those who did had blood group O predominately followed by groups B, A, and AB, with no statistical significance.

Table 1 Correlation of blood groups with severity of disease (P value 0 .443)

			Mild	Moderate	Severe	Total
			Severity of cases			**Total**
Blood group	A+	Count	18	7	6	31
		% within Blood group	58.1%	22.6%	19.4%	100.0%
		% within Severity of cases	23.7%	25.0%	28.6%	24.8%
	B+	Count	14	1	5	20
		% within Blood group	70.0%	5.0%	25.0%	100.0%
		% within Severity of cases	18.4%	3.6%	23.8%	16.0%
	B-	Count	1	1	0	2
		% within Blood group	50.0%	50.0%	0.0%	100.0%
		% within Severity of cases	1.3%	3.6%	0.0%	1.6%
	O+	Count	39	16	8	63
		% within Blood group	61.9%	25.4%	12.7%	100.0%
		% within Severity of cases	51.3%	57.1%	38.1%	50.4%
	O-	Count	2	1	2	5
		% within Blood group	40.0%	20.0%	40.0%	100.0%
		% within Severity of cases	2.6%	3.6%	9.5%	4.0%
	AB+	Count	2	2	0	4
		% within Blood group	50.0%	50.0%	0.0%	100.0%
		% within Severity of cases	2.6%	7.1%	0.0%	3.2%
Total		Count	76	28	21	125
		% within Blood group	60.8%	22.4%	16.8%	100.0%
		% within Severity of cases	100.0%	100.0%	100.0%	100.0%
		% of Total	60.8%	22.4%	16.8%	100.0%

Table 2 Correlation between blood groups and cough (P value 0.109)

			Yes	No	Total
			Cough		**Total**
Blood group	A+	Count	30	1	31
		% within Blood group	96.8%	3.2%	100.0%
		% within Cough	28.0%	5.6%	24.8%
	B+	Count	18	2	20
		% within Blood group	90.0%	10.0%	100.0%
		% within Cough	16.8%	11.1%	16.0%

Al-Amiri et al. The Association between ABO System and Rh Factor with COVID-19 in Basrah Province, Iraq, Vol. 49 No. 12 December 2022

193

Continuation of Table 2				
B-	Count	1	1	2
	% within Blood group	50.0%	50.0%	100.0%
	% within Cough	0.9%	5.6%	1.6%
O+	Count	52	11	63
	% within Blood group	82.5%	17.5%	100.0%
	% within Cough	48.6%	61.1%	50.4%
O-	Count	3	2	5
	% within Blood group	60.0%	40.0%	100.0%
	% within Cough	2.8%	11.1%	4.0%
AB+	Count	3	1	4
	% within Blood group	75.0%	25.0%	100.0%
	% within Cough	2.8%	5.6%	3.2%
Total	Count	107	18	125
	% within Blood group	85.6%	14.4%	100.0%
	% within Cough	100.0%	100.0%	100.0%
	% of Total	85.6%	14.4%	100.0%

Table 3 Correlation between blood groups and dyspnea (P value 0.785)

		Dyspnea		Total
		Yes	No	
	% within Blood group	71.0%	29.0%	100.0%
	% within dyspnea	27.2%	20.5%	24.8%
B+	Count	11	9	20
	% within Blood group	55.0%	45.0%	100.0%
	% within dyspnea	13.6%	20.5%	16.0%
B-	Count	1	1	2
	% within Blood group	50.0%	50.0%	100.0%
	% within dyspnea	1.2%	2.3%	1.6%
O+	Count	41	22	63
	% within Blood group	65.1%	34.9%	100.0%
	% within dyspnea	50.6%	50.0%	50.4%
O-	Count	4	1	5
	% within Blood group	80.0%	20.0%	100.0%
	% within dyspnea	4.9%	2.3%	4.0%
AB+	Count	2	2	4
	% within Blood group	50.0%	50.0%	100.0%
	% within dyspnea	2.5%	4.5%	3.2%
Total	Count	81	44	125
	% within Blood group	64.8%	35.2%	100.0%
	% within dyspnea	100.0%	100.0%	100.0%
	% of Total	64.8%	35.2%	100.0%

Table 4 Correlation between blood groups and chronic disease (P value 0.324)

			Chronic diseases		Total
			Yes	No	
Blood group	A+	Count	3	28	31
		% within Blood group	9.7%	90.3%	100.0%
		% of Total	2.4%	22.4%	24.8%
	B+	Count	3	17	20
		% within Blood group	15.0%	85.0%	100.0%
		% within chronic diseases	12.5%	16.8%	16.0%
	B-	Count	0	2	2
		% within Blood group	0.0%	100.0%	100.0%
		% within chronic diseases	0.0%	2.0%	1.6%
	O+	Count	15	48	63
		% within Blood group	23.8%	76.2%	100.0%
		% within chronic diseases	62.5%	47.5%	50.4%
		% of Total	12.0%	38.4%	50.4%
	O-	Count	1	4	5
		% within Blood group	20.0%	80.0%	100.0%
		% within chronic diseases	4.2%	4.0%	4.0%
	AB+	Count	2	2	4
		% within Blood group	50.0%	50.0%	100.0%
		% within chronic diseases	8.3%	2.0%	3.2%
Total		Count	24	101	125
		% within Blood group	19.2%	80.8%	100.0%
		% within chronic diseases	100.0%	100.0%	100.0%

Continuation of Table 4			
% of Total	19.2%	80.8%	100.0%

4. Discussion

In clinical medicine, the ABO blood group is frequently employed. The expression of blood group antigens can affect how susceptible the host is to various diseases and infections. The relationship between blood type and COVID-19 infection has been widely studied worldwide; however no studies have been conducted in Basrah city, Iraq.

This study showed that patients with blood group O are more commonly impacted by COVID19 infections, accounting for approximately 54% of all cases, whereas individuals with blood group A were infected in 24, 8% of cases, and those with blood group AB are less likely to be affected. Although the finding is not significant, it can indicate a blood group's susceptibility to infection.

This finding contradicts numerous studies [15-18]. This discrepancy could be explained by the fact that people in Basrah City were primarily of blood type O [19]. Patients with blood group AB had no severe cases, while those with blood group A had more severe cases within this group, although most patients with blood group O had milder and less severe cases, this finding is in agreement with [16], [17]. The lack of severe cases among blood group AB patients in this study may be attributed to the small sample size and low percentage of our population that belonged to this blood type [19] ; nonetheless, this finding conflicts with the findings of other studies [17].

All the patients in our study had fevers, which is consistent with other studies that have shown that fevers is a more common symptom [20]. cough presented in most patients and was more common in patients with blood group O, in which about half of the cases followed by patients with type A, these findings disagree with other study [21], these finds also true for shortness of breath among our patients. This could be explained by the fact that most of our patients had the blood type O, as well as the smaller sample size.

5. Conclusion

Our study shows that patients with blood group O had a higher risk of COVID-19 infection, although having milder cases, Those with blood group O present more frequently with cough in addition to fever, while patients with blood group AB do not experience any severe cases.

The study's key challenges and limitations were the small sample size and the challenge of locating consenting patients. In the future, a larger sample size might be required, especially since the epidemic attack has decreased.

We urge the study to use a large sample size and to compare the results with a control group that is representative of our population in terms of the distribution of blood types. We propose considering blood group while managing patients with COVID-19 infection.

References

[1] ZHANG Y., GARNER R., SALEHI S., LA ROCCA M., and DUNCAN D. Association between ABO blood types and coronavirus disease 2019 (COVID-19), genetic associations, and underlying molecular mechanisms: a literature review of 23 studies. *Annals of Hematology*, 2021, 100(5): 1123–1132. https://doi.org/10.1007/s00277-021-04489-w

[2] ZHOU F., YU T., DU R., FAN G., LIU Y., LIU Z., XIANG J., WANG Y., SONG B., GU X., GUAN L., WEI Y., LI H., WU X., XU J., TU S., ZHANG Y., CHEN H., and CAO B. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China : a retrospective cohort study. *Lancet*, 2020, 395(10229): 1054–1062. https://doi.org/10.1016/S0140-6736(20)30566–3

[3] HENEKA M. T., GOLENBOCK D., LATZ E., MORGAN D., and BROWN R. Immediate and long-term consequences of COVID-19 infections for the development of neurological disease. *Alzheimer's Research & Therapy*, 2020, 12(1): 69. https://doi.org/10.1186/s13195-020-00640-3

[4] LAN J., GE J., YU J., SHAN S., ZHOU H., FAN S., ZHANG Q., SHI X., WANG Q., ZHANG L., and WANG X. Structure of the SARS-CoV-2 spike receptor-binding domain bound to the ACE2 receptor. *Nature*, 2020, 581: 215–220. https://doi.org/10.1038/s41586-020-2180-5

[5] HUANG C., WANG Y., LI X., REN L., ZHAO J., HU Y., ZHANG L., FAN G., XU J., GU X., CHENG Z., YU T., XIA J., WEI Y., WU W., XIE X., YIN W., LI H., LIU M., XIAO Y., GAO H., GUO L., XIE J., WANG G., JIANG R., GAO Z., JIN Q., WANG J., and CAO B. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*, 2020, 395(10223): 497–506. https://doi.org/10.1016/S0140-6736(20)30183–5

[6] JING W., ZHAO S., LIU J., and LIU M. ABO blood groups and hepatitis B virus infection : a systematic review and meta-analysis. *BMJ Open*, 2020, 10: e034114. https://doi.org/10.1136/bmjopen-2019-034114

[7] MOHAMMADALI F., & A. POURFATHOLLAH. Association of ABO and Rh Blood Groups to Blood-Borne Infections among Blood Donors in Tehran – Iran. *Iranian Journal of Public Health*, 2014, 43(7): 981–989. https://pubmed.ncbi.nlm.nih.gov/25909065/

[8] ELNADY H. G., ABDEL SAMIE O. M., SALEH M. T., SHERIF L. S., ABDALMONEAM N., KHOLOUSSI N. M., KHOLOUSSI S. M., and EL-TAWEEL A. N. ABO blood grouping in Egyptian children with rotavirus gastroenteritis. *Przegląd Gastroenterologiczny*, 2017, 12(3): 175–180. https://doi.org/10.5114%2Fpg.2017.70469

[9] MURUGANANTHAN K., & SUBRAMANIYAM S. Blood group AB is associated with severe forms of dengue virus infection. *Virus Disease*, 2018, 29(1): 103–105. https://doi.org/10.1007/s13337-018-0426-8

[10] COOLING L. Blood Groups in Infection and Host Susceptibility. *Clinical Microbiology Reviews*, 2015, 28(3):

Al-Amiri et al. The Association between ABO System and Rh Factor with COVID-19 in Basrah Province, Iraq, Vol. 49 No. 12 December 2022

195

801-870. https://doi.org/10.1128/CMR.00109-14

[11] ALKOUT T. A., & ALKOUT, A. M. Original article ABO blood groups among Coronavirus disease 2019 patients. *Iberoamerican Journal of Medicine*, 2020, 04: 268–274. http://dx.doi.org/10.5281/zenodo.3893256

[12] GÖKER H., ALADAĞ-KARAKULAK E., DEMIROĞLU H., and AYAZ C. M. The effects of blood group types on the risk of COVID-19 infection and its clinical outcome. *Turkish Journal of Medical Sciences*, 2020, 50(4): 679–683 https://doi.org/10.3906/sag-2005-395

[13] LIU N., ZHANG T., MA L., ZHANG H., WANG H., WEI W., PEI H., and LI H. The impact of ABO blood group on COVID-19 infection risk and mortality: A systematic review and meta-analysis. *Blood Reviews*, 2021, 48: 100785. https://doi.org/10.1016/j.blre.2020.100785

[14] CORONAVIRUS DISEASE 2019 (COVID-19) TREATMENT GUIDELINES. *Clinical Spectrum of SARS-CoV-2 Infection*, 2022. https://www.covid19treatmentguidelines.nih.gov/overview/clinical-spectrum/

[15] SOLMAZ İ., & ARAÇ, S. ABO blood groups in COVID-19 patients；Cross-sectional study. *Clinical Practice*, 75(4): e13927. https://doi.org/10.1111/ijcp.13927

[16] LEHRER S., & RHEINSTEIN P. H. ABO blood groups, COVID-19 infection and mortality. *Blood Cells, Molecules & Diseases*, 89: 102571. https://doi.org/10.1016/j.bcmd.2021.102571

[17] WU B.-B., GU D.-Z., YU J.-N., YANG J., and SHEN W.-Q. Association between ABO blood groups and COVID-19 infection, severity and demise. A systematic review and meta-analysis. *Infection, Genetics and Evolution: Journal of Molecular Epidemiology and Evolutionary Genetics in Infectious Diseases*, 84: 104485. https://doi.org/10.1016/j.meegid.2020.104485

[18] FAN Q., ZHANG W., LI B., LI D. J., ZHANG J., and ZHAO F. Association Between ABO Blood Group System and COVID-19 Susceptibility in Wuhan. *Frontiers in Cellular and Infection Microbiology*, 2020, 10: 1–7. https://doi.org/10.3389/fcimb.2020.00404

[19] AL BARAZANCHI Z. A., AL-BUSLIMY T. A., and SUKER D. K. The Distribution of ABO Blood Groups Among Basrah Governorate Population. *Basrah Journal of Surgery*, 2010, 16(2): 0–0. https://doi.org/10.33762/bsurg.2010.55453

[20] MAHMUD R., RASSEL M. A., MONAYEM F. B., SAYEED S. K. J. B., ISLAM M. S., ISLAM M. M., YUSUF M. A., RAHMAN S., ISLAM K. M. N., MAHMUD I., HOSSAIN M. Z., CHOWDHURY A. H., KABIR A. K. M. H., AHMED K. G. U., and RAHMAN M. M. Association of ABO blood groups with presentation and outcomes of confirmed SARS CoV-2 infection：A prospective study in the largest COVID-19 dedicated hospital in Bangladesh. *PloS One*, 16(4), e0249252. https://doi.org/10.1371/journal.pone.0249252

[21] SAIFY K., ALBORZ M. S., and SAADAT M. Susceptibility to the novel coronavirus disease（COVID-19）is associated with ABO and Rh blood groups：a case-control study from Afghanistan. *Nature Public Health Emergency Collection*, 2021, 22(1): 1. https://doi.org/10.1186%2Fs43042-020-00124-x

参考文:

[1] ZHANG Y., GARNER R., SALEHI S., LA ROCCA M., 和 DUNCAN D. ABO血型与2019年冠状病毒病之间的关联、遗传关联和潜在的分子机制：23项研究的文献综述。血液学年鉴, 2021, 100(5): 1123–1132. https://doi.org/10.1007/s00277-021-04489-w

[2] ZHOU F., YU T., DU R., FAN G., LIU Y., LIU Z., XIANG J., WANG Y., SONG B., GU X., GUAN L., WEI Y., LI H., WU X., XU J., TU S., ZHANG Y., CHEN H., 和 CAO B. 中国武汉新冠肺炎成年住院患者死亡的临床病程和危险因素：一项回顾性队列研究。柳叶刀, 2020, 395(10229): 1054–1062. https://doi.org/10.1016/S0140-6736(20)30566–3

[3] HENEKA M. T., GOLENBOCK D., LATZ E., MORGAN D., 和 BROWN R. 新冠肺炎感染对神经系统疾病发展的直接和长期后果。老年痴呆症研究与治疗, 2020, 12(1): 69. https://doi.org/10.1186/s13195-020-00640-3

[4] LAN J., GE J., YU J., SHAN S., ZHOU H., FAN S., ZHANG Q., SHI X., WANG Q., ZHANG L., 和 WANG X. 与血管紧张素转换酶2受体结合的新冠肺炎是刺突受体结合域的结构。自然, 2020, 581: 215–220. https://doi.org/10.1038/s41586-020-2180-5

[5] HUANG C., WANG Y., LI X., REN L., ZHAO J., HU Y., ZHANG L., FAN G., XU J., GU X., CHENG Z., YU T., XIA J., WEI Y., WU W., XIE X., YIN W., LI H., LIU M., XIAO Y., GAO H., GUO L., XIE J., WANG G., JIANG R., GAO Z., JIN Q., WANG J., 和 CAO B. 中国武汉市2019年新型冠状病毒感染患者的临床特征。柳叶刀, 2020, 395(10223): 497–506. https://doi.org/10.1016/S0140-6736(20)30183–5

[6] JING W., ZHAO S., LIU J., 和 LIU M. ABO血型和乙型肝炎病毒感染：系统评价和水槽分析。生物医学杂志公开, 2020, 10: e034114. https://doi.org/10.1136/bmjopen-2019-034114

[7] MOHAMMADALI F., 和 A. POURFATHOLLAH. 伊朗德黑兰献血者ABO和恒河猴血型与血源性感染协会。伊朗公共卫生杂志, 2014, 43(7): 981–989. https://pubmed.ncbi.nlm.nih.gov/25909065/

[8] ELNADY H. G., ABDEL SAMIE O. M., SALEH M. T., SHERIF L. S., ABDALMONEAM N., KHOLOUSSI N. M., KHOLOUSSI S. M., 和 EL-TAWEEL A. N. 患有轮状病毒胃肠炎的埃及儿童的ABO血型。胃肠病学评论, 2017, 12(3): 175–180. https://doi.org/10.5114%2Fpg.2017.70469

[9] MURUGANANTHAN K., & SUBRAMANIYAM S. AB 血型与严重形式的登革热病毒感染有关。病毒病, 2018, 29(1): 103–105. https://doi.org/10.1007/s13337-018-0426-8

[10] COOLING L. 感染中的血型和宿主易感性。临床微生物学评论, 2015, 28(3): 801-870. https://doi.org/10.1128/CMR.00109-14

[11] ALKOUT T. A., 和 ALKOUT, A. M. 2019年冠状病毒病患者的原始文章ABO血型。伊比利亚美洲医学杂志, 2020, 04: 268–274. http://dx.doi.org/10.5281/zenodo.3893256

[12] GÖKER H., ALADAĞ-KARAKULAK E., DEMIROĞLU H., 和 AYAZ C. M. 血型对新冠肺炎感染风险及其临床结果的影响。土耳其医学科学杂志, 2020, 50(4): 679–683 https://doi.org/10.3906/sag-2005-395

[13] LIU N., ZHANG T., MA L., ZHANG H., WANG H., WEI W., PEI H., 和 LI H. ABO血型对新冠肺炎感染风险和死亡率的影响：系统评价和"萃分析。血液评论, 2021, 48: 100785. https://doi.org/10.1016/j.blre.2020.100785

[14] 2019年冠状病毒病(新冠肺炎)治疗指南. 新冠肺炎感染的临床谱,2022. https://www.covid19treatmentguidelines.nih.gov/overview/clinical-spectrum/

[15] SOLMAZ İ., 和 ARAÇ, S. 新冠肺炎患者的ABO血型；横断面研究。临床实践, 75(4): e13927. https://doi.org/10.1111/ijcp.13927

[16] LEHRER S., 和 RHEINSTEIN P. H. ABO血型、新冠肺炎感染和死亡率。血细胞、分子与疾病, 89: 102571. https://doi.org/10.1016/j.bcmd.2021.102571

[17] WU B.-B., GU D.-Z., YU J.-N., YANG J., 和 SHEN W.-Q. ABO血型与新冠肺炎感染、严重程度和死亡之间的关联。系统的回顾和强化分析。感染、遗传学和进化：传染病分子流行病学和进化遗传学杂志, 84: 104485. https://doi.org/10.1016/j.meegid.2020.104485

[18] FAN Q., ZHANG W., LI B., LI D. J., ZHANG J., 和 ZHAO F. 武汉市ABO血型系统与新冠肺炎易感性的关系。细胞和感染微生物学前沿, 2020, 10: 1–7. https://doi.org/10.3389/fcimb.2020.00404

[19] AL BARAZANCHI Z. A., AL-BUSLIMY T. A., 和 SUKER D. K. 巴士拉省人口中ABO血型的分布。巴士拉外科杂志, 2010, 16(2): 0–0. https://doi.org/10.33762/bsurg.2010.55453

[20] MAHMUD R., RASSEL M. A., MONAYEM F. B., SAYEED S. K. J. B., ISLAM M. S., ISLAM M. M., YUSUF M. A., RAHMAN S., ISLAM K. M. N., MAHMUD I., HOSSAIN M. Z., CHOWDHURY A. H., KABIR A. K. M. H., AHMED K. G. U., 和 RAHMAN M. M. ABO血型与确诊新冠肺炎感染的表现与结果的关联：一项在孟加拉国最大的新冠肺炎专用医院进行的前瞻性研究。科学一号公共图书馆, 16(4), e0249252. https://doi.org/10.1371/journal.pone.0249252

[21] SAIFY K., ALBORZ M. S., 和 SAADAT M. 对新型冠状病毒病(新冠肺炎)的易感性与ABO和恒河猴血型有关：一项来自阿富汗的病例对照研究。自然公共卫生紧急征集, 2021, 22(1): 1. https://doi.org/10.1186%2Fs43042-020-00124-x