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Prevalence and Trends of Transfusion-Transmissible Infections, Microfilariae, and Anemia among First-Time Blood Donors in Lambaréné, Gabon: A Four-Year Retrospective Study (2018-2021)

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Abstract

Aim: To determine the prevalence and temporal trends of hepatitis B and C viruses, human immunodeficiency virus (HIV), syphilis, microfilariae, and associated anemia among blood donors in Lambaréné between 2018 and 2021. **Methods:** A retrospective study was carried out among first-time blood donors in Lambaréné. Screening for HBsAg, anti-HIV, and anti-*Treponema pallidum* antibodies was performed by rapid diagnostic tests, and microfilariae diagnosis was performed microscopically following leuko-concentration. **Results:** A total of 4581 blood donors were recruited, with a mean age of 32.0 years (SD = 9.06). Males predominated (89%), and the age group 17 - 29 years (45.7%) was the most represented. Anemia was observed in 35.6% of donors, while the overall prevalence of microfilariae was 4.5%. The prevalence of TTIs was 4.3% for HBsAg, 2.5% for anti-HCV, 0.2% for HIV, and 2.7% for syphilis. Both microfilaremia and anemia were associated with the younger age group (17 - 29 years) respectively (OR 2.23, $p < 0.01$) and anemia (OR 1.83, $p < 0.01$). **Conclusions:** First-time blood donors in Lambaréné are predominantly young males, with a high burden of anemia and detectable microfilariae. Although microfilarial prevalence has declined, its association with anemia and

concurrent TTIs raises concerns for transfusion safety. Thus, the results of our study highlight the need to revise the diagnostic algorithm currently used in Gabon for blood donation screening and suggest that it should include the detection of parasitic infections. Integrated screening for blood-borne infections and parasitic infections should be a priority in blood donation qualification processes in endemic regions.

Keywords

Blood, Transfusion, Infections, Microfilariae, Anemia, Lambaréné

1. Introduction

Blood transfusion is a vital component of modern healthcare systems, providing life-saving support in trauma, surgery, obstetric emergencies, and the management of severe anemia and hematological disorders. However, in sub-Saharan Africa (SSA), ensuring the safety of transfused blood remains a persistent public health challenge. Despite notable improvements in blood screening infrastructure and donor recruitment practices, transfusion-transmissible infections (TTIs) including hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and syphilis continue to contribute substantially to morbidity and mortality across the region [1] [2]. These infections not only endanger recipients but also reflect broader systemic vulnerabilities in blood safety surveillance, laboratory capacity, and community health education.

In addition to these well-characterized viral and bacterial threats, parasitic infections such as filariasis remain endemic in many areas of Central and West Africa. Filarial parasites, primarily *Wuchereria bancrofti* and *Loa loa*, may circulate as microfilariae in peripheral blood and therefore pose an underrecognized risk for transfusion safety [3]. While transmission of microfilariae through transfusion is considered rare, the presence of these parasites in donor blood highlights ongoing gaps in pre-donation screening, particularly in regions where vector-borne diseases and TTIs co-occur. Yet, data quantifying the prevalence of microfilariae among blood donors remain extremely limited across much of Africa, including Gabon.

First-time blood donors are of particular epidemiological interest, as they often exhibit higher infection rates compared with repeat donors. This difference is attributed to the "healthy donor effect", where regular donors undergo repeated health assessments, while first-time donors represent a more heterogeneous and less pre-screened population [4] [5]. Surveillance among first-time donors therefore provides a crucial indicator of community-level infection patterns and the effectiveness of pre-donation screening protocols. In Gabon, evidence regarding microfilarial carriage among blood donors is scarce, with only a few recent reports documenting the persistence of filariasis despite ongoing control programs [6]. Anemia remains another major concern in donor health and transfusion safety.

Its prevalence in SSA reflects a complex interplay of nutritional deficiencies, infectious diseases such as malaria, and chronic parasitic infections. Anemia not only leads to donor deferral but may also signal underlying systemic or parasitic disease burdens [7] [8]. The association between anemia and filarial infection is biologically plausible, as chronic microfilaremia can induce inflammation and contribute to iron dysregulation and erythropoietic suppression [9] [10]. However, this interaction remains poorly characterized in the context of blood donor populations.

Understanding the overlap between TTIs, anemia, and parasitic infections among blood donors is crucial for strengthening transfusion safety and informing national blood service policies. In endemic regions such as Gabon, where parasitic and viral infections coexist, comprehensive epidemiological data are essential to guide evidence-based screening strategies. To address this gap, the present study aimed to assess the prevalence and temporal trends of TTIs, microfilariae, and anemia among first-time blood donors in Lambaréné, Gabon, between 2018 and 2021, and to identify demographic and hematological factors associated with microfilaremia.

2. Materials and Methods

2.1. Study Design and Setting

A retrospective descriptive study was conducted between January 2018 and December 2021 in the blood banks of the Centre Hospitalier Régional Georges Rawiri (CHRGRL) and the Albert Schweitzer Hospital (HAS) in Lambaréné, located in the central-western region of Gabon. These two institutions form the primary network for blood collection, processing, and distribution in Lambaréné and its surrounding districts.

All first-time blood donors who presented at the participating blood banks during the study period were eligible for inclusion. Donors were recruited after completing a standardized pre-donation questionnaire and undergoing clinical evaluation by trained staff. Eligibility criteria followed both national blood service and WHO recommendations: donors aged 17 - 60 years, weighing at least 50 kg, and in good general health were considered eligible. Donors were excluded if they were pregnant, had a history of previous blood transfusion, or presented with clinical signs suggestive of jaundice, viral hepatitis, or active infection. Individuals reporting high-risk sexual behavior within six months before donation were also excluded. Sociodemographic data, including age, sex, and blood group, were recorded in a secure, anonymized electronic database. Venous blood samples were collected using sterile blood collection bags under aseptic conditions, following standard national transfusion procedures.

2.2. Hemoglobin Measurement and Anemia Classification

Hemoglobin concentration was measured using a DH36 hematology analyzer (Shenzhen Dymind Biotechnology Co., Ltd, China), a 21-parameter automated

device capable of differentiating three cell populations. For each donor, 4 mL of venous blood were collected into an EDTA K_3 tube. Anemia was defined according to WHO thresholds: hemoglobin < 120 g/L for women and <130 g/L for men. Donors meeting these criteria were classified as anemic and deferred from blood donation.

2.3. Detection of Microfilariae

Screening for diurnal microfilariae (*Loa loa* and *Mansonella spp.*) was performed using microscopy after leuko-concentration. Briefly, erythrocytes were lysed with 2% saponin for two minutes in a conical tube, followed by centrifugation at 2000 rpm for 10 minutes. Twenty microliters of the sediment were examined under a light microscope using a ×10 objective. The presence of microfilariae was confirmed independently by two experienced microscopists. In the event of discordant results, a third examiner performed an adjudication. Morphological confirmation and species identification were based on Giemsa-stained smears, following established parasitological criteria.

2.4. Screening for Transfusion-Transmissible Infections (TTIs)

All blood donors were routinely screened for major TTIs using rapid diagnostic tests (RDTs).

Detection of anti-HIV-1/2 antibodies was performed using the DETERMINE™ HIV-1/2 assay (Abbott, USA). Reactive samples were retested for confirmation using the SD Bioline HIV-1/2 3.0 test (Standard Diagnostics, Gyeonggi-do, South Korea).

HBsAg was detected using the Determine™ HBsAg kit (Alere S.A.S., Jouy-en-Josas, France), which has demonstrated 100% sensitivity and specificity compared with enzyme-linked immunosorbent assay (ELISA) methods.

Qualitative detection of hepatitis C virus (HCV)-specific antibodies was performed using the SD BIOLINE HCV rapid immunochromatographic assay (Abbott Laboratories, USA).Screening followed a two-step algorithm comprising a non-treponemal Rapid Plasma Reagin (RPR) test (BIOLABO, Maizy, France) for initial detection, followed by a confirmatory Treponema pallidum haemagglutination assay (TPHA, Cypress Diagnostics, Belgium) for all RPR-reactive samples.

A result was considered positive when both the initial and confirmatory tests were reactive. All testing procedures adhered to manufacturer guidelines and national transfusion safety protocols.

2.5. Ethical Approval Statement

Ethical approval was obtained from the Institutional Ethics Committee of the Centre Hospitalier Régional Georges Rawiri (CHRGRL) in Lambaréné, Gabon. Written informed consent was obtained from all donors before participation. For participants younger than 18 years, written consent was also provided by parents or legal guardians. All study procedures complied with the principles of the Declaration of Helsinki and relevant national ethical regulations governing biomedical research.

2.6. Statistical Analysis

Data were analyzed to determine the prevalence of microfilaremia, anemia, and TTIs according to donor demographic characteristics, including sex, age group, and hospital site. Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as means with standard deviations (mean ± SD). Associations between microfilaremia, anemia, and sociodemographic factors were assessed using logistic regression models. Both univariate and multivariate analyses were performed, and results are reported as odds ratios (OR) with 95% confidence intervals (95% CI). Statistical significance was defined as $p < 0.05$. All analyses were conducted using R software version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Characteristics of Blood Donors

Table 1. Baseline characteristics of blood donors from 2018 to 2021.

Variable		N (%)
		(N = 4581)
Hospital	HAS	2008 (43.8%)
	CHRGRL	2573 (56.2%)
Age (years)	[17 - 29]	2092 (45.7%)
	[30 - 39]	1496 (32.7%)
	[40 - 49]	780 (17.0%)
	[50 - 60]	213 (4.6%)
	Mean (SD)	32.0 (9.06)
Sex	Female	502 (11.0%)
	Male	4079 (89.0%)
Years	2018	1358 (29.6%)
	2019	1403 (30.6%)
	2020	1023 (22.3%)
	2021	797 (17.4%)
Blood group	O	2972 (64.9%)
	Non-O	1609 (35.1%)
Hemoglobin	Mean (SD)	13.4 (1.56)
	Anemia	1631 (35.6%)
	No-anemia	2950 (64.4%)

HAS: Hôpital Albert Schweitzer; CHRGRL: Centre Hospitalier Régional George Rawiri de Lambaréné.

A total of 4581 first-time blood donors were included in the analysis (Table 1). Of these, 43.8% were recruited from the Albert Schweitzer Hospital (HAS) and 56.2% from the Centre Hospitalier Régional Georges Rawiri (CHRGRL). The mean donor age was 32.0 years (SD 9.06), with the 17 - 29-year age group representing the

largest proportion (45.7%). The majority of donors were male (89.0%). Blood donations showed a progressive decline over the four-year period, decreasing from 29.6% in 2018 to 17.4% in 2021. Blood group O was the most prevalent (64.9%), followed by group A (22.4%), group B (10.5%), and group AB (2.2%). The mean hemoglobin concentration was 13.4 g/dL (SD 1.56), and 35.6% of donors were classified as anemic according to WHO criteria.

3.2. Prevalence and Temporal Trends of Transfusion-Transmissible Infections, Microfilaremia, and Anemia

The overall prevalence of microfilaremia was 4.5% (206/4581), with a significant decline from 5.7% in 2018 to 2.8% in 2021 (p = 0.002) (Table 2). The prevalence of transfusion-transmissible infections (TTIs) was as follows: HBsAg 4.3%, anti-HCV 2.5%, HIV 0.2%, and syphilis 2.7%. Only the seroprevalence of HBsAg varied significantly from 5.3% in 2018 to 2.8% in 2021 (p = 0.006). Anemia was present in 35.6% of donors overall, with a peak prevalence observed in 2020 (48.5%) followed by a decline in 2021 (38.8%). Compared with 2018, the likelihood of anemia was significantly higher in 2019 (OR 1.45), 2020 (OR 2.68), and 2021 (OR 1.80; all p < 0.001). Conversely, the risk of microfilaremia decreased progressively over time, with OR 0.66 (95% CI 0.46 - 0.93; p = 0.02) in 2019 and OR 0.47 (95% CI 0.28 - 0.74; p = 0.002) in 2021, compared with 2018 (Table 3). Co-infections involving microfilaremia and one or more viral markers were observed but uncommon (Figure 1). The most frequent combinations included microfilaremia with HBsAg or anti-HCV positivity.

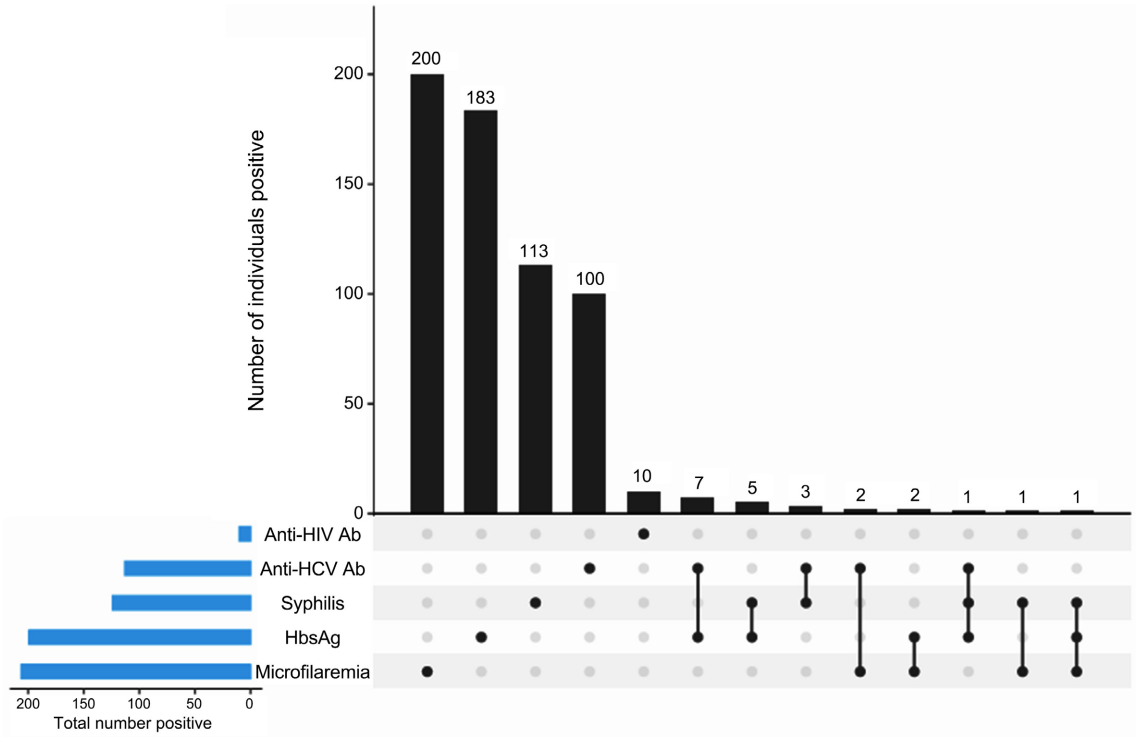

Figure 1. Combination of co-infections among first-time blood donors.

Table 2. Trends in the prevalence of Transfusion-Transmissible infections from 2018 to 2021.

Variable	Overall (N = 4581)	2018 (N = 1358)	2019 (N = 1403)	2020 (N = 1023)	2021 (N = 797)	p-value
Anemia	1631 (35.6%)	353 (26.0%)	473 (33.7%)	496 (48.5%)	309 (38.8%)	<0.0001
Microfilaremia+	206 (4.5%)	78 (5.7%)	54 (3.8%)	52 (5.1%)	22 (2.8%)	0.002
HbsAg+	199 (4.3%)	72 (5.3%)	62 (4.4%)	43 (4.2%)	22 (2.8%)	0.006
Anti-HCV Ab+	113 (2.5%)	35 (2.6%)	23 (1.6%)	42 (4.1%)	13 (1.6%)	0.124
Anti-HIV Ab+	10 (0.2%)	1 (0.1%)	0 (0.0%)	5 (0.5%)	4 (0.5%)	0.227
Syphilis+	124 (2.7%)	39 (2.9%)	24 (1.7%)	34 (3.3%)	27 (3.4%)	0.517

Table 3. Annual variation of microfilaremia and anemia among blood donors from 2018 to 2021.

Year	Microfilariae			Anemia		
Variable	OR	95% CI	p-value	OR	95% CI	p-value
2018		—			—	
2019	0.66	0.46, 0.93	0.02	1.45	1.23, 1.71	<0.001
2020	0.88	0.61, 1.26	0.483	2.68	2.26, 3.19	<0.001
2021	0.47	0.28, 0.74	0.002	1.8	1.50, 2.17	<0.001

3.3. Factors Associated with Microfilaremia

Table 4. Sociodemographic characteristics associated with microfilaremia.

Variable		Positive	Negative	p-value	OR 95% CI	p-ratio
Age (years)	[17 - 29]	56 (27.2%)	2036 (46.5%)	<0.01	2.23 [1.45; 3.39]	<0.01
	[30 - 39]	89 (43.2%)	1407 (32.2%)		0.97 [0.65; 1.42]	0.87
	[40 - 49]	45 (21.8%)	735 (16.8%)		Ref.	Ref.
	[50 - 60]	16 (7.77%)	197 (4.50%)		0.75 [0.41; 1.46]	0.35
Sex	Female	18 (8.74%)	484 (11.1%)	0.35	Ref.	Ref.
	Male	188 (91.3%)	3891 (88.9%)		0.77 [0.44; 1.26]	0.30
Hospital	HAS	24 (11.7%)	1984 (45.3%)	< 0.01	Ref.	Ref.
	CHRGRL	182 (88.3%)	2391 (54.7%)		0.16 [0.10; 0.25]	0.00
Blood group	O	129 (62.6%)	2843 (65.0%)	0.54	Ref.	Ref.
	Non-O	77 (37.4%)	1532 (35.0%)		0.90 [0.67; 1.22]	0.49
Hemoglobin	Anemia	102 (49.5%)	1529 (34.9%)	<0.01	1.83 [1.37; 2.44]	<0.01
	No-anemia	104 (50.5%)	2846 (65.1%)		Ref	Ref.

Independent factors associated with microfilaremia are summarized in Table 4. Younger donors aged 17 - 29 years were significantly more likely to be infected compared with those aged 40 - 49 years (OR 2.23; 95% CI 1.45 - 3.39; $p < 0.01$).

No significant associations were observed with sex (p = 0.30) or ABO blood group (p = 0.49). Donor location was a strong predictor of microfilaremia: donors from CHRGRL accounted for 88.3% of microfilarial infections, compared with 11.7% from HAS (OR 0.16; 95% CI 0.10 - 0.25; p < 0.001). Furthermore, microfilaremia was significantly more prevalent among anemic donors (49.5%) than among non-anemic donors (34.9%) (OR 1.83; 95% CI 1.37 - 2.44; p < 0.01).

4. Discussion

This study provides a comprehensive assessment of transfusion-transmissible infections (TTIs), anaemia and microfilariae carriage among new blood donors in Gabon. The results revealed a strong male predominance (89%) and a high proportion of young donors aged 17 to 29 years (45.7%), which is consistent with previously reported demographics in Gabon and throughout sub-Saharan Africa [6] [11] [12] [13]. This trend likely reflects sociocultural norms and the higher frequency of exclusions among women due to iron deficiency anaemia [14]-[16]. Targeted strategies to promote donor retention and improve iron supplementation could help rebalance the donor demographic. The predominance of blood group O (64.9%) is consistent with previous studies conducted in Gabon and Central and West Africa, where the frequency of group O exceeds global averages [17]-[19]. Although blood group distribution does not directly influence transfusion safety, understanding it is essential for managing blood stocks and planning compatibility in resource-limited settings.

The prevalence rates of STIs observed in this study (HBsAg 4.3%, anti-HCV 2.5%, HIV 0.2% and syphilis 2.7%) are consistent with previous findings in Gabon and comparable African settings [2] [20] [21]. These results confirm that STIs remain a persistent barrier to transfusion safety in the region, despite improvements in donor screening and testing algorithms. Strengthening confirmatory testing capacities and integrating molecular tests for HBV and HCV could further improve detection accuracy.

The prevalence of microfilaremia (4.5%) observed in new donors is remarkable and highlights the need to recognise parasitic infections as an underestimated element of transfusion safety. Although a significant decline was observed between 2018 and 2021, this trend may reflect the cumulative effect of community control efforts, including mass administration of ivermectin and vector management initiatives, as reported in other endemic regions of Africa [22]. Marked heterogeneity was observed between donation sites, with a significantly higher prevalence of microfilaremia among CHRGRL donors compared to HAS donors (OR 0.16; p < 0.001). This disparity may reflect ecological and occupational differences between donor recruitment areas. Donors from the CHRGRL region, who often reside in forested environments, are more exposed to filarial vectors, while the HAS population, dominated by fishing and sand extraction communities, is located in lake areas less conducive to vector proliferation [23]. Variations in diagnostic practices or differences in donor recruitment strategies could also contribute to this dispar-

ity [24].

The fluctuations observed in the prevalence of anaemia, particularly the peak reached in 2020 (48.5%), likely reflect the indirect impact of the COVID-19 pandemic on health systems and population well-being. Disruptions to health services, reduced access to malaria prevention, and food insecurity during this period have been documented throughout sub-Saharan Africa and may have contributed to the increase in anaemia prevalence [25]-[28].

It is important to note that this study demonstrated a significant association between anaemia and microfilaremia (OR = 1.83; $p < 0.01$), corroborating previous findings reported in Gabon. Microfilariae have been described as potentially contributing to the development of anaemia by competing with host cells for nutrients essential to their growth and survival [6]. Several biological mechanisms could explain this relationship. Chronic filarial infection can lead to systemic inflammation and increased hepcidin expression, resulting in inflammatory anaemia [7] [8]. In addition, splenic hypertrophy and hypersplenism associated with chronic helminthiasis may promote the sequestration and destruction of red blood cells [29]. Co-endemicity with malaria or intestinal helminths may further exacerbate the burden of anaemia [30]. Conversely, a study conducted in Congo found a strong association between Loa loa microfilarial density and anatomical hyposplenism, suggesting that regional and host-related factors may influence the haematological response to infection [31].

The results suggest that the current national blood donor eligibility algorithm based on systematic screening for HIV, hepatitis B and C viruses, and syphilis should be strengthened to include routine screening for *Plasmodium* species and microfilariae.

Several studies have identified these parasitic infections as risk factors for, or conditions associated with, anemia. However, the detection of anemia during donor screening constitutes grounds for rejection or temporary deferral of blood donation. The high prevalence of anemia among blood donors in Gabon highlights the challenges in maintaining an adequate and sustainable supply of high-quality blood products. Furthermore, these parasitic infections are recognized as transfusion-transmissible and have been implicated in the occurrence of per- and post-transfusion reactions [6] [7] [9].

Integrating systematic screening for parasitic infections into the current blood donor eligibility algorithm could help reduce the risk of such reactions. It would also facilitate the accurate identification of parasite-related anemia and support the implementation of appropriate, evidence-based corrective measures. Ultimately, this approach could expand the pool of eligible donors while minimizing the risk of transfusion-transmitted parasitic infections.

From a transfusion safety perspective, the coexistence of microfilariae and significant transfusion infections such as HBV, HCV, HIV or *Treponema pallidum* presents a potential risk, particularly for immunocompromised recipients. Although transfusion-transmitted filariasis is rare, documented cases confirm its

plausibility [3] [32]. Furthermore, helminth-induced immune modulation via Th2 polarisation and regulatory T cell activation could potentially alter recipients' immune responses to co-transmitted pathogens [33] [34]. This interaction warrants further immunohematological research in endemic regions.

This study has several limitations. Its retrospective and descriptive design does not allow us to establish a causal link between microfilaremia, anemia and other variables. The lack of detailed clinical and nutritional data (e.g. folate, vitamin B12, malaria, intestinal helminths) limits our understanding of the determinants of anemia in this population. Furthermore, reliance on rapid diagnostic tests (RDTs) for the screening of blood-borne infections may introduce bias by potentially underestimating their true prevalence. Compared with laboratory-based assays such as ELISA and PCR, RDTs generally have lower sensitivity, particularly during the early or latent (window) period of infection, when detectable levels of antigens or antibodies may not yet be present. The results cannot be extrapolated to the general population, as blood donors represent a selected subgroup. Finally, the COVID-19 pandemic may have influenced donor availability, demographic profile, and health status, complicating the interpretation of fluctuations in anemia.

5. Conclusion

In summary, this study highlights a noteworthy prevalence of microfilaremia (4.5%) among first-time blood donors in Gabon and demonstrates its significant association with anemia. While the prevalence of microfilaremia showed a steady decline between 2018 and 2021, anemia rates fluctuated, peaking during the COVID-19 pandemic. The predominance of young male donor's mirrors trends observed throughout sub-Saharan Africa. These findings emphasize the need to integrate parasitic disease surveillance particularly filariasis into transfusion safety frameworks in endemic regions. Monitoring donor hemoglobin levels and strengthening pre-donation screening for both TTIs and parasitic infections are essential to safeguard both donor health and recipient safety. Continued investment in diagnostic standardization, community-level vector control, and donor education will be key to achieving sustainable improvements in blood transfusion safety in Gabon and across the region.

Author Contributions

CB and SP conceived and designed the study; SP and RB acquired the data; SM analyzed and interpreted the data; SP and CB drafted the manuscript; BMN, CB and DI critically reviewed the manuscript for important intellectual content; all authors gave approval of the version to be submitted; all authors agree to be accountable for all aspects of the work.

Consent for Publication

All authors concur with the submission presented by the corresponding author.

Conflicts of Interest

The authors declare that they have no competing interests.

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