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Seroprevalence of Human Immunodeficiency Virus, Hepatitis B Virus, and *Treponema pallidum* among First-Time Blood Donors in Lambaréné, a Semi-Urban Area of Gabon

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Abstract

Introduction: In sub-Saharan Africa, the high prevalence of transfusion-transmissible infections (TTIs) such as human immunodeficiency virus (HIV), hepatitis B virus (HBV) and *Treponema pallidum* remains a major challenge for blood safety. The objective of this study was to determine the seroprevalence of HIV, HBV and *Treponema pallidum* among first-time blood donors in Lambaréné, a semi-urban area in central western Gabon. Methods: Screening for HIV, HBV and *Treponema pallidum* was performed using rapid diagnostic tests (RDTs). Results: Of the 1530 predominantly male donors, 150 (9.8%) were seropositive for at least one infectious marker and 5 (0.33%) had serological suspicion of multiple infections. The overall seropositive of HIV, HBsAg and syphilis was 2.68%, 5.16% and 1.63%, respectively. The seropositivity of HIV and syphilis was not associated with either sex or donors' age. Only HBsAg was significantly higher in donors of the age groups 20 - 29 years and ≥50 years compared to donors of the age group 30 - 39 years (7% vs 3.1, AOR = 2.24, P = 0.016; 13% vs 3.1, AOR = 4.5, P = 0.017). Conclusion: Low seropositivity of HIV, HBsAg and syphilis were found among first-time blood donors in Lambaréné compared to those reported in the general population or among blood donors in Libreville. This could be due to the difference of blood-borne epidemiology between Libreville and Lambaréné or the use of RDTs in the qualification of blood donations, which could underestimate the detection of TTIs, particularly in blood donors in the seroconversion phase.

Keywords

Blood Donors, HBsAg, HIV, Syphilis, Lambaréné, Gabon

1. Introduction

The high prevalence of blood-borne pathogens in sub-Saharan Africa (SSA) negatively affects blood transfusion safety in this area [1]. In most Central and West African countries, blood transfusion is characterized by the shortage of labile blood products, the high number of first-time family blood donors, a lack of qualified personnel and inadequate financial resources [2].

In Gabon, transfusion safety is unequal. In large cities such as Libreville, the capital, it is guaranteed by the use of robust and efficient equipment for the diagnosis of transfusion-transmitted infections (TTI), while in rural and semi-urban areas, it relies mainly on the use of rapid diagnostic tests (RDT) [3].

Previous studies carried out in urban areas in Gabon among blood donors have reported a seroprevalence of 7.28% for hepatitis B surface antigen (HBsAg); 3.4% for anti-HIV antibodies and 2.4% for anti-*Treponema pallidum* antibodies [4]-[6]. However, few data are available on the epidemiology of ITTs in rural or semi-urban areas in Gabon [3] [7] [8]. In rural areas, a previous study carried out in Koula-Moutou, south-eastern Gabon, reported the seroprevalence of 3.1%, 5.9% and 3.3% for HIV, HBsAg and syphilis, respectively [3].

To our knowledge, no study has yet been carried out among blood donors in Lambaréné, a semi-urban area in the center-west of Gabon. Lambaréné, situated along the Ogooué River, represents a semi-urban setting with both town-based and rural catchment populations. Its role as a regional referral center, combined with its intermediate level of urbanization, high population mobility, and reliance on fishing and farming, may shape distinct transfusion-transmissible infection dynamics compared to the urban capital Libreville or the predominantly rural Koula-Moutou.

This study aimed to determine the seroprevalence of HIV, HBV and syphilis among blood donors in Lambaréné and to identify among them the populations at high risk of TTIs.

2. Methods

Study site and blood donors

This study was conducted at the blood bank of the «Centre Hospitalier Régional Georges Rawiri de Lambaréné» (CHRGRL), Gabon. This blood bank supervises the collection and distribution of blood bags in the city of Lambaréné and its surroundings.

It retrospectively analyses data from blood donors recruited from 24 March 2018 to 03 October 2019. Blood donors of both sexes, mainly family or replacement donors (FRD) and voluntary non-remunerated donors (VNRD), were subjected to a pre-donation questionnaire. Only prospective donors, aged 16 - 65 with a body mass ≥ 50 kg were eligible to donate blood. Pregnant women, people who had received a blood transfusion, or those with clinical signs of jaundice, viral hepatitis, any infection, or risky sexual behavior in the last six (6) months before donation were excluded. The socio-demographic characteristics of the selected donors were recorded in a database and the venous blood was collected following the standard procedure.

Serological marker detection

Screening for TTIs in blood donors was performed using RDTs. Anti-HIV-1 and 2 antibodies were detected by DETERMINE (Abbott, USA).

HBsAg was detected by Determine™ HBV kit (Alere S.A.S. Jouy En Josas, France) according to the manufacturer's recommendations.

Syphilis screening used a two-step algorithm: a non-treponemal RPR test (BIOLABO, Maizy, France) to detect possible infection, followed by a *Treponema pallidum* haemagglutination test (TPHA, Cypress Diagnostics, Belgium) to confirm true positives, combining the sensitivity of the RPR with the specificity of the TPHA for accurate diagnosis.

All the samples reactive for HIV were re-tested for confirmation using an alternative RDT SD Bioline HIV-1/2 3.0 (Standard Diagnostics, INC, Gyeonggy-do, South Korea).

No confirmatory testing was performed for HBsAg, as the Determine™ HBsAg kit has previously demonstrated 100% sensitivity and specificity compared to ELISA for the detection of hepatitis B surface antigen [9].

A result was considered positive if both the first and second tests were positive.

Ethical considerations

This study obtained the approval of the CHRGRL institutional ethics committee. All participants, as well as the parents or guardians of blood donors under 18 years old, gave their free and informed consent.

Statistical analysis

The seroprevalence of HIV, HBsAg and syphilis was described according to demographic characteristics (sex, age group, occupation and type of donor). Logistic regression was used to assess the impact of socio-demographic factors on the seroprevalence of TTIs in univariate and multivariate analyses. Odds ratios (OR) and 95% confidence intervals are presented. Data analysis was performed using R software version 4.2.1. Results were considered significant for $P < 0.05$.

3. Results

Sociodemographic characteristics of blood donors

A total of 1530 first-time blood donors were recruited. They were mostly male (84.7%), aged between 16 and 65. Among blood donors, the 20 - 29 age group was the most represented and that ≥50 years was in the minority. Blood donors were mostly family or replacement donors (FRD) representing 93.9% of total donors (**Table 1**).

Regarding socio-professional categories, pupils and students represented 21.3% of blood donors, while teachers (2.7%) and health personnel (2.8) were the least represented. The majority of blood donors were single (61.1%) and resided mainly in the second district of Lambaréné (63.9%) while a minority of blood donors came from the lakes (0.5%) (**Table 1**). Blood donors mainly belonged to blood group O (60.3%) and Rhesus positive (96.7%) while blood groups AB and Rh negative were the least represented with 2.2% and 3.5% respectively (**Table 1**).

Seroprevalence of infectious markers in blood donors

Of the 1530 first-time blood donors recruited in this study, 9.80% (150/1530) were positive for at least one infectious marker and 0.33% (5/1530) showed serological evidence of multiple infections. The seroprevalence of 2.68% (95% CI: 1.92 - 3.64) for HIV; 5.16% (95% CI 4.09 - 6.44) for HBsAg and 1.63% (95% CI: 1.06 - 2.41) for syphilis were observed among blood donors (**Table 2**). As regards co-infections, they were respectively 0.07% (95% CI 0.02 - 0.36) for the HIV-syphilis association; 0.13% (95% CI 0.02 - 47) for HBsAg-syphilis and 0.13% (95% CI 0.02 - 47) for HBsAg-HIV (**Table 2**).

Table 1. Sociodemographic characteristics of blood donors from 2018 to 2019.

Characteristics of blood donors	Number	Percentage
Gender		
Female	234	15.3
Male	1296	84.7
Age groups (years)		
<20	94	6.1
20 - 29	718	46.9
30 - 39	448	29.3
40 - 49	239	15.6
≥50	31	2
Blood donors		
VNRD	94	6.1
FRD	1436	93.9
Occupations		
Carriers	105	6.9
Technical activities	224	14.6
Mining, forestry and oil activities	163	10.7
Commercial and hotel activity	84	5.5
Teachers	41	2.7
Pupils and students	326	21.3
Health personal	43	2.8
Defence and security force	83	5.4

Continued

Administrative agent	46	3
Unemployed	334	21.8
Others	81	5.3
Marital status		
Single	935	61.1
Married	75	4.9
Concubinage	520	34
Residence		
First District of Lambarene	283	18.5
Second District of Lambarene	977	63.9
Road to Mouila	125	8.2
Road to Libreville	89	5.8
Road to Ndjole	39	2.5
Lakes	8	0.5
Others	9	0.6
Blood groups		
O	923	60.3
A	303	19.8
AB	34	2.2
B	270	19.6
Rhesus		
Positive	1477	96.5
Negative	53	3.5

Table 2. Seroprevalence of anti-HIV, HBsAg and syphilis in blood donors.

N = 1530			
Infection	Number of positive samples	Percentage	95% CI
HIV	41	2.68	1.92 - 3.64
HBsAg	79	5.16	4.09 - 6.44
Syphilis	25	1.63	1.06 - 2.41
Co-infections	5	0.33	0.11 - 0.76
HIV-Syphilis	1	0.07	0.02 - 0.36
HBsAg-Syphilis	2	0.13	0.02 - 0.47
HBsAg-HIV	2	0.13	0.02 - 0.47

CI = Confidence Interval.

Seroprevalence of HIV, HBsAg and syphilis according to sociodemographic characteristics of blood donors

HIV seroprevalence was assessed according to the sociodemographic characteristics of first-time blood donors (Table 3). HIV seroprevalence was similar in male and female donors (2.6 vs 2.9, AOR = 0.97, P = 0.949) (Table 3).

Table 3. Seroprevalence of HIV according to sociodemographic characteristics of blood donors.

			Univariate			Multivariate		
Variable	N	Positive (%)	COR	95% CI	P-value	AOR	95% CI	P-value
Gender								
Female	234	6 (2.6%)	Referent					
Male	1296	38 (2.9%)	1.15	0.52 - 3.05	0.757	0.97	0.39 - 2.75	0.949
Age groups (years)								
<20	94	2 (2.1%)	Referent					
20 - 29	718	19 (2.6%)	1.25	0.36 - 7.93	0.766	1.47	0.39 - 9.59	0.622
30 - 39	448	17 (3.7%)	1.81	0.51 - 11.6	0.431	2.43	0.55 - 17.4	0.292
40 - 49	239	5 (2.1%)	0.98	0.21 - 6.95	0.984	1.37	0.24 - 11.1	0.737
≥50	31	1 (3.2%)	1.53	0.07 - 16.6	0.731	2.18	0.09 - 27.3	0.556
Blood donors								
VNRD	94	4 (4.3%)	1.55	0.46 - 3.95	0.412	1.78	0.51 - 4.73	0.297
FRD	1436	40 (2.8%)	Referent					
Occupations								
Carriers	105	5 (4.8%)	4	0.63 - 77.5	0.21	3.67	0.51 - 4.73	0.297
Technical activities	224	8 (3.6%)	2.96	0.53 - 55.4	0.309	2.82	0.50 - 53.0	0.334
Mining, forestry and oil activities	163	7 (4.3%)	3.59	0.62 - 67.7	0.236	3.46	0.58 - 65.9	0.255
Commercial and hotel activity	84	0 (0%)	NA	NA	NA	NA	NA	NA
Teachers	41	1 (2.4%)	2	0.08 - 51.5	0.627	2.08	0.08 - 55.2	0.614
Pupils and students	326	11 (3.4%)	2.79	0.53 - 51.4	0.329	3.88	0.67 - 74.3	0.213
Personal health	43	0 (0%)	NA	NA	NA	NA	NA	NA
Defence and security force	83	2 (2.4%)	1.98	0.19 - 43.0	0.581	1.66	0.15 - 36.4	0.684
Administrative agent	46	0 (0%)	NA	NA	NA	NA	NA	NA
Unemployed	334	9 (2.7%)	2.22	0.41 - 41.1	0.454	2.32	0.41 - 43.5	0.433
Others	81	1 (1.2%)	Referent					
Marital status								
Married	75	1 (1.3%)	Referent					

Continued

Single	935	24 (2.6%)	1.95	0.40 - 35.1	0.516	1.28	0.22 - 24.6	0.822
Concubinage	520	19 (3.7%)	2.81	0.57 - 50.8	0.318	1.97	0.35 - 37.3	0.53
Residence								
Second District of Lambaréné	977	28 (2.9%)	1.28	0.38 - 8.03	0.736	1.39	0.40 - 8.81	0.664
First District of Lambaréné	283	9 (3.2%)	1.43	0.36 - 9.49	0.652	1.53	0.37 - 10.4	0.596
Road to Mouila	125	5 (4%)	1.81	0.38 - 12.9	0.483	1.54	0.32 - 11.1	0.617
Road to Libreville	89	2 (2.2%)	Referent					
Road to Ndjole	39	0 (0%)	NA	NA	NA	NA	NA	NA
Lakes	8	0 (0%)	NA	NA	NA	NA	NA	NA
Others	9	0 (0%)	NA	NA	NA	NA	NA	NA
Blood groups								
O	923	27 (2.9%)	1.05	0.57 - 1.97	0.887	1	0.54 - 1.89	0.993
Non-O	607	17 (2.8%)	Referent					
Rhesus								
Positive	1477	43 (2.9%)	1.56	0.33 - 27.9	0.664	1.6	0.33 - 28.9	0.651
Negative	53	1 (1.9%)	Referent					

COR = Crude Odd Ratio; AOR = Adjusted Odd Ratio; CI = Confidence Interval.

Regarding the age of donors, the age group < 20 years (2.1%) and 40 - 49 years (2.1%) were the least affected by HIV. However, no statistically significant difference was obtained in either univariate or multivariate analysis when comparing the age group < 20 years to the other age groups among blood donors (**Table 3**).

Seroprevalence of the three infectious agents tested was lower in FRDs than in VNRDs, being nearly half in FRDs compared to VNRDs for HIV (2.8% vs 4.3%, AOR = 1.78, P = 0.297), 5.4% versus 6.4% for HBsAg and 1.8 versus 2.1 for syphilis. However, none of these differences were statistically significant. No significant difference was observed when comparing HIV seroprevalence according to socio-professional categories even if, among these, carriers were the most infected donors (4.8%) (**Table 3**). Married donors were half as likely to be infected with HIV as single (1.3 vs 2.6, AOR = 1.95) or cohabiting (1.3% vs 3.7%, AOR = 2.81) donors. However, the differences observed were not significant. No statistically significant differences were found when comparing HIV seroprevalence between donor locations and between O and non-O blood groups and between positive and negative rhesus (**Table 3**).

For HBsAg, univariate and multivariate analyses showed no significant difference between male and female donors (5.6% vs. 4.3%, AOR = 1.35, P = 0.42), between VNRDs and FRDs (6.4% vs. 5.4%, AOR = 1.43, P = 0.432) (**Table 4**). HBsAg seroprevalence was higher among teachers (7.3%) and miners and foresters (7.4%) compared to the defence and security forces (1.2%). However, the differences observed were not significant in either uni or multivariate analysis (Table 4). Neither place of residence, marital status, nor ABO and rhesus blood groups were associated with HBsAg seroprevalence (Table 4). HBsAg seroprevalence was associated with the age of the blood donors. It was significantly higher in the age groups 20 - 29 and ≥50 years compared to the age group 30 - 39 years (7% vs 3.1, AOR = 2.24, P = 0.016; 13% vs 3.1, AOR = 4.5, P = 0.017) (Table 4).

The seroprevalence of syphilis in blood donors was similar between men and women but also between VNRD and FRD (Table 5). It was not significantly associated with the age of blood donors, although it was four (4) times higher in donors ≥ 50 years old compared to donors in the 30 - 39 age group (Table 5). Syphilis was not associated with socio-professional categories, marital status, place of residence or ABO and rhesus blood groups of blood donors (Table 5).

Table 4. Seroprevalence of HBsAg according to socioeconomic characteristics of blood donors.

			Univariate			Multivariate		
Variable	N	Positive (%)	COR	95% CI	P-value	AOR	95% CI	P-value
Gender								
Female	234	10 (4.3%)	Referent					
Male	1296	73 (5.6%)	1.34	0.71 - 2.79	0.4	1.35	0.68 - 2.92	0.42
Age groups (years)								
<20	94	5 (5.3%)	1.74	0.55 - 4.68	0.299	1.69	0.49 - 5.16	0.376
20 - 29	718	50 (7%)	2.32	1.30 - 4.41	0.006	2.24	1.19 - 4.45	0.016
30 - 39	448	14 (3.1%)	Referent					
40 - 49	239	10 (4.2%)	1.35	0.58 - 3.07	0.473	1.22	0.51 - 2.82	0.643
≥50	31	4 (13%)	4.59	1.24 - 13.8	0.011	4.5	1.16 - 14.4	0.017
Blood donors								
VNRD	94	6 (6.4%)	1.2	0.46 - 2.62	0.672	1.43	0.53 - 3.27	0.432
FRD	1436	77 (5.4%)	Referent					
Occupations								
Carriers	105	6 (5.7%)	4.97	0.83 - 94.9	0.141	5.12	0.83 - 99.0	0.138
Technical activities	224	10 (4.5%)	3.83	0.72 - 70.9	0.203	3.67	0.67 - 68.4	0.222
Mining forestry and oil activities	163	12 (7.4%)	6.52	1.25 - 120	0.074	6.98	1.30 - 129	0.067
Commercial and hotel activity	84	4 (4.8%)	4.1	0.59 - 81.1	0.211	4.2	0.58 - 84.7	0.21
Teachers	41	3 (7.3%)	6.47	0.80 - 133	0.11	6.57	0.77 - 139	0.115
Pupils and students	326	22 (6.7%)	5.93	1.22 - 107	0.083	5.05	0.94 - 94.2	0.128
Personal health	43	1 (2.3%)	1.95	0.08 - 50.2	0.639	2.06	0.08 - 54.6	0.618

Continued

Defence and security force	83	1 (1.2%)	Referent					
Administrative agent	46	2 (4.3%)	3.73	0.35 - 81.5	0.288	3.75	0.34 - 83.0	0.29
Unemployed	334	17 (5.1%)	4.4	0.88 - 79.8	0.153	4.22	0.81 - 77.9	0.152
Others	81	5 (6.2%)	5.39	0.85 - 105	0.127	4.97	0.75 - 97.8	0.152
Marital status								
Married	75	4 (5.3%)	Referent					
Single	935	50 (5.3%)	1	0.39 - 3.39	0.996	0.81	0.27 - 3.05	0.724
Concubinage	520	29 (5.6%)	1.05	0.40 - 3.61	0.931	1.01	0.34 - 3.78	0.983
Residence								
Second District of Lambaréné	977	53 (5.4%)	1.38	0.59 - 4.01	0.504	1.29	0.54 - 3.84	0.603
First District of Lambaréné	283	13 (4.6%)	1.16	0.43 - 3.67	0.788	1.23	0.44 - 3.99	0.705
Road to Mouila	125	5 (4%)	Referent					
Road to Libreville	89	8 (9%)	2.37	0.76 - 8.08	0.142	2.38	0.75 - 8.24	0.147
Road to Ndjole	39	3 (7.7%)	2	0.40 - 8.56	0.358	1.98	0.38 - 8.83	0.377
Lakes	8	1 (12%)	3.43	0.17 - 25.6	0.289	4.09	0.19 - 34.2	0.243
Others	9	0 (0%)	NA	NA	NA	NA	NA	NA
Blood groups								
Group O	923	46 (5%)	Referent					
Versus group non-O	607	37 (6.1%)	1.24	0.79 - 1.93	0.348	1.18	0.74 - 1.86	0.477
Rhesus								
Positive	1477	82 (5.6%)	3.06	0.66 - 54.4	0.271	3.43	0.68 - 63.6	0.242
Negative	53	1 (1.9%)	Referent					

COR = Crude Odd Ratio; AOR = Adjusted Odd Ratio; CI = Confidence Interval.

Table 5. Seroprevalence of syphilis markers according to sociodemographic characteristics of blood donors.

			Univariate			Multivariate		
Variables	N	Positive (%)	COR	95% CI	P-value	AOR	95% CI	P-value
Gender								
Female	234	4 (1.7%)	Referent					
Male	1296	24 (1.9%)	1.08	0.41 - 3.7	0.881	0.68	0.23 - 2.53	0.525
Age groups (years)								
<20	94	2 (2.1%)	1.37	0.2 - 5.77	0.698	1,26	0.16 - 6.97	0.808
20 - 29	718	12 (1.7%)	1.07	0.43 - 2.9	0.887	1.03	0.37 - 3.02	0.948

Continued

30 - 39	448	7 (1.6%)	Referent					
40 - 49	239	5 (2.1%)	1.35	0.39 - 4.26	0.615	1.55	0.45 - 5.03	0.466
≥50	31	2 (6.5%)	4.34	0.63 - 19.0	0.075	4.88	0.66 - 23.7	0.069
Blood donors								
VNRD	94	2 (2.1%)	1.18	0.19 - 4.03	0.824	0.95	0.15 - 3.49	0.952
FRD	1436	26 (1.8%)	Referent					
Occupations								
Carriers	105	1 (0.95%)	1.06	0.05 - 8.39	0.959	1.32	0.06 - 11.1	0.813
Technical activities	224	7 (3.1%)	3.56	0.98 - 16.7	0.068	4.12	1.07 - 20.2	0.05
Mining, forestry and oil activities	163	4 (2.5%)	2.78	0.61 - 14.2	0.185	3.74	0.77 - 20.2	0.1
Commercial and hotel activity	84	1 (1.2%)	1.33	0.07 - 10.5	0.806	1.44	0.07 - 11.6	0.753
Teachers	41	0 (0%)	0	NA	0.989	0	NA	0.995
Pupils and students	326	6 (1.8%)	2.07	0.54 - 9.87	0.307	1.85	0.44 - 9.50	0.419
Personal health	43	1 (2.3%)	2.63	0.13 - 21.0	0.408	2.83	0.13 - 24.4	0.385
Defence and security force	83	1 (1.2%)	1.35	0.07 - 10.7	0.798	1.62	0.08 - 6.86	0.686
Administrative agent	46	2 (4.3%)	5.02	0.65 - 31.1	0.082	5.91	0.71 - 39.6	0.067
Unemployed	334	Referent						
Others	81	2 (2.5%)	2.79	0.36 - 17.1	0.265	2.93	0.37 - 18.7	0.256
Marital status								
Single	935	22 (2.4%)	2.06	0.88 - 5.64	0.118	2.42	0.98 - 6.86	0.069
Married	75	0 (0%)	0	NA	0.985	0	NA	0.993
Concubinage	520	6 (1.2%)	Referent					
Residence								
Second District of Lambaréné	977	19 (1.9%)	1.22	0.35 - 7.71	0.791	1.23	0.33 - 8.10	0.789
First District of Lambaréné	283	7 (2.5%)	1.56	0.37 - 10.6	0.583	1.67	0.37 - 11.8	0.54
Road to Mouila	125	2 (1.6%)	Referent					
Road to Libreville	89	0 (0%)	0	NA	0.989	0	NA	0.993
Road to Ndjole	39	0 (0%)	0	NA	0.993	0	NA	0.995
Lakes	8	0 (0%)	0	NA	0.997	0	NA	0.998
Others	9	0 (0%)	0	NA	0.997	0	NA	0.998
Blood groups								
O	923	18 (2%)	1.19	0.55 - 2.69	0.666	1.1	0.50 - 2.52	0.821

Continued

Non-O	607	10 (1.6%)	Referent					
Rhesus								
Positive	1477	27 (1.8%)	Referent					
Negative	53	1 (1.9%)	1.03	0.06 - 5.00	0.975	1.11	0.06 - 5.62	0.918

COR = Crude Odd Ratio; AOR = Adjusted Odd Ratio; CI = Confidence Interval.

4. Discussion

The aim of this study was to determine the seroprevalence of infectious markers in 1530 first-time blood donors from Lambaréné, a semi-urban area of Gabon. We found that blood donors were mostly men (84.7%).

This result is similar to those reported in Gabon and other African countries [3] [10] [11] and can be explained on the one hand by sociocultural factors considering men as better candidates for blood donation than women; and on the other hand, by gynaecological, obstetrical and physiological factors such as menstrual cycles, pregnancy and breastfeeding which do not favor blood donation in women [3] [10] [12].

The most represented age group among blood donors was 20 - 39 years old with 76.2%. This high proportion of young people among blood donors in most African countries can be explained by the demographic structure of the African population, which is predominantly young [13].

In this study, the majority of first-time blood donors were FRDs, with 93.9%. These results are in agreement with previous studies that have shown a predominance of family donors in sub-Saharan Africa with a frequency of 75 - 100% [2] [3].

Indeed, FRDs, recruited mainly among close family members, are a low-cost and easily accessible source of blood collection. Whereas the recruitment of VNRD requires implementating of an awareness and recruitment program, which is often costly and difficult to maintain in blood transfusion centers due to significant logistical requirements and limited human and financial resources [14] [15].

We found that 9.8% of blood donors were seropositive for at least one of the serological markers tested. Similar prevalence in TTIs of 9.4% and 10.16% have been reported in Kenya, and the Democratic Republic of Congo, respectively [11] [16]. Higher seroprevalences in TTIs of 14.96%, 15.9% and 18.5% were reported in Nigeria, Sudan and Gabon, respectively [3] [17] [18]. However, lower TTI seroprevalences of 3.6%, 3.9% and 6% were reported in Eritrea, DRC and Ethiopia, respectively [19]-[21]. These results support the hypothesis that there are geographical variations in the epidemiology of TTIs in sub-Saharan Africa [3].

In this study, HIV seroprevalence was 2.68% among first-time blood donors.

It was similar to the seroprevalence of 3.1%, 2.6% and 2.21% reported respectively in Gabon, Ethiopia and Burkina Faso [3] [22] [23]. Higher HIV seroprevalences of 11.8% and 4.2% were observed in blood donors from Mauritania and Nigeria [10] [17]. The observed difference could be explained by the use of RDTs in detecting infectious markers in blood donors in the present study. Indeed, previous studies have highlighted the low sensitivity and specificity of RDTs compared to third and fourth-generation enzyme-linked immunosorbent assays in the diagnosis of HIV in blood donors in sub-Saharan Africa [24] [25].

No statistically significant differences were observed between HIV seroprevalence and socio-demographic characteristics of first-time blood donors such as gender, age, type of donation, socio-professional categories, marital status, and place of residence (**Table 3**). Our results are similar to those reported in Koula-Moutou [3], but contrast with those of Koudougou, a semi-urban area of Burkina Faso, which had shown a higher HIV seroprevalence among blood donors > 40 years old [23].

HBsAg seroprevalence among first-time donors was 5.16%. This is similar to the 5.6% seroprevalence reported in Koula-Moutou and in koudougou but higher than the 3.8% seroprevalence observed in Cameroon [3] [12] [26]. Another study conducted at the national blood transfusion center in Libreville, Gabon, reported a HBsAg seroprevalence of 7.28% [4]. Even higher HBsAg seroprevalences of 10.01%, 14.96%, 18.6% and 22.3% were found in Equatorial Guinea, Ethiopia, Burkina Faso, and Nigeria, respectively [23] [27]-[29]. HBsAg seroprevalence was not significantly associated with the gender of blood donors (**Table 4**). This result differs from those reported in many previous studies that showed higher HBsAg seroprevalence in men compared to women [4] [30] [31].

Similarly, HBsAg seroprevalence was not associated with type of donation, socio-professional category, place of residence, marital status, and ABO and rhesus blood groups (**Table 4**). However, it was significantly associated with the age of first-time donors. HBsAg seroprevalence was significantly higher in donors in the age groups 20 - 29 years (7%) and ≥50 years (13%) compared to donors in the age group 30 - 39 years (**Table 4**). The increase in HBsAg seroprevalence with age corroborates findings reported from Morocco and Gabon [4] [32]. This increase in HBsAg seroprevalence with age could be partly explained by sexual transmission of HBV due to exposure to the virus after loss of immunity or by the chronic carriage of hepatitis B by infected blood donors before the introduction of the HBV vaccine in Gabon in 2004 [4].

The findings of this study may have been affected by the reliance on rapid RDTs for HBsAg detection. Although assays such as the Determine™ HBsAg 2 kit have demonstrated excellent sensitivity and specificity under controlled laboratory conditions, their performance in field settings may be compromised. Low antigen concentrations, genetic variations within the HBsAg determinant, and interference from nonspecific substances have all been reported as potential sources of false-negative results [33].

For syphilis, this study reports a seroprevalence of 1.63%. This seroprevalence of syphilis among first-time blood donors is similar to the 1.5% seroprevalence reported among blood donors in Burkina Faso [34]. However, it is lower than the seroprevalences of 3.96% and 3.3% reported in Koudougou, Burkina Faso and Koula-Moutou, Gabon, respectively [3] [23]. Other studies have reported even higher syphilis seroprevalences of 21.51% in Equatorial Guinea, 8.1% in Cameroon, and 12.7% in Tanzania [12] [26] [35]. Variations in syphilis seroprevalence can be explained by differences in the sensitivity and specificity of the diagnostic test kits used, as well as by sexual behaviour, limited access to health care, marital practices, sample size and blood donor selection criteria during recruitment [3] [36]. Syphilis seroprevalence was not significantly associated with socio-demographics factors of first-time blood donors (**Table 5**).

However, a 4-fold higher seroprevalence was observed in blood donors ≥ 50 years of age. These results are in agreement with those reported in Koula-Moutou which showed a higher seroprevalence in donors over 45 years of age but, differ from those obtained in Nigeria where syphilis seroprevalence was higher in blood donors in the 18 - 24 age group [3] [28]. The persistence of antibodies in the absence of infection (immunological scarring) in older blood donors at higher risk of infection than younger donors, may partly explain the observed difference [3].

Syphilis RDTs present important limitations. The Rapid Plasma Reagin (RPR) test, a widely used non-treponemal assay, detects antibodies generated in response to cellular damage induced by *Treponema pallidum*. However, its sensitivity varies with the stage of infection and can be affected by cross-reactivity with other treponemal diseases. In one study conducted in rural Africa, RPR demonstrated a sensitivity of 77.5% and a specificity of 94.1% [37]. Moreover, field performance may be further reduced by factors such as inadequate storage conditions, improper handling, and variability in test interpretation, all of which contribute to reduced diagnostic accuracy [25].

The co-infection prevalences observed in our study (HIV-syphilis 0.07%; HBsAg-syphilis 0.13%; HBsAg-HIV 0.13%) are generally lower than those reported in several other sub-Saharan African blood-donor studies. For instance, in Koudougou, Burkina Faso, HBV-syphilis and HBV-HIV co-infections were 0.66% and 0.38%, respectively, while HIV-syphilis was 0.04% [23]. Regional syntheses and country-level surveys likewise report higher pooled prevalences for HBV and mixed infections. Differences between our findings and those from other settings may reflect variation in community prevalence, donor selection criteria, the sensitivity of screening algorithms (RDTs vs. ELISA/molecular assays), temporal trends in infection control, and local hemovigilance practices. These factors should be considered when interpreting the low co-infection rates observed here [38].

Strengthening transfusion safety against syphilis, HIV, and hepatitis B virus (HBV) in semi-urban areas of Gabon will require the adoption of more sensitive diagnostic approaches tailored to local conditions. Recently, the World Health Organization prequalified combined RDTs capable of simultaneously detecting these three infections [38] [39]. While this represents a significant advance, their diagnostic sensitivity remains limited, particularly in the presence of co-infections or low viral loads. In this context, molecular point-of-care technologies such as loop-mediated isothermal amplification (LAMP) represent a promising alternative. LAMP offers rapid detection, tolerance to common DNA inhibitors, and operational simplicity without the need for sophisticated laboratory infrastructure. Its integration into transfusion screening protocols could enhance blood safety, reduce the risk of nosocomial transmission, and contribute to broader public health benefits by limiting the circulation of these infections within the community.

5. Conclusion

This study presents for the first time the seroprevalence of infectious markers in first-time blood donors in Lambaréné (semi-rural area of Gabon). It shows a seroprevalence of 5.16% for HBsAg. This seroprevalence was significantly associated with the age of the donors and not with sex, which reinforces the thesis of improving transfusion safety in rural areas through more efficient diagnostic tests.

Authors' Contributions

Conceptualization: CB, SP and IT; Methodology: SP; Data analysis: SM and CB; Writing—original draft preparation: SP; Writing—review and editing: CB and IT; Supervision: CB.

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Conflicts of Interest

The authors declare no competing interest.

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