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EVALUATION OF RISK OF TRANSFUSION-TRANSMISSIBLE INFECTIONS IN BLOOD DONORS AT THE LAQUINTINIE HOSPITAL IN DOUALA, CAMEROON

Christiane Sike Medi[1*, 2], Celestin Roger Ayangma[3], Esther Voundi Voundi[2, *], Annick Mintya Ndoumba[2], Marie Paule Ngogang[2], Bertrand Bille Eyoum[1], Elisée Enyegue Embolo[4], Noël Emmanuel Essomba[1, 5]

[1]Douala Laquintinie Hospital, Douala, Cameroon
[2]Faculty of Medicine and Biomedical Sciences of The University of Yaoundé I, Yaoundé, Cameroon
[3]Higher Institute of Medical Technology, Yaoundé, Cameroon
[4]Ministry of Scientific Research and Innovation,Yaounde, Cameroon
[5]Faculty of Medicine and Pharmaceutical Sciences of The University of Douala, Douala, Cameroon

Corresponding Author:
Esther Voundi Voundi, email: esther.voundi@fmsb-uy1.cm

Abstract

Introduction: *Unsafe blood transfusions have the potential to transmit a variety of infections known as transfusion-transmitted infections (TTIs). The overall objective of our study was to determine the seroprevalence and factors associated with TTIs related to human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and Treponema pallidum bacteria among blood donors at the Laquintinie Hospital in Douala.* ***Methodology:*** *A cross-sectional analytical study was conducted among blood donors at the HDH for 12 months, from January 1 to December 30, 2021. HIV, HBV and HCV serological markers were tested by two immunological techniques, immuno-chromatography and Enzyme-Linked Immunosorbent Assays (ELISA). Treponema pallidum infection was tested by hemaglutination and ELISA. Factors associated with infection were investigated by multinomial logistic regression with a statistical significance level of 5%.* ***Results:*** *We analyzed 7222 blood bags, 1010 of which were positive for at least one of the infectious markers, i.e. a prevalence of TTI of 14.0%; this prevalence was significantly higher in male donors (p=0.001), those aged between 45 and 54 years (p=0.009), workers in the private sector (p=0.003), married donors (p=0.034). No significant difference was observed between compensatory and voluntary donation.* ***Conclusion:*** *TTIs remain a major public health concern, hence the need for awareness and surveillance strategies.*

Keywords: *transfusion, infection, blood donation, Cameroon.*

INTRODUCTION

Blood transfusion is a life-saving therapy for millions of people who would otherwise have died of natural causes and disasters [1]. However, blood transfusions when unsafe have the potential to transmit various infections to blood recipients [2]. These infections are known as Transfusion Transmitted Infections (TTIs), which are defined as any infection that can be transmitted from one person to another through the parenteral administration of blood or any other blood product. They can be viral, bacterial, parasitic, mycotic or from prions. The most important of these are the human immunodeficiency virus (HIV), the hepatitis B virus (HBV), the hepatitis C virus (HCV) and the Treponema pallidum bacterium, which causes syphilis [1-3]. Therefore, the World Health Organization (WHO) recommends that all collected blood be screened for TTIs caused by these pathogens [3]. In recent years, screening for TTIs has increased significantly in developing countries. Prior to the 2000s, more than 40% of donated blood had not been screened for TTIs [4]. Now, with the use of rapid and simple serological tests for TTIs screening, more than 80% of resource-limited countries routinely screen for TTIs following basic quality assurance procedures [3]. However, the prevalence of TTIs remains much higher in resource-limited countries [5-8] than in developed countries, due to the high prevalence of these infections in the community [3]. Over the last decade, studies conducted in blood banks of some hospitals in Cameroon have shown high rates of seropositivity for the four conventional markers of TTIs, of the order of 10.5% in Bamenda [9], 13.7% in Douala [10] and nearly 20% in Yaoundé [11]. These high prevalences of TTIs highlight the problems of blood safety in Cameroon. Ongoing monitoring of the extent of TTIs among blood donors is important to evaluate the effectiveness of screening programs, optimize donor recruitment strategies, and minimize infectious disease transmission. The overall objective of our study was to determine the seroprevalence and factors associated with HIV, HBV, HCV, and syphilis infections among blood donors at the Douala Laquintinie Hospital (DLH).

Methodology

Type, place and period of the study

We conducted a cross-sectional analytical study at the Blood Bank of the DLH over a 12-month period from January 1 to December 30, 2021. The DLH, located in Douala, is a second category reference institution in Cameroon with the imperative to provide medical and medico-health care to patients and to respond appropriately during major events.

Study population

Our target population consisted of blood donation candidates of all sexes, ages and nationalities recruited consecutively during the study period. Not all candidates who did not give informed consent, those not eligible to donate after medical interview, and only the last donation were included when the candidate had made more than one donation during the year.

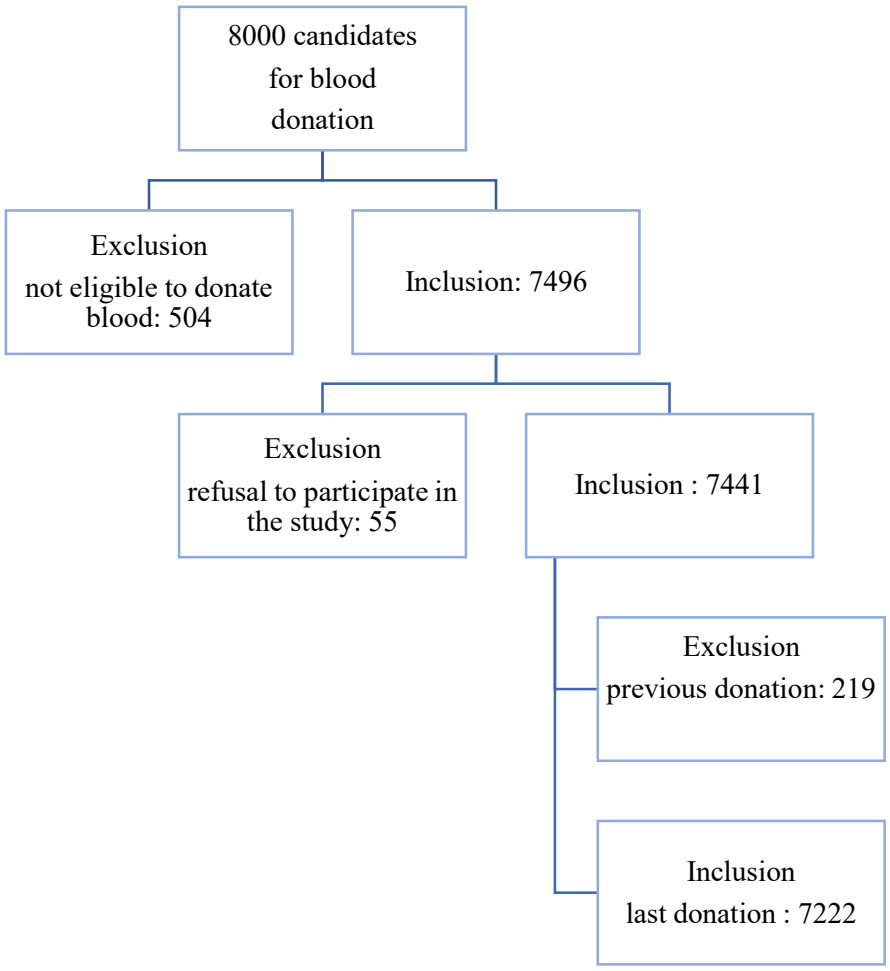

Figure 1: Blood donor inclusion chart

Procedure

After obtaining informed consent from the blood donation candidates, the collection of data from the medical interview took place. During this exchange, the participant answered questions related to previous medical conditions and blood transfusion history. A physical examination was done to assess their ability to tolerate the donation. Any individual in apparent good health, between the ages of 18 and 65, with a weight of more than 50 kg and a hemoglobin level > 12 g/dL in women and more than 13 g/dL in men was considered eligible to donate. Blood collection followed a strict protocol that included explanation of the collection procedure, adherence to aseptic rules, the actual collection and post-collection monitoring. Venous blood was collected in a bag containing citrate-phosphate-dextrose and adenine (CPD-A,Hindustan Latex Ltd, Kerala, India, 2021) as well as 5mL collected in a dry tube for serological analysis and 5mL for blood grouping on tube with ethylene diamine tetra-acetic acid (EDTA). The qualification of the blood bags was done after collection and on a daily basis in order to retain those eligible for delivery and eliminate the others. The following elements were evaluated: volume (450 ml), absence of clot, absence of reactivity to at least one of the two methods of microbiological qualification, absence of hemolysis and delivery before the expiration date.

Microbiological qualification

Serological markers for HIV, HBV, and HCV were tested in parallel using a combination of two immunological techniques, immunochromatography and Enzyme-Linked Immunosorbent Assays (ELISA). The kits used for HIV testing were the Alere DetermineTM HIV-1/2 Ag/Ab Combo (Orgenics Ltd., Israel, 2021) and the HIV 4th Gen Ag/Ab ELISA Kit (Fortress Diagnostics Ltd., United Kingdom, 2021) allowing the detection of p24 antigen and HIV-1 and 2 antibodies. For HBV surface antigen (HBsAg) testing, the tests used were the Wondfo® One Step HBsAg Serum/Plasma Test Strip (Guangzhou Wondfo Biotech Co. Ltd., China, 2021) and the HBsAg ELISA Kit (Fortress Diagnostics Ltd, United Kingdom, 2021). HCV serodiagnosis by testing for anti-HCV antibodies was performed using the Wondfo® One Step HCV Serum/Plasma Test Strip Kit (Guangzhou Wondfo Biotech Co. Ltd., China, 2021) and HCV Ab ELISA Kit (Fortress Diagnostics Ltd, United Kingdom, 2021). As for the detection of anti-Treponema pallidum antibodies, an indirect hemagglutination test (TPHA 100 TEST, Fortress Diagnostics Ltd, United Kingdom, 2021) and an ELISA (Syphilis ELISA Kit, Fortress Diagnostics Ltd, United Kingdom, 2021) were used. Regarding the interpretation of the results, the 2 serological tests allowed to classify them as non-reactive if they were negative, as reactive if they were positive and as

indeterminate if they were discordant. Reactive and indeterminate samples led to the management of the subjects concerned and the safe disposal of the blood bags collected.

Study variables

Socio-demographic characteristics such as sex, age, marital status, place of residence, religion, blood type, HIV, HBV, HCV and Treponema pallidum results were our study variables.

Statistical analyses

The SPSS (Statistical package for social sciences) software version 23.0 was chosen for data analysis with a statistical significance threshold set at 5% ($p < 0.05$). A univariate analysis using a Chi^2 test or Fisher's exact test and then a multivariate analysis using the multinomial logistic regression method were used to search for factors associated with infections. Our variable of interest was the presence of TTIS. The strength of association was measured by the Odd Ratio (OR) with its 95% confidence interval (95% CI).

Ethical Considerations

In order to carry out this work, we obtained an administrative research authorization from the management of Laquintinie Hospital and the ethical clearance of the Institutional Research Ethics Committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I. The information collected was used exclusively within the framework of this study and in strict compliance with medical confidentiality.

Results

Socio-demographic characteristics of donors

A total of 7222 donor blood bags were screened at the LHD Blood Bank. Of these donors, 6479 (89.7%) were male. The most represented age group was 25 - 34 years, which represented 3170 (43.9%) donors. Nearly two-thirds (65.3%) of the donors were working in the private sector, while nearly a quarter (24.9%) were students. More than 90.0% (6,503) of the donors had an education level higher than primary school and 72.0% (5,205) of them were single. Almost all of the blood donations examined in this study were from donors of Cameroonian nationality (99.2%). A total of 3,744 (51.8%) donors were blood group O rhesus positive. Only 141 (2%) of the blood donations received during the study period were from volunteer donors, the vast majority (98.0%) of which were replacements (Table I).

Table I: Distribution of socio-demographic characteristics and blood group in our study population

Variables	Modalities	Number N=7222	Percentage (%)
Sex			
	Male	6479	89.7
	Female	743	10.3
Age range (years)			
	< 25	1946	27.0
	25-34	3170	43.9
	35-44	1623	22.5
	45-54	416	5.8
	55 and over	67	0.9
Profession			
	Public sector employee	398	5.5
	Private sector employee	4719	65.3
	Pupil/Student	1797	24.9
	Unemployed	308	4.3
Level of education			
	Primary	719	10.0
	Secondary	3419	47.3
	University	3084	42.7
Marital status			
	Single	5205	72.1
	Married	1919	26.6
	Divorced	81	1.1
	Widow(er)	17	0.2
Country of origin			
	Cameroon	7167	99.2
	Other	55	0.8
Blood type			
	A-	42	0.6

	A+	1636	22.7
	AB-	5	0.1
	AB+	227	3.1
	B-	49	0.7
	B+	1364	18.9
	O-	155	2.2
	O+	3744	51.8
Type of donation			
	Volunteer	141	2.0
	Replacement	7081	98.0

Prevalence of transfusion-transmissible infections

Of the 7222 blood bags tested, 1010 were confirmed positive for at least one of the pathogens tested, giving an TTIs prevalence of 14.0%. The rates of positivity for HBV, Syphilis, HCV and HIV were 4.9%, 3.0%, 2.5% and 2.1% respectively. In addition, 111 out of 7222 (1.5%) donors had a double or triple infection, of which the most frequent combinations were HBV/HCV (0.4%), HBV/Syphilis (0.3%) and HIV/HBV (0.2%) (Table II).

Table II: Prevalence of infections in our study population

Variables	**Modalities**	**Number N=7222**	**Percentage (%)**
Infectious profile			
	HIV	151	2.1
	HBV	353	4.9
	HCV	178	2.5
	Syphilis	217	3.0
	HIV/HBV	17	0.2
	HIV/HCV	11	0.2
	HIV/Syphilis	15	0.2
	HBV/HCV	26	0.4
	HBV/Syphilis	21	0.3
	HCV/Syphilis	16	0.2
	HIV/HBV/HCV	1	0.0
	HIV/HBV/Syphilis	2	0.0
	HIV/HCV/Syphilis	1	0.0
	HBV/HCV/Syphilis	1	0.0
	Non-reactive	6212	86.0
Condition of the pocket			
	Contaminated	1010	14.0
	Healthy	6212	86.0

HIV: human immunodeficiency virus; HBV: hepatitis B virus ; HCV: hepatitis C virus

Factors related to blood bag contamination

The prevalence of TTIs was significantly higher in male donors than in female donors (p=0.001). TTIs were significantly more prevalent in donors aged 45-54 years (p=0.009), and less prevalent in those under 25 years (p=0.007). The prevalence of TTIS also showed significant differences between the different types of occupation. Donors working in the private sector had a high prevalence of TTIs (p=0.003) while students had the lowest infection rates (p=0.001). On the other hand, the prevalence of TTIs was significantly lower among donors with a university education (p=0.009). With regard to marital status, the prevalence of TTIS was significantly higher in married donors (p=0.034) and lower in single donors (p=0.029). On the other hand, no significant difference was observed between compensatory and voluntary donation (Table III).

Table III: Factors associated with transfusion-transmissible infections in our study population

Variables		TTIs		OR [CI 95%]	p
		Presence n (%)	Absence n (%)		
Sex					
	Male	937 (92.8)	5542 (89.2)	1.55 [1.21-2.00]	**0.001**
	Female	73 (7.2)	670 (10.8)		
Age range (years)					
	< 25	237 (23.5)	1709 (27.5)	0.81 [0.69-0.94]	**0.007**
	< 35	684 (67.7)	4432 (71.3)	0.84 [0.73-0.97]	**0.019**
	< 45	919 (91.0)	5820 (93.7)	0.68 [0.54-0.86]	**0.001**
	< 55	995 (98.5)	6160 (99.1)	0.56 [0.31-1.00]	**0.046**
Profession					
	Public sector employee	53 (5.2)	345 (5.5)	0.94 [0.70-1.27]	0.692
	Private sector employee	702 (69.5)	4017 (64.5)	1.25 [1.08-1.44]	**0.003**
	Pupil/Student	210 (20.8)	1587 (25.5)	0.77 [0.65-0.90]	**0.001**
	Unemployed	45 (4.4)	263 (4.2)	1.05 [0.76-1.46]	0.746
Level of education					
	Primary	108 (10.7)	611 (9.8)	1.10 [0.88-1.36]	0.399
	Secondary	509 (50.4)	2910 (46.8)	1.15 [1.01-1.32]	**0.036**
	University	393 (38.9)	2691 (43.3)	0.83 [0.73-0.95]	**0.009**
Country of origin					
	Cameroon	1000 (99.0)	6167 (99.2)	0.73 [0.37-1.45]	0.368
	Other	10 (1.0)	45 (1.0)		
Marital status					
	Single	699 (69.2)	4506 (75.5)	0.85 [0.74-0.98]	**0.029**
	Married	296 (29.3)	1623 (26.1)	1.17 [1.01-1.36]	**0.034**
	Divorced	14 (1.4)	67 (1.1)	1.29 [0.72-2.30]	0.419
	Widow(er)	1 (0.1)	16 (0.2)	0.38 [0.05-2.90]	0.496
Type of donation					
	Volunteer	13 (1.3)	128 (2.1)	0.62 [0.35-1.10]	0.111
	Replacement	997 (98.7)	6084 (97.9)		

TTIs : Transfusion Transmitted Infections

Discussion

The aim of our study was to investigate TTIs in blood donors in HD and the contributing factors, 8000 blood donation candidates were recruited and a total of 7222 donors were included. A high proportion of the blood donors were male, 6479 (89.7%), aged 18-34 years (70.8%) and were mainly replacement donors, 7081 (98.0%). This is consistent with observations made in several other studies in Africa [6, 9-12]. The World Health Organization (WHO) recommends that 80-100% of blood collection operations should be conducted with regular unpaid volunteer donors to ensure a safe and adequate blood supply [3]. The presence of a low proportion of voluntary blood donors in this study indicates that the characteristics of the blood donor at the Laquintinie Hospital in Douala do not yet meet the standards of blood safety recommended by the WHO. These results, similar to those previously observed in Cameroon [9-12] and other African countries [5, 8, 13, 14], reflect a fundamental lack of awareness and education in the general population. Yet, such activities are absolutely necessary to break down the misconceptions and fear associated with blood donation in the community [6]. Special programs should be organized to promote voluntary donation and to provide enough blood to meet the clinical demand. In this regard, with the recent creation of the National Blood Transfusion Center (CNTS) in Cameroon, we can hope that in the near future, voluntary blood donation will take over and become more frequent than

replacement donation. Furthermore, the predominance of blood donations from men under the age of 34 in this study has been reported previously in other studies in Africa [6, 7, 10, 11]. The contraindications associated with the female gender, particularly related to certain physiological conditions of women, such as menstruation, pregnancy and breastfeeding, which temporarily prevent women from donating blood [15], coupled with the general belief that men are healthier than women, and therefore more likely to donate blood [6, 11, 16], would partly explain this result. In addition, the large proportion of young people under 35 years of age in the Cameroonian population, which represents the main age groups meeting the selection criteria for blood donation, justifies the results observed in this study.

In this study, the prevalence of TTIs was 14.0%, with overall HBV, Syphilis, HCV and HIV positivity rates of 4.9%, 3.0%, 2.5% and 2.1% respectively. The results of our study confirm the endemicity of HBV infection in Cameroon, in agreement with previous studies [17]. Hepatitis B virus infection has shown an intermediate to high level of endemicity in low-income countries over the past decades. Africa is overall considered to have high HBV endemicity [18]. However, compared to studies published in Cameroon over the last decade, lower seropositivity rates were noted in this study, much more marked for HBV [10, 11]. These results confirm the downward trend in HBV serological markers already described by Samje et al [9] in Bamenda, Cameroon in 2021. This downward trend of the different serological markers is not a Cameroonian specialty, as the same phenomenon can be observed in other African countries as well [6, 14]. Indeed, a meta-analysis involving 17 African countries that reported seroprevalence data for TTIs between October 2009 and June 2016 showed that the rates of all TTIs have decreased significantly over the years. According to the results of this study, West African countries had the highest seroprevalence of TTIs compared to other countries, especially for HBV (10.0-15.0%) and HCV (1.5-8.7%), but HIV prevalence showed a decreasing trend over the years [19, 20]. Our results, as well as those obtained in other settings, thus reflect the effectiveness of interventions implemented to prevent the transmission of these infections in the general population.

The prevalence of TTIs was significantly higher in male donors (14.5%) than in female donors (9.8%). The predominance of TTIs in male donors has already been described in several studies in Cameroon [11] as well as in other African countries such as Ethiopia [6,14], Tanzania [7] and Nigeria [5]. This could be due to the increase in risk behaviors such as multiple sexual relationships which are frequently observed among men, and also during their gestation period, women are tested for various infections transmissible to the fetus, including TTIs, and are therefore subject to self-exclusion from blood donation. These results may also be due to the low proportion of female donors in our study population, which explains why fewer women are screened than men. Furthermore, the seroprevalence rates of TTIs in relation to the age distribution showed that the prevalence of TTIs increases with age. Donors in the 18-24 year age group showed a low prevalence of TTIs (12.2%) while those in the 45-54 year age group had the highest rates (22.4%). These results are similar to those obtained in other studies carried out in countries with a similar context to ours [7, 8]. Although young adults (< 25 years) are generally characterized by intense sexual activity and increased risk behaviors, they are still beginning their sexual activities and therefore have been less exposed to TTIs compared to their elders, which would explain this low prevalence. In addition, this positive result among young adults could be partly attributed to the success of intensified awareness campaigns on sexually transmitted infections, which would have limited transmission in this age group. The results of this study also showed lower prevalence rates among donors with a university education. This could be explained by a better knowledge of these infections and of the means of prevention among those with a higher level of education.

Our study has some limitations, notably the absence of molecular tests that would have allowed the detection of early stage infections as well as occult infections in the case of hepatitis B. Nevertheless, the realization of two simultaneous tests and the large number of donors included in this study are strong points.

Conclusion

Cameroon, like many other sub-Saharan African countries, continues to face major challenges in blood availability and safety. The high prevalence (14.0%) of blood-borne infections, including HIV, HBV, HCV, and syphilis, demonstrates that these infections remain a major public health concern. In addition to the need for community outreach strategies to increase the proportion of voluntary donors, the results of this study demonstrate the importance of monitoring the magnitude and trends of TTIs in the donor population in order to develop effective intervention strategies.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contribution of the authors

The authors carried out the data collection, statistical analysis, drafting of the manuscript and its critical reading. All authors gave their approval for publication.

REFERENCES

[1] Bloch EM, Vermeulen M, Murphy E. Blood Transfusion Safety in Africa: A Literature Review of Infectious Disease and Organizational Challenges. Transfus Med Rev. avr 2012;26(2):164-80.

[2] Tagny CT, Mbanya D, Tapko JB, Lefrère JJ. Blood safety in Sub-Saharan Africa: a multi-factorial problem. Transfusion (Paris). 2008;48(6):1256-61.

[3] World Health Organization (WHO). Blood safety and availability [Internet]. 2020 [cité 31 janv 2022]. Disponible sur: https://www.who.int/news-room/fact-sheets/detail/blood-safety-and-availability

[4] Ifland L, Bloch EM, Pitman JP. Funding blood safety in the 21st century. Transfusion (Paris). janv 2018;58(1):105-12.

[5] Okoroiwu HU, Okafor IM, Asemota EA, Okpokam DC. Seroprevalence of transfusion-transmissible infections (HBV, HCV, syphilis and HIV) among prospective blood donors in a tertiary health care facility in Calabar, Nigeria; an eleven years evaluation. BMC Public Health. 22 mai 2018;18(1):645.

[6] Ataro Z, Urgessa F, Wasihun T. Prevalence and Trends of Major Transfusion Transmissible Infections among Blood Donors in Dire Dawa Blood bank, Eastern Ethiopia: Retrospective Study. Ethiop J Health Sci. nov 2018;28(6):701-10.

[7] Mremi A, Yahaya JJ, Nyindo M, Mollel E. Transfusion-Transmitted Infections and associated risk factors at the Northern Zone Blood Transfusion Center in Tanzania: A study of blood donors between 2017 and 2019. PLOS ONE. 24 mars 2021;16(3):e0249061.

[8] Stokx J, Gillet P, De Weggheleire A, Casas EC, Maendaenda R, Beulane AJ, et al. Seroprevalence of transfusion-transmissible infections and evaluation of the pre-donation screening performance at the Provincial Hospital of Tete, Mozambique. BMC Infect Dis. 23 mai 2011;11(1):141.

[9] Samje M, Fondoh VN, Nguefack-Tsague G, Kamalieuk LKJ, Mbanya D, Murphy EL, et al. Trends in serological markers of transfusion transmissible infections in blood donations at the Bamenda Hospital-based Blood Service, Cameroon. Transfus Clin Biol. 1 août 2021;28(3):228-33.

[10] Eboumbou Moukoko CE, Ngo Sack F, Essangui Same EG, Mbangue M, Lehman LG. HIV, HBV, HCV and T. palliduminfections among blood donors and Transfusion-related complications among recipients at the Laquintinie hospital in Douala, Cameroon. BMC Hematol. 12 févr 2014;14(1):5.

[11] Ankouane F, Noah Noah D, Atangana MM, Kamgaing Simo R, Guekam PR, Biwolé Sida M. Séroprévalence des virus des hépatites B et C, du VIH-1/2 et de la syphilis chez les donneurs de sang de l'hôpital central de Yaoundé, région du centre, Cameroun. Transfus Clin Biol. 1 mai 2016;23(2):72-7.

[12] Noubiap JJN, Joko WYA, Nansseu JRN, Tene UG, Siaka C. Sero-epidemiology of human immunodeficiency virus, hepatitis B and C viruses, and syphilis infections among first-time blood donors in Edéa, Cameroon. Int J Infect Dis. 1 oct 2013;17(10):e832-7.

[13] Pessoni LL, Aquino ÉC de, Alcântara KC de. Prevalence and trends in transfusion-transmissible infections among blood donors in Brazil from 2010 to 2016. Hematol Transfus Cell Ther. 1 oct 2019;41(4):310-5.

[14] Shiferaw E, Tadilo W, Melkie I, Shiferaw M. Sero-prevalence and trends of transfusion-transmissible infections among blood donors at Bahir Dar district blood bank, northwest Ethiopia: A four year retrospective study. PLOS ONE. 11 avr 2019;14(4):e0214755.

[15] Tagny CT, Owusu-Ofori S, Mbanya D, Deneys V. The blood donor in sub-Saharan Africa: a review. Transfus Med. 2010;20(1):1-10.

[16] Bani M, Giussani B. Gender differences in giving blood: a review of the literature. Blood Transfus Trasfus Sangue. oct 2010;8(4):278-87.

[17] Andoulo FA, Tagni-Sartre M, Noah DN, Djapa R, Ndam ECN. Prevalence of the hepatitis B surface antigen in a population of workers in Cameroon. Open J Gastroenterol. 26 déc 2013;3(8):323-7.

[18] Zampino R, Boemio A, Sagnelli C, Alessio L, Adinolfi LE, Sagnelli E, et al. Hepatitis B virus burden in developing countries. World J Gastroenterol. 14 nov 2015;21(42):11941-53.

[19] Tafesse TB, Gebru AA, Gobalee S, Belay GD, Belew MT, Ataro D, et al. Seroprevalence and diagnosis of HIV, HBV, HCV and syphilis infections among blood donors. Hum Antibodies. 2017;25(1-2):39-55.

[20] Fong IW. Blood Transfusion-Associated Infections in the Twenty-First Century: New Challenges. Curr Trends Concerns Infect Dis. 7 mars 2020;191-215.