## Original Research Article

# Study of seroprevalence of antibodies to SARS-COV-2 among the healthy blood donors of Jammu region

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### ABSTRACT

**Background**: SARS-CoV-2 emerged in China and spread throughout the world due to its rapid transmission. The exposure rate in the healthy population is unknown, mainly in resource-limited countries. Herein, we estimated the seroprevalence of anti-SARS-CoV-2 antibodies and risk factors among blood donors at our blood bank and to describe some characteristics of those that test positive. The objective of the study was to measure the levels of IgG antibodies targeting the SARS-CoV2 during the peak period of the COVID-19 pandemic in Jammu State, India to know the magnitude of SARS-CoV-2 exposure, the prevalence of herd immunity in the population.
**Methods:** This is prospective observational study of COVID-19 seroprevalence among blood donors that complied with blood donation protocol. Participation in study was voluntary after taking proper consent on the consent form.
**Results:** A total of 750 random blood donors who voluntarily participated, were enrolled in this study after obtaining their proper consent on the consent form. Out of 750 donors, 287 (38.2%) were positive for IgG antibodies and 463 (61.7%) were negative for IgG antibodies. In our study, male donors (745) outnumbered the female donors but on the other hand female donors showed a higher prevalence of covid antibodies i.e., 60% as compared to male donors i.e., 38% which is a statistically significant difference (p<0.005).
**Conclusions:** A high prevalence of SARS-CoV-2 antibodies was detected among blood donors which indicated a high level of exposure to the virus within the population and development of innate immunity against the virus. This could help us to introduce a protocol of antibody testing in the screening of blood donors to enhance the number of plasma donation cases for the treatment of serious COVID patients.

**Keywords:** SARS-CoV IgG antibodies, Blood donors, Seroprevalence, ABO blood groups

## INTRODUCTION

The ongoing COVID-19 pandemic, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which first spread in Wuhan province of China is continuing to cause major disruption globally.[1,2] The outbreak of COVID-19 was declared as a public health emergency on 30th January, 2020 by the world health organization and a COVID-19 pandemic on 11th March, 2020.[3] With COVID-19 continuing to be a global threat, it is really important to take necessary steps in early detection and thus prevention of spread of this virus. Serologic testing based on antibody detection provides good understanding of SARS-CoV-2 prevalence and its transmission and has been used in different parts of the world.[4] Nucleic acid testing for SARS-CoV-2 by real time polymerase chain reaction remains the gold standard investigation in early detection of patients infected with SARS COV-2.[5] A host of factors can however lead to false negative results including wrong site, inadequate

sampling and fluctuating viral load.[6] There are other hindrances like cost of the test, availability of kits and other logistical issues in carrying out RT-PCR on a mass scale. Hence a test which is easy to do, sensitive and not very expensive is required to detect the seroprevalence of the virus. Antibody screening can hence be a preferred method to identify the sero-positive individuals who have been infected with COVID-19 thereby facilitating the control of spread of the disease and ensure prompt public health management.[7] It is important to evaluate the prevalence of SARS-CoV2 infection among healthy blood donors. There are no current recommendations about screening of donors by RTPCR or immunoassays. The WHO however recommends to defer blood donation for 4 weeks for symptomatic individuals, covid contacts and those with travel history to an epidemic area. It is also recommended that the donors have to inform the blood bank in case they get symptomatic within 28 days of blood donation.[8] As COVID-19 virus does not transmit through blood donations and is not a blood borne disease, the identification of seroprevalence among the donors can give an estimate infection among healthy individuals, hence providing actual disease burden and case fatality rate in a population. Information regarding antibody response against SARS-CoV-2 in asymptomatic individuals is lacking in our part of the subcontinent. In our study, we conducted specific serological testing (total antibodies) to identify prevalence of SARS-2-CoV antibodies among the healthy blood donors who visited blood bank at our institute. With this aim, we estimated the seroprevalence of anti-SARS-CoV-2 antibodies and risk factors among blood donors at our blood bank and to describe some characteristics of those that test positive.

### Aims and objectives

The aim and objectives of the study were to estimate the prevalence of anti-SARS-CoV-2 antibodies among blood donors and to study correlation of COVID antibodies to demography, educational and occupational status of blood donors.

## METHODS

This is an observational prospective study conducted in the department of blood transfusion medicine and immunohematology, government medical college, Jammu on routine healthy blood donors and 750 donors were tested for SARS-CoV-2 immunoglobulin G (IgG) antibody over a period of three months from June to August 2021. In addition to the routine criteria for selection of blood donors, the following additional criteria was applied based on national guidelines:

### Inclusion criteria

Donors fulfilling the donor acceptance criteria: 1. Donor should be free of any flu-like symptom for 28 days before blood donation. 2. The donor should not have a close contact with suspected or confirmed SARS-CoV-2 cases

in the past 28 days before blood donation. 3.The donor should not have a history of travel to a containment zone-domestic or international in the past 28 days and 4. The donor should not have a history of SARS-CoV-2 infection. The donor consent for testing for SARS-CoV-2 antibody was taken at the time of blood donation in writing were include in the study.

### Exclusion criteria

Patients with less than 28 days from the COVID-19 recovery, donors vaccinated against COVID-19 and donor not fulfilling the donor acceptance criteria were exclude from the study.

The SIEMENS ADVIA centaur XPT immunoassay system for the qualitative detection of IgG antibodies to SARS-CoV-2 was used to run the blood donor samples. This assay is intended as an aid in the diagnosis of patients with suspected - SARS-CoV2 infection and as an aid in identifying patients with an adaptive immune response to SARS-CoV2 indicating recent or prior infection.

### Principle of the procedure

The ADVIA centaur immunoassay is a fully automated 1-step antigen sandwich immunoassay using acridinium ester chemiluminescent technology, in which antigens are bridged by antibodies present in patient sample. The solid phase contains a preformed complex of streptavidin coated microparticles and biotinsylated SARS-CoV-2 recombinant antigens. This reagent is used to capture anti SARS-CoV-2 antibodies in the patient sample. The lite reagent contains acridinium ester labeled SARS-CoV-2 recombinant antigens used to detect anti SARS-CoV-2 antibodies bound to the solid phase. A direct relationship exists between the number of SARS-CoV-2 antibodies present in the patient sample and the amount of relative light units detected by the system.

The samples were collected from the Donors who came voluntarily for the blood donation and agreed to undergo the screening of the IgG antibodies against SARS-COV-2 infection and their consent was taken on consent form. They were later on informed regarding the value of IgG antibodies present in their body after getting the results. The samples were allowed to settle in clot retraction or EDTA vials for around 10-15 min after proper mixing. The vials were centrifuged for 20 min at 4200 revolutions per minute (rpm) or more after clotting. Control run valid for 24 h was necessary before processing the donor samples. After control run, samples were run in the system.

### Ethical clearance

The institutional ethical clearance was obtained from institutional ethics committee of our hospital.

*Statistical analysis*

The results were entered into Microsoft excel sheets, and statistical analysis was performed. All the responses were expressed as frequencies and percentages.

## RESULTS

A total of 750 random blood donors who voluntarily participated, were enrolled in this study after obtaining their proper consent on the consent form. Out of 750 donors, 287 (38.2%) were positive for IgG antibodies and 463 (61.7%) were negative for IgG antibodies. The following results were obtained on studying the different characteristics of donors in relation to COVID antibodies:

*Sex*

Out of a total of 750 donors, 745 are males and 5 were females. Out of 5 females 3 (60%) were positive for IgG antibodies and out of 745 males, 284 (38%) are positive for IgG antibodies which clearly shows high prevalence of covid antibodies in females as compared to males with a statistically significant difference(P<0.05), as shown in Table 1.

*Age*

Age of Blood Donors ranged from 18-60 years with maximum number (429) from 21-40 years age group. The number of SARSCOV-2 IgG positive cases was highest from 21–40 years age group i.e., 183 out of 429 (43%). This was followed 84 out of 228 i.e., 37% from 41-60 years' and 20 out of 93 i.e., 21.5% from 18-20 years' age groups respectively, as shown in Table 1.

*Blood groups*

Blood group wise distribution of donors with antibodies is as following: Out of total 214 donors with group A, 167 (58%) showed the presence of covid antibodies. Out of 198 donors with blood group B, 66 donors (22%) showed the presence of COVID antibodies. Out of 309 donors with blood group O, 50 donors (17%) showed the presence of covid antibodies. Out of 29 donors with blood group AB, 4 (1.4%) showed the presence of covid antibodies. In our study, donors with blood group A showed significant number of antibodies i.e., 58% followed by blood group B (22%) followed by blood group O (17%) followed by AB blood groups, as shown in Table 1.

*Educational status*

The donors were divided into four groups depending on the educational levels. Primary education: Out of 750 donors, 88 are primarily educated and showed the presence of COVID antibodies in 24(27%). 164 donors were with secondary education, out of which 59 (36%) showed the presence of anti IgG COVID antibodies. Out

of 297 donors with graduate degree, 169 (56%) showed the presence of COVID antibodies. Out of 201 postgraduate donors only 35 (17%) donors showed the presence of antibodies, as shown in Table 1.

*Rural/urban*

Depending on the address of the donors they were divided into rural and urban areas. Out of total of 750 donors, 493 donors belonged to rural areas out of which 195 (68%) were positive for anti IgG COVID antibodies and out of 257 donors who belonged to urban areas, 92 (32%) donors were positive for COVID antibodies, as shown in Table 1.

**Table 1: Relationship of SARS-CoV 2 antibodies with different characteristics of blood donors, (n=750).**

| Independent variable | | IgG positive, n (%) | IgG negative, n (%) |
|---|---|---|---|
| Overall | | 287 (38.2) | 463 (61.7) |
| Gender | Male (n=745) | 284 (38) | 461(62) |
| | Females (n=5) | 3 (60) | 2 (40) |
| Age (years) | 18-20 (n=93) | 20 (21.5) | 73 (78.5) |
| | 21-40 (n=429) | 183 (43) | 246 (57) |
| | 41-60 (n=228) | 84 (37) | 144 (63) |
| Blood group | O (n=309) | 50 (16.2) | 259 (83.8) |
| | A (n=214) | 167 (78) | 47 (22) |
| | B (n=198) | 66 (33) | 132 (67) |
| | AB (n=29) | 4 (14) | 25 (86) |
| Educational level | Primary (n=88) | 24 (27) | 64 (73) |
| | Secondary (n=164) | 59 (36) | 105 (64) |
| | Graduate (n=297) | 169 (57) | 128 (43) |
| | Postgraduate (n=201) | 35 (17) | 166 (83) |
| Residence area | Rural (n=493) | 195 (40) | 298 (60) |
| | Urban (n=257) | 92 (36) | 165 (64) |

## DISCUSSION

The COVID-19 Pandemic has resulted in crisis and challenges within communities and economies being affected. Sero-epidemiological research study can help in the detection of asymptomatic or subclinical infections in the overall population. As SARS-CoV-2 is a novel virus, the surveillance of antibody seropositivity is likely to offer valuable information regarding the true magnitude of the infection. Moreover, the antibody profile against SARS-CoV-2 in samples from healthy blood donors could represent the epidemiological situation of the population at the time of donation. In this survey of SARS-CoV-2 antibodies in blood donors, we found an overall seroprevalence of 38% i.e., out of total of 750 donors 287 came out to be positive for covid antibodies.

The seroprevalence of 38% in our study is comparable to other studies ranging from 24.4-33.7% obtained at different points in time among blood donors in Pakistan and France.[9,10] The high rate of seropositivity to SARS-CoV-2 antibodies in our study suggests a wider circulation of the virus at the community level by the end of the first wave of resurgence of the pandemic. The seroprevalence observed in our study is higher comparable to that observed in a large population based sero-epidemiological study in New York (6.9%), Spain (5.0%), Switzerland (4.8%), and China (3.2%).[11-14] Regarding blood donors, our results were high compared to the results observed in blood donors from Brazil (3.3%), Italy (2.9%), Denmark (1.9%), Saudi Arabia (1.4%), and Germany (0.91%), but it was comparable to the results obtained in previous studies carried out with blood donors from Pakistan (21.4%) and South Africa (31.8-62.5%).[10,15-20] These differences in antibody seroprevalence might reflect a different epidemiological status between the countries. Besides, our study showed an extremely significant increase (p<0.001) in SARS-CoV-2 infection from 8.3% in September 2021 to 38% in September 2021. As expected, we observed an increase in seroprevalence over time (from September 2020 to September 2021), which can be attributed to the fact that the epidemic curve was on the rise since the introduction of the first cases of SARS-CoV-2. Once again, it is worth mentioning that this increase in the seroprevalence of anti-SARS-CoV-2 might be the result of the rapid spread of SARS-CoV-2 infection in the community. In our study, male donors (745) outnumbered the female donors but on the other hand female donors showed a higher prevalence of covid antibodies i.e., 60% as compared to male donors i.e., 38% which is a statistically significant difference (p<0.005). Despite the male-to-female ratio of 149:1, we observed that the incidence was lower in males (38%) than females (60%) (p<0.005). Seroprevalence was ~1.6-fold higher among female donors compared to males. Here it is a possibility that females have more probability for asymptomatic infections whereas males are more likely to suffer symptomatic disease. The gender difference could be attributed to estrogen receptor signaling mediated protections which had been demonstrated in previous SARS-CoV animal study.[21] Similar results showing high prevalence of covid antibodies in females as compared to males was observed in certain studies by Mahapatra in Cuttack Odisha India and in another study done in Mexico in 2020 also showed higher frequency in females as compared to males.[22,23] The results showed that asymptomatic SARS-CoV-2 infections were more frequent in females, contrary to males who tend to be symptomatic with higher morbidity and mortality.[24] This observation can be attributed to the fact that the innate antiviral immune response is higher in women.[25] In our study the number of SARSCOV-2 IgG positive cases was highest from 21-40 years age group i.e. 133 out of 287 (46%). Similar results with high frequency of antibodies in young population was observed in other studies, by Mahapatra in Odisha and in Mexico in 2020 as well.[22,23] Since highest number of

blood donors belonged to the age group 21-40 years, the seroprevalence was highest in this age group. However, recent study has correlated the increased vulnerability to infection with increasing age. The age-dependent pattern of disease severity has been well established; however, the underlying reasons for the differential spread of the virus among different age groups remain unclear.[26] Our study already expected greater seroprevalence in younger donors, since in addition to being more likely to get around, make up the core of the workforce, which increases the exposure rate to SARSCoV-2 despite the social distance imposed by health authorities. A study carried out with blood donors from Brazil and Kenya also observed a reduction in the SARS-CoV-2 infection rate with increasing age, while contrary results in which adult individuals were more exposed were observed in Denmark, Saudi Arabia, and Iran.[15,17,18,28] Recent studies have shown the existence of an association between ABO blood groups with SARS-CoV-2 and another coronavirus.[29,30] We observed a significant difference between ABO/RH blood groups with SARS-CoV-2 infection (p<0.05) Similar to that reported in previous studies,[10] we found that blood group A increases the risk of SARS-CoV-2 infection, whereas blood group O decreases the risk of SARS-CoV-2 infection . Although in our study prevalence of covid antibodies was highest in group A i.e., 58% as observed in other studies as well and least in group AB i.e., 1.4% in contrary to other studies which showed least antibodies in group O which could be due to least no. of donors in group AB which participated in our study. The reason for the high risk of SARS-CoV-2 infection in blood group A compared to all non-A groups remains unknown and needs further investigation, although some studies showed that the protection mechanism of circulating anti-A antibodies inhibits the interaction between SARSCoV-2 and the ACE2 receptor.[31,32] Consequently, blood group A individuals might need reinforcing protection to reduce the chance of getting the SARS-CoV-2 infection or in case of infection, reinforcement of clinical surveillance and aggressive treatment to avoid the severity of the infection. In our study, 56% donors with bachelor degree showed the presence of covid antibodies followed by 36% donors with secondary education followed by 27% donors with primary education and 17% graduated donors showed the presence of antibodies .On the other hand, similar to our study, where infection in highly educated blood donors was lower , a study carried out in Brazil reported a high risk of infection in blood donors with low education.[15] Furthermore, we observed a higher risk in non-urbanized regions and in Brazil, they observed less risk in urbanized regions, indicating on the one hand that individuals with high socioeconomic status tend to comply more with the measures imposed by health facilities to prevent the dissemination of the SARS-CoV-2 infection and on the other hand that the infection might be easily controlled in the population with a high socioeconomic level.[15] However, results contrary to those observed in our study and Brazil were observed in Canada, where blood donors from

underserved areas did not have significantly higher rates of SARS-CoV-2 infection compared to blood donors from more affluent neighborhoods.[33] Our results also showed that prevalence of covid antibodies was more in rural population i.e., 68% as compared to urban population i.e., 32%. Also, our study showed that the risk of SARS-CoV-2 infection was 2 times more in non-urbanized regions when compared to urban. Weak basic sanitation and low socioeconomic status could help explain the increase in SARS-CoV-2 infections in non-urbanized regions of Jammu since in these regions, the population might have economic difficulties which prevent the acquisition of protective materials or the fulfillment of social isolation to prevent the spread of SARS-CoV-2 infection. We already expected higher seroprevalence and risk of SARS-CoV-2 infection among less-educated blood donors, in non-urbanized regions and unemployed. Due to sociodemographic characteristics, these groups of individuals belong to a low socioeconomic stratum, lived in dwellings without a basic sanitation system, and have high difficulty in fulfilling social distance or adhering to basic hygiene measures to control SARS-CoV-2 dissemination. Unlike other studies in which seroprevalence estimates did not vary by occupation, our results indicate a higher risk of infection in unemployed blood donors compared to employed blood donors, which is different from the results obtained in South Africa, where high seroprevalence of SARS-CoV-2 was observed in employed.[29,34]

It is worth mentioning that our study is accompanied by limitations especially regarding the representativeness of the population. Therefore, patterns of SARS-CoV-2 susceptibility among blood donors might differ from the general population. In this study, young people and adults aged ranging between 18 and 60 years, are overrepresented compared to the underrepresented group which included children, the elderly, and individuals with some limitation or infectious disease.

## CONCLUSION

The data obtained from the present study provide an estimate of the exposure to SARS-CoV-2 infection among healthy blood donors in Jammu region. Moreover, our results indicate that SARS-CoV-2 seroprevalence has increased over a period of time and the exposure rate might be higher than that reported based on the molecular assay. Continuous screening for anti-SARS-CoV-2 in blood donors and/or other groups could be an important tool to monitor the extent of the SARS-CoV-2 infection and support authorities in decision-making for the management of the COVID-19 pandemic.

## REFERENCES

1. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J et al. A novel corona- virus from patients with pneumonia in China, 2019. N Engl J Med. 2020;382:727-33.
2. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y et al. Early transmission dynamics in Wuhan, China, of novel coronavirus–infected pneumonia. N Engl J Med. 2020;382:1199-207.
3. World Health Organization. COVID-19 Weekly Epidemiological Update. WHO. 2020. Available at: https://www.who.int/docs/default-source/coronavirus e/situation-reports/20201012-weekly-epi-update-9.pdf. Accessed on 10 June 2021.
4. Filho LA, Szwarcwald CL, Mateos S de OG, De Leon ACMP, De Andrade Medronho R, Veloso VG et al. Seroprevalence of anti-SARS-CoV-2 among blood donors in Rio de Janeiro, Brazil. Rev Saude Publica. 2020;54:1-10.
5. Wang P, Anderson N, Pan Y, Poon L, Charlton C, Zelyas N et al. The SARS-CoV-2 outbreak: diagnosis, infection prevention, and public perception. Clin Chem. 2020;66(5):644-51.
6. Wang W, Xu Y, Gao R, Lu R, Han K, Wu G et al. Detection of SARS-CoV-2 in different types of clinical specimens. JAMA. 2020;323(18):1843-4.
7. Theel ES, Slev P, Wheeler S, Couturier MR, Wong SJ, Kadkhoda K. The role of antibody testing for SARS-CoV-2: is there one? J Clin Microbiol. 2020;29.
8. World Health Organization. Maintaining a safe and adequate blood supply during the pandemic outbreak of coronavirus disease (COVID-19). Interim guidance 2020. Available at: https://apps.who.it/iris/hadle/10665/331523.
9. Fontanet A, Tondeur L, Madec Y. Cluster of COVID-19 in northern France: A retrospective closed cohort study. Medrxiv 2020.
10. Younas A, Waheed S, Khawaja S, Imam M. Seroprevalence of SARS-CoV-2antibodies among healthy blooddonors in Karachi, Pakistan. Transfus Apheresis Sci. 2020;59:102923.
11. Havers FP, Reed C, Lim T, Montgomery JM, Klena JD, Hall AJ et al. Sero- prevalence of antibodies to sars-cov-2 in 10 sites in the United States. JAMA Intern Med. 2020;180:1776-86.
12. Pollán M, Pérez-Gómez B, Pastor-Barriuso R, Oteo J, Hernán MA, Pérez- Olmeda M et al. Prevalence of SARS-CoV-2 in Spain (ENE-COVID): a nationwide, population-based sero-epidemiological study. Lancet. 2020;396:535-44.
13. Stringhini S, Wisniak A, Piumatti G, Azman AS, Lauer SA, Baysson H et al. Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Geneva, Switzer- land (SEROCoV-POP): a population-based study. Lancet. 2020;396:313-9.
14. Xu X, Sun J, Nie S, Li H, Kong Y, Liang M. Seroprevalence of immunoglobulin M and G

antibodies against SARS-CoV-2 in China. Nat Med. 2020;26:1193-5.

15. Filho LA, Szwarcwald CL, Mateos S de OG, de Leon ACMP, de Andrade Medronho R, Veloso VG et al. Seroprevalence of anti-SARS-CoV-2 among blood donors in Rio de Janeiro, Brazil. Rev Saude Publica. 2020;54:1-10.

16. Valenti L, Bergna A, Pelusi S, Facciotti F, Lai A, Tarkowski M et al. SARS- CoV-2 seroprevalence trends in healthy blood donors during the COVID-19 outbreak in Milan. Blood Transfus. 2021;19:181-9.

17. Erikstrup C, Hother CE, Pedersen OBV, Mølbak K, Skov RL, Holm DK et al. Estimation of SARS-CoV-2 infection fatality rate by real-time antibody screening of blood donors. Clin Infect Dis. 2021;72:249-53.

18. Banjar A, Al-Tawfiq JA, Alruwaily A, Alserehi H, Al-Qunaibet A, Alaswad R et al. Seroprevalence of antibodies to SARS-CoV-2 among blood donors in the early months of the pandemic in Saudi Arabia. Int J Infect Dis. 2021;104:452-7.

19. Fischer B, Knabbe C, Vollmer T. SARS-CoV-2 IgG seroprevalence in blood donors located in three different federal states, Germany. Eurosurveillance. 2020;25:1-4.

20. Sykes W, Mhlanga L, Swanevelder R, Glatt TN, Grebe E, Coleman C et al. Prevalence of anti-SARS-CoV-2 antibodies among blood donors in Northern Cape, KwaZulu-Natal, Eastern Cape, and Free State provinces of South Africa in January 2021. Res Sq. 2021;rs.3.rs-233375.

21. Channappanavar R, Fett C, Mack M. Sex-based differences in susceptibility to severe acute respiratory syndrome coronavirus infection. J Immunol. 2017;198:4046-53.

22. Mahapatra S. SARS COV-2 IgG antibodies in blood donors in pandemic-A gamechanger for policy makers. Elsevier Masson. 2021;S1246-7820(21)00480-8.

23. Martinez-Acuña N, Avalos-Nolazco DM, Rodriguez-Rodriguez DR, Martinez-Liu CG, Galan-Huerta KA, Padilla-Rivas GR et al. Seroprevalence of Anti-SARS-CoV-2 Antibodies in Blood Donors from Nuevo Leon State, Mexico, during 2020: A Retrospective Cross-Sectional Evaluation. Viruses. 2021;13:1225.

24. Golinelli D, Boetto E, Maietti E, Fantini MP. The association between ABO blood group and SARS-CoV-2 infection: a meta-analysis. PLOS ONE. 2020;15:e0239508.

25. Nimgaonkar I, Valeri L, Susser E, Hussain S, Sunderram J, Aviv A. The age pattern of the male-to-female ratio in mortality from COVID-19 mirrors that of cardiovascular disease in the general population. Aging. 2021;13:3190-201.

26. Gupta S, Nakabo S, Blanco LP, O'Neil LJ, Wigerblad G, Goel RR et al. Sex differences in neutrophil biology modulate response to type I interferons and immunometabolism. Proc Natl Acad Sci USA. 2020;117:16481-491.

27. Uyoga S, Adetifa IMO, Karanja HK, Nyagwange J, Tuju J, Wanjiku P et al. Seroprevalence of anti-SARS-CoV-2 IgG antibodies in Kenyan blood donors. MedRxiv. 2020;82:79-82.

28. Poustchi H, Darvishian M, Mohammadi Z, Shayanrad A, Delavari A, Bahadorimonfared A et al. SARS-CoV-2 antibody seroprevalence in the general population and high-risk occupational groups across 18 cities in Iran: a population-based cross-sectional study. Lancet Infect Dis. 2021;21:473-81.

29. Zhao J, Yang Y, Huang H, Li D, Gu D, Lu X et al. Relationship Between the ABO Blood Group and the Coronavirus Disease 2019 (COVID-19) Susceptibility. Clin Infect Dis. 2020;1-35.

30. Jokela M, Virtanen M, David Batty G, Kivimaki M. ABO blood group and susceptibility to severe acute respiratory syndrome. JAMA. 2005;293:1447.

31. Li J, Wang X, Chen J, Cai Y, Deng A, Yang M. Association between ABO blood groups and risk of SARS-CoV-2 pneumonia. Br J Haematol. 2020;190:24-7.

32. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497-506.

33. Saeed S, Drews SJ, Pambrun C, Yi QL, Osmond L, O'Brien SF. SARS-CoV-2 seroprevalence among blood donors after the first COVID-19 wave in Canada. Transfusion. 2021;61:862-72.

34. Shaw JA, Meiring M, Cummins T, Chegou NN, Claassen C, Du Plessis N et al. Higher SARS-CoV-2 seroprevalence in workers with lower socioeconomic status in Cape Town, South Africa. PLoS One. 2021;16:1-12.

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