Scientific Research Publishing

Open Journal of Blood Diseases, 2022, 12, 124-132
https://www.scirp.org/journal/ojbd
ISSN Online: 2164-3199
ISSN Print: 2164-3180

Seroprevalence of SARS-CoV-2 among Blood Donors in the Republic of Congo

Serge Oscar Mokono[1,2], Edwige Paola Chancelle Louanga Nanitelamio[1,2], Chaldam Jespère Mbani[2], Aude Tabapika[3], Taty Taty[2], Nina Esther Ngoyi Née Ontsira[1,4], Donatien Moukassa[1,4*]

[1]Faculty of Health Sciences, Marien Ngouabi University, Brazzaville, Republic of Congo
[2]National Blood Transfusion Centre, Brazzaville, Republic of Congo
[3]Faculty of Science and Technology, Marien Ngouabi University, Brazzaville, Republic of Congo
[4]Hospital and University Centre, Brazzaville, Republic of Congo
Email: *paolananit@gmail.com

How to cite this paper: Mokono, S.O., Nanitelamio, E.P.C.L., Mbani, C.J., Tabapika, A., Taty, T., Ontsira, N.E.N.N. and Moukassa, D. (2022) Seroprevalence of SARS-CoV-2 among Blood Donors in the Republic of Congo. *Open Journal of Blood Diseases*, **12**, 124-132.
https://doi.org/10.4236/ojbd.2022.124013

Received: September 29, 2022
Accepted: December 27, 2022
Published: December 30, 2022

Abstract

Corona Virus Disease 2019 (COVID-19) is a highly transmissible and pathogenic viral infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which erupted in Wuhan, China, in 2019 and has spread worldwide [1]. The objective of this study was to assess the seroprevalence of SARS-CoV-2 among blood donors in the Republic of Congo. **Method:** This is an analytical and cross-sectional study that was carried out during the period from July to December 2021. Biological analyses were performed with the serological tests n2019 rapid IgG/IgM from Beijing Diagreat Biotechnologies and antigen tests from Abbot using the serum for the detection of anti-SARS-Cov-2 antibodies and nasal mucus for the detection of SARS-Cov-2 antigens. Statistical analysis was performed using SPSS version 22. **The Results:** Out of 2553 donors recruited in our study, we observed a predominance of male sex with 86.1% or a ratio of 6.19, the age group of 18 - 30 years was dominant with 45.9%, family donation represented 59.2%, the dominant profession was workers with 46.9% and the dominant blood group was O Rh positive with 54%. The prevalence of anti-SRAS-CoV-2 antibodies and antigens were respectively 31.4% for anti-SRAS CoV-2 IgG antibodies, 36.7% for anti-SRAS CoV-2 IgM antibodies and 2.93% for SARS-CoV-2 antigen.

Keywords

Seroprevalence, Blood Donors, Anti IgM Antibody, Anti IgG Antibody, Antigen, SARS-CoV-2

1. Introduction

In December 2019, several cases of severe pneumonia of unknown etiology erupted

in Wuhan, China. Shortly after the first case was reported, the epidemic gradually spread, reaching almost every country in the world. The causative agent was the beta coronavirus-SARS-CoV-2, which causes a severe acute respiratory syndrome (SARS) called COVID-19 [1]. By the end of the first week of May 2020, there were more than 3.8 million confirmed cases worldwide and about 260,000 deaths [2]. In the Republic of the Congo, the first COVID-19 case was reported in March 2020, and currently, as of 15 July, there are 24,483 confirmed cases and 386 deaths [3].

As a major challenge in the diagnosis and management of this disease, several countries have implemented strategies to control the spread of this pandemic, adopting measures to limit viral transmission through barrier measures, vaccination and mass screening using simple, sensitive and specific tests that ensure immediate and accurate results to rapidly identify patients infected with SARS-CoV-2 [4]. Screening provides information on the prevalence of SARS-CoV-2 in asymptomatic individuals for two main reasons.

Firstly, asymptomatic individuals are an important source of transmission and can infect healthy individuals. This is supported by a study in China, which found that 86% of COVID-19 positive cases were undetected but accounted for 79% of contact cases [5]. Secondly, herd immunity indicates an infection that has spread within a community [6].

Some authors have assessed the prevalence among blood donors to enhance and reduce the potential risk of infection through blood transfusion [7]. Others monitor the circulation of the virus in healthy people. [8] [9]. It is in this context that we conducted a seroprevalence survey among voluntary blood donors in the Republic of Congo.

2. Method

2.1. Study Design and Population

This is an analytical and cross-sectional study, including donors able to donate blood from the inter-departmental blood transfusion centres of the two major cities of Congo (Brazzaville and Pointe Noire).

Covering the period from July to December 2021. A total of 2553 blood donors were collected in compliance with the barrier measures (hand hygiene, temperature taking, mandatory mask wearing), whatever the type of donation (family, volunteer or regular), the suitability for donation was defined, after the medical screening, as people in good general health and showing no symptoms of influenza. The importance of screening was explained in the language of their choice before sample collection and informed consent was obtained.

The inclusion criteria were as follows:

- Blood donor aged 18 - 60 years;
- Not vaccinated;
- No stay in a high-risk country.

2.2. Sample Collection

We carried out two types of collection at the same time successively after the medical consultation in which the donor is deemed fit to donate blood:

- Nasopharyngeal with a swab for the determination of SARS-CoV-2 Antigens;
- Blood in the satellite bag, the blood bag device designed for the collection of samples for the biological quality of blood donations. For this purpose, 5 ml were collected in two tubes (dry and EDTA).

The dry tubes were centrifuged at 3000 rpm for 3 minutes and the recovered serum was placed in two cryotubes and stored at −20˚C for the detection of IgG and IgM SARS-CoV-2 antibodies, while the EDTA tubes were stored at 4˚C for blood typing.

2.3. Biological Tests

The anti-SARS-CoV-2 Antibody (IgM and IgG) were determined using the 2019-nCoV IgG/IgM Rapid Antibody Test Kit from Beijing Diagreat Biotechnologies of China and SARS-CoV-2 Antigen with the PanbioTM COVID-19 Ag Rapid Test Device from Abbot Diagnostics Jena GmbH of Germany.

2.4. Statistical Analyses

Statistical analyses of the data were performed with SPSS Software version 18.0, the different groups were compared using the student t-test, and the Significance thresholds used was 5% ($p \leq 0.05$).

3. Results

3.1. Socio-Demographic Variable

Out of 2553 donors recruited in our study, we observed a predominance of males with 86.1% against 13.9% of females, *i.e.*, a sex ratio of 6.19. The age group of 18 - 30 years was dominant with 45.9%, family donation represented 59.2%, the dominant profession was open with 46.9% and the dominant blood group was O Rh positive with 54%.

3.2. Seroprevalence of Anti-SRAS-CoV-2 Antigens and Antibodies (IgM and IgG)

The prevalence of anti-SRAS-CoV-2 antibody and antigen was 31.4% for IgG, 36.7% for IgM and 2.93% for antigen, respectively (Table 1).

We found that 2.93 percent of donors were positive for the SARS-CoV-2 antigen, 12 percent also had SARS-CoV-2 IgG antibodies from a long time ago, and 38.6 percent had with IgM antibodies SARS-CoV-2 from just recently (Table 2).

3.3. Seroprevalence of Anti-SRAS-CoV-2 IgM/IgG Antibodies by Socio-Demographic Characteristics

There were no statistically significant abnormalities between anti-SRAS-CoV-2 IgG and socio-demographic data no age, gender, donor type, occupation and

blood type we found that most donors with a remote infection were men, that the dominant age group was younger, that the dominant occupation was blue collar and that the dominant blood group was group O. Those familial donations were the most common (Table 3).

Table 1. Seroprevalence of anti-SRAS-CoV-2 antigens and antibodies (IgM and IgG).

Designation		Number of donors	Percentage
Ag SRAS-CoV-2	Positif	75	2.93
	Négatif	2478	97.07
Ac IgG anti-SRAS-CoV-2	Positif	801	31.4
	Négatif	1752	68.6
Ac IgM anti-SRAS-CoV-2	Positif	937	36.7
	Négatif	1616	63.3

Table 2. Seroprevalence of anti-SRAS-CoV-2 antigen and antibody positive carriers (IgM and IgG).

Immunoglobulins	SARS-CoV-2 Ag positive Donors N = 75 (2.93%)	P-value
IgM+	29 (38.6%)	0.29
IgG+	9 (12%)	0.78
IgG−/IgM−	37 (49.4)	

Table 3. Seroprevalence of anti-SRAS-CoV-2 IgG antibodies by socio-demographic characteristics.

Features	Variable	IgG+ n (%)	IgG− n (%)	P-value
Gender	Male	683 (85.3)	1514 (86.4)	0.84
	Female	118 (14.7)	238 (13.6)	
Age	18 - 30	359 (44.8)	811 (46.3)	0.39
	31 - 45	342 (42.7)	774 (42.6)	0.38
	46 - 60	100 (12.5)	167 (11.1)	
Profession	Pupil/Student	131 (16.4)	292 (16.7)	
	Officials	78 (9.7)	204 (4.6)	0.06
	Unemployed	206 (25.7)	514 (30.7)	0.79
	Worker	375 (46.8)	710 (46.2)	0.45
	Health workers	11 (1.4)	32 (1.8)	
Type of donation	Family	491 (61.3)	1041 (59.4)	1
	Volunteers	253 (31.6)	593 (33.9)	0.66
	Regular	57 (7.1)	118 (6.7)	
Blood type	O	403 (50.4)	968 (55.3)	0.46
	A	165 (20.6)	412 (23.5)	0.69
	B	191 (23.8)	324 (18.5)	0.85
	AB	42 (5.2)	48 (2.7)	

Table 4. Seroprevalence of anti-SRAS-CoV-2 IgM antibodies by socio-demographic characteristics.

Features	Variable	IgM+ n (%)	IgM− n (%)	P-value
Gender	Male	806 (86.1)	1391 (86.2)	0.52
	Female	131 (13.9)	225 (13.8)	
Age	18 - 30	525 (56)	645 (50.8)	0.67
	31 - 45	332 (38.7)	784 (43.7)	0.45
	46 - 60	80 (5.3)	187 (5.5)	
Profession	Pupil/Student	157 (14.8)	266 (15.9)	0.61
	Officials	136 (9.3)	146 (4.5)	0.06
	Unemployed	207 (27.7)	513 (30.7)	0.62
	Worker	417 (46.9)	669 (46.9)	0.47
	Health workers	20 (1.3)	22 (2.0)	
Type of donation	Family	559 (59.6)	973 (60.2)	1
	Volunteers	310 (33.1)	536 (33.2)	0.2
	Regular	68 (7.3)	107 (6.6)	
Blood type	O	519 (55.4)	848 (52.5)	0.85
	A	180 (19.2)	397 (24.6)	0.85
	B	194 (20.7)	325 (20.1)	0.73
	AB	44 (4.7)	46 (2.8)	

Comparinganti-SRAS-CoV-2 IgM and socio-demographic data,no statistically significant differences were observed for age, gender, type of donor, occupation and blood type in contrast to SARS-CoV-2. We see that most donors whit recent infection were men, that the youngest age group is the most common, that blue collar jobs are the most common occupation, that type O blood is the most common blood type and that family donation were the most common (Table 4).

4. Discussion

The objective of this study was to determine the seroprevalence of SARS-CoV-2 in blood donors. We collected 2553 blood donors, of whom 75 were positive for the SARS-CoV-2 antigen, a rate of 2.9%. Of these, nine (9) were positive for IgG antibody to SARS-CoV-2 and twenty-nine (29) were positive for IgM antibody to SARS-CoV-2. These infected donors were all asymptomatic when they presented at the donation site. The hypotheses that can arise are remote immune sensitivity to SARS-CoV-2 or chronic carriers.

It also revealed that the prevalence of IgG and IgM antibodies to SARS-CoV-2 in blood donors was 31.4% and 36.7%, respectively. The positive IgM and IgG tests for SARS-CoV-2 antibodies detected in the donor blood samples indicate: firstly, that they are asymptomatic donors and, secondly, that they are probably in the early convalescence stage of the infection. IgM is the first antibody pro-

duced by the immune system. They appear within five to seven days of the onset of infection and peak at around 21eme days. If they are detected without IgG, the person has the virus or has recently contracted it. The high prevalence of anti-SRAS-CoV-2 IgG identified in this study reflects the fact that the disease is endemic. This high IgG seroprevalence indicates frequent past exposure to SARS-CoV-2 in blood donors. Immunoglobulin G (IgG) appears around days 10 - 14 after the onset of infection. If it is detected together with IgM, the infection has occurred within the past month. If its presence is detected without IgM, the infection occurred more than one month ago; our data is similar to some studies [10] [11]. On the other hand, other authors report lower seroprevalence of 1.5% positive for IgM and 4.7% positive for IgG in Angola [12] [13]. The high prevalence obtained in our study shows a widespread community transmission of SARS-CoV-2 and a low vaccination coverage which was 0% in our donors.

These results corroborate those published by Percivalle *et al.* in Italy indicating a low prevalence in female donors of 30% compared to 70% of male donors [14]. This can be explained by the fact that the number of male donors was in the majority and that the virus is not gender specific.

In this study, the prevalence of anti-SRAS-CoV-2 antibodies was very high in young people in the age group 18 - 30 years, in contrast to the age group 46 - 60 years. This is in agreement with the results published by Bobrovitz *et al.* in Italy [15], who stated that seroprevalence is low in the elderly. These results show us that the exposure of young people to SARS-CoV-2 in Congo is much higher. This can be explained by the reflection of the Congolese population, which is young, and the lack of compliance with barrier measures [16]-[21].

Depending on the occupation, seroprevalence was high among workers and very low among health workers. These values can be explained by the social standard of living, vaccination and the insufficient number of health workers in our study. This is in contrast to a study published by Galanis *et al.*, which reported higher seroprevalences among health workers [22]. These results show that the occupation may be correlated with a higher risk of infection.

This result is similar to that published in Angola, where a prevalence of 85.7% was found [12]. This may be explained by the predominance of family donation in sub-Saharan Africa. [18] [21] [23] [24] [25].

The seroprevalence SARS-CoV-2 antibody was high in blood group O donors compared to other blood groups, but no significant difference was found. In this study, we note that blood group O donors were more exposed to SARS-CoV-2. Indeed, N. Liu *et al.*; Wu *et al.* suggests that compared to individuals of blood groups O and B, individuals of blood groups A and AB were associated with an increased risk of death. However, blood group B individuals appeared to have a reduced mortality rate [26] [27].

5. Conclusion

The present study shows a significant immunological sensitisation to SARS-CoV-2

in asymptomatic blood donors in the Republic of Congo. There were no statistically significant abnormalities by gender, age, occupation, donor type and blood type. Since Congo has a low death rate ,it would be interesting to continue this study to learn more the different strains.

Acknowledgements

The authors would like to thank the blood donors and the staff of the National Blood Transfusion Centre who agreed to participate in the study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Filho, A.L., Szwarcwald, C.L., De Oliveira Garcia Mateos, S., De Leon, A.C.M.P., De Andrade Medronho, R., Veloso, V.G., Lopes, J.I.F., De Moraes Sobrino Porto, L.C., Chieppe, A. and Werneck, G.L. (2020) Seroprevalence of Anti-SARS-CoV-2 among Blood Donors in Rio de Janeiro, Brazil. *Revista de Saúde Pública*, **54**, 69. https://doi.org/10.11606/s1518-8787.2020054002643

[2] https://www.worldometers.info/coronavirus/

[3] Xu, Z., Shi, L., Wang, Y., Zhang, J., Huang, L., Zhang, C., Liu, S., Zhao, P., Liu, H., Zhu, L., Tai, Y., Bai, C., Gao, T., Song, J., Xia, P., Dong, J., Zhao, J. and Wang, F.S. (2020) Pathological Findings of COVID-19 Associated with Acute Respiratory Distress Syndrome. *The Lancet Respiratory Medicine*, **8**, 420-422. https://doi.org/10.1016/S2213-2600(20)30076-X

[4] Li, Z., Yi, Y., Luo, X., Xiong, N., Liu, Y., Li, S., Sun, R., Wang, Y., Hu, B., Chen, W., Zhang, Y., Wang, J., Huang, B., Lin, Y., Yang, J., Cai, W., Wang, X., Cheng, J., Chen, Z., *et al.* (2020) Development and Clinical Application of a Rapid IgM-IgG Combined Antibody Test for SARS-CoV-2 Infection Diagnosis. *Journal of Medical Virology*, **92**, 1518-1524. https://doi.org/10.1002/jmv.25727

[5] Li, R., Pei, S., Chen, B., Song, Y., Zhang, T., Yang, W. and Shaman, J. (2020) Substantial Undocumented Infection Facilitates the Rapid Dissemination of Novel Coronavirus (SARS-CoV-2). *Science*, **368**, 489-493. https://doi.org/10.1126/science.abb3221

[6] Barreto, M.L., De Barro, A.J.D., Carvalho, M.S., Codeço, C.T., Hallal, P.R.C., Medronho ,R., De Andrade Medronho, R., Struchiner, C.J., Victora, C.G. and Werneck, G.L.O. (2020) que é urgente e necessário para subsidiar as políticas de enfrentamento da pandemia de COVID-19 no Brasil? *Revista Brasileira de Epidemiologia*, **23**, E200032. https://doi.org/10.1590/1980-549720200032

[7] Dimeglio, C., Loubes, J.-M., Deporte, B., Dubois, M., Latou, J., Mansuy, J.-M. and Izopet, J. (2020) The SARS-CoV-2 Seroprevalence Is the Key Factor for Deconfinement in France. *Journal of Infection*, **81**, 318-356. https://doi.org/10.1016/j.jinf.2020.04.031

[8] Erikstrup, C., Hother, C.E., Vestager, P.O.B., Mølbak, K., Skov, R.L., Holm, D.K., Sækmose, S., Nilsson, A.C., Brooks, P.T., Kjærgaard, B.J., Mikkelsen, C., Gybel-Brask, M., Sørensen, E., Dinh, K.M., Mikkelsen, S., Møller B.K., Haunstrup, T., Harritshøj, L., Jensen, B.A., *et al.* (2021) Estimation of SARS-CoV-2 Infection Fatal-

ity Rate by Real-Time Antibody Screening of Blood Donors. *Clinical Infectious Diseases*, **72**, 249-253. https://doi.org/10.1093/cid/ciaa849

[9] Slot, E., Hogema, B.M., Reuske, C.B.E.M., Reimerink, J.H., Molier, M., Karregat, J.H.M., Ijlst, J., Novotný, V.M.J., Van Lier, R.A.W. and Zaaijer, H.L. (2020) Low SARS-CoV-2 Seroprevalence in Blood Donors in the Early COVID-19 Epidemic in the Netherlands. *Nature Communications*, **11**, Article No. 5744. https://doi.org/10.1038/s41467-020-19481-7

[10] Sykes, W., Mhlanga, L., Swanevelder, R., Glatt, T.N., Grebe, E., Coleman, C., Pieterson, N., Cable, R., Welte, A., Van Den Berg, K. and Vermeulen. M. (2021) 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. In Review. https://doi.org/10.21203/rs.3.rs-233375/v1

[11] Younas, A., Waheed, S., Khawaj, S., Imam, M., Borhan, M. and Shamsi, T. (2020) Seroprevalence of SARS-CoV-2 Antibodies among Healthy Blood Donors in Karachi, Pakistan. *Transfusion and Apheresis Science*, **59**, Article ID: 102923. https://doi.org/10.1016/j.transci.2020.102923

[12] Sebastião, C.S., Galangue, M., Gaston, C., Van-Dunen, R., Quivinja, J., Lunbungululo, E., Alfredo, D., Sozinho, A., Teixeira, A., Manico, E., Machado, D., Mateus, A., David, Z., Paixão, J., Neto, Z., De Vasconcelos, J.N. and Morais, J. (2021) Seroprevalence of Anti-SARS-CoV-2 Antibodies and Risk Factors among Healthy Blood Donors in Luanda, Angola. *BMC Infectious Diseases*, **21**, Article No. 1131. https://doi.org/10.1186/s12879-021-06814-0

[13] Uyoga, S., Adetifa, I.M.O., Karanja, H.K., Nyagwange, J., Tuju, J., Wanjiku, P., Aman, R., Mwangangi, M., Amoth, P., Kasera, K., Ng'ang'a, W., Rombo, C., Yegon C., Kithi, K., Odhiambo, E., Rotich, T., Orgut, I., Kihara, S., Otiende, M., *et al.* (2021) Seroprevalence of Anti-SARS-CoV-2 IgG Antibodies in Kenyan Blood Donors. *Science*, **371**, 79-82. https://doi.org/10.1126/science.abe1916

[14] Percivalle, E., Cambiè, G., Cassaniti, I., Nepita, E.V., Maserati, R., Ferrari, A., Di Martino, R., Isernia, P., Mojoli, F., Bruno, R., Tirani, M., Cereda, D., Nicora, C., Lombardo, M. and Baldanti, F. (2020) Prevalence of SARS-CoV-2 Specific Neutralising Antibodies in Blood Donors from the Lodi Red Zone in Lombardy, Italy, as at 06 April 2020. *Eurosurveillance*, **25**, Article ID: 2001031, https://doi.org/10.2807/1560-7917.ES.2020.25.24.2001031

[15] Bobrovitz, N., Arora, R.K., Cao, C., Boucher, E., Liu, M., Donnici, C., Yanes-Lane, M., Whelan, M., Perlman-Arrow, S., Chen, J., Rahim, H., Ilincic, N., Segal, M., Duarte, N., Van Wyk, J., Yan, T., Atmaja, A., *et al.* (2021) Global Seroprevalence of SARS-CoV-2 Antibodies : A Systematic Review and Meta-Analysis. *PLOS ONE*, **16**, Article ID: 0252617. https://doi.org/10.1371/journal.pone.0252617

[16] Eko Mba, J.M., Bisseye, C., Ndong, N.J.M., Mombo, L.E., Bengone, C., Mouelet Migolet, G., M'batchi, B., Kosiorek, H.E., Butterfield, R.J., Roberts, L.R., Borad, M.J. and Nagalo, B.M. (2018) Prevalent Hepatitis B Surface Antigen among First-Time Blood Donors in Gabon. *PLOS ONE*, **13**, Article ID: 0194285. https://doi.org/10.1371/journal.pone.0194285

[17] Publié par l'UNICEF (2021). https://www.unicef.org/

[18] Mongo-Onkouo, A., Lepfoundzou, A.D., Yvonne, D.O.M., Philestine, A.A.C., Monamou, J.F.M., Itoua-Ngaporo, N.A., Ngami, R.S., Ngalessami, M.M., Adoua, C.S., Gassaye, D., Ibara, B.I.A. and Ibara, J.-R. (2019) Viral Hepatitis B: Seroprevalence and Genetic Diversity in Blood Donors North of Congo. *Open Journal of Gastroenterology*, **9**, 239-245. https://doi.org/10.4236/ojgas.2019.912027

[19] Cunha, L., Plouzeau, C., Ingrand, P., Gudo, J.P., Ingrand, I., Mondlane, J., Beauchant, M.

and Agius, G. (2007) Utilisation de donneurs de sang de remplacement pour étudier l'épidémiologie des principaux virus transmissibles par le sang dans la population générale de Maputo, au Mozambique. *Journal of Medical Virology*, **79**, 1832-1840. https://doi.org/10.1002/jmv.21010

[20] Tagny, C.T., Mbanya, D., Tapk, J.-B. and Lefrère, J.-J. (2008) Blood Safety in Sub-Saharan Africa: A Multi-Factorial Problem. *Transfusion*, **48**, 1256-1261. https://doi.org/10.1111/j.1537-2995.2008.01697.x

[21] Tagny, C.T., Diarra, A., Yahaya, R., Hakizimana, M., Nguessan, A., Mbensa, G., Nébié, Y., Dahourou, H., Mbanya, D., Shiboski, C., Murphy, E. and Lefrère, J.J. (2009) Characteristics of Blood Donors and Donated Blood in Sub-Saharan Francophone Africa. *Transfusion*, **49**, 1592-1599. https://doi.org/10.1111/j.1537-2995.2009.02137.x

[22] Galanis, P., Vraka, I., Fragkou, D., Bilali, A. and Kaitelidou, D. (2021) Seroprevalence of SARS-CoV-2 Antibodies and Associated Factors in Healthcare Workers: A Systematic Review and Meta-Analysis. *The Journal of Hospital Infection*, **108**, 120-134. https://doi.org/10.1016/j.jhin.2020.11.008

[23] Allain, J.P., Sarkodie, F., Boateng, P., Asenso, K., Kyerematen, E. and Owusu-Ofori, S. (2008) Un pool de donneurs de sang répétés peut être généré avec peu de frais pour le centre de transfusion d'Afrique sub-saharienne. *Transfusion*, **48**, 735-741. https://doi.org/10.1111/j.1537-2995.2007.01599.x

[24] Mokono, S.O., Mbani, C.J., Angounda, B.M., Bakoua, B.S., Mbao-Bongo, S.R., Nanitelamio, E.P.L., Niama, F.R. and Moukassa D. (2021) Prevalence and Risk Factors for Hepatitis Delta Virus Transmission among HBsAg Positive Blood Donors in Brazzaville, Congo. *Journal of Biosciences and Medicines*, **9**, 43-50. https://doi.org/10.4236/jbm.2021.98004

[25] International Labour Organization (2018). https://www.ilo.org/

[26] Liu, N., Zhang, T., Ma, L., Zhang, H., Wang, H., Wei, W., Pei, H., and Li, H. (2021) The Impact of ABO Blood Group on COVID-19 Infection Risk and Mortality: A Systematic Review and Meta-Analysis. *Blood Reviews*, **48**, Article ID: 100785. https://doi.org/10.1016/j.blre.2020.100785

[27] Wu, B.-B., Gu, D.-Z., Yu, J.-N., Yang, J. and Shen, W.-Q. (2020) Association between ABO Blood Groups and COVID-19 Infection, Severity and Demise: A Systematic Review and Meta-Analysis. *Infection Genetics and Evolytion*, **84**, Article ID: 104485.