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Research Article

Seroprevalence of Transfusion-transmissible Infections Among Blood Donors at the THIES Regional Hospital Blood Bank, Senegal (January–June 2024)

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Abstract

Background: Blood transfusion is an essential life-saving therapy but remains associated with a risk of transmitting infectious agents. In sub-Saharan Africa, transfusion-transmissible infections (TTI) such as HIV, hepatitis B virus (HBV), hepatitis C virus (HCV), and syphilis continue to pose a major challenge to blood safety. This study aimed to determine the seroprevalence of TTI among blood donors at the THIES Regional Hospital Blood Bank, Senegal. *Methods:* A cross-sectional study was conducted from January to June 2024 among 2,599 blood donors aged 18–65 years. Serological screening for HIV, HBV (HBsAg), HCV, and syphilis was performed using validated rapid immunochromatographic tests. Sociodemographic and clinical data were collected and analyzed using R software. *Results:* The overall prevalence of TTI was 7.9%. HBV was the most prevalent infection (7.1%), followed by syphilis (0.4%), HIV (0.2%), and HCV (0.2%). One case of HIV/syphilis co-infection was identified. Male sex and replacement or family donor status were significantly associated with HBsAg positivity ($p < 0.05$). HIV seropositivity was significantly associated with first-time donor status ($p = 0.005$). *Conclusion:* Despite the low prevalence of HIV and HCV, the high burden of hepatitis B highlights the need for strengthened donor selection, vaccination strategies, and improved screening practices. Continuous surveillance remains essential to ensure transfusion safety in Senegal.

Keywords

Blood Safety, Seroprevalence, Transfusion-transmissible Infections, HIV, Hepatitis B, Senegal

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1. Introduction

Blood transfusion constitutes a rational and life-saving therapeutic intervention, essential in a wide range of clinical situations, including massive blood loss, major surgical procedures, and hematological disorders [1]. According to the World Health Organization (WHO), approximately 118.5 million blood donations are collected worldwide each year; however, the supply remains largely insufficient to meet demand, particularly in low- and middle-income countries [2].

Despite its undeniable benefits, blood transfusion carries a risk of transmitting infectious agents, representing a major public health concern. Transfusion safety relies primarily on systematic screening for transfusion-transmissible infections (TTI), including human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and *Treponema pallidum*, the causative agent of syphilis [3-5].

In sub-Saharan Africa, the risk of transfusion-transmitted infections is heightened by the high prevalence of these pathogens in the general population, the frequent use of replacement or family donor, and technical, financial, and logistical constraints that limit the effectiveness of screening strategies [6, 7]. Rapid immunochromatographic tests, although practical and cost-effective, generally exhibit lower sensitivity and specificity compared with enzyme-linked immunosorbent assays (ELISA) and molecular techniques such as polymerase chain reaction (PCR) [7].

In Senegal, blood transfusion safety represents a national public health priority. The prevalence of HBV infection is estimated to range between 7.35% and 14.2%, while the national prevalence of HIV is approximately 0.29%, with a lower prevalence of about 0.1% reported in the THIES region [8-10]. Most transfusion-related viral transmissions are associated with the diagnostic "window period," defined as the interval between infection onset and pathogen detectability using available screening tests [11, 12]. This period includes an initial eclipse phase, during which the pathogen remains undetectable even by highly sensitive methods, followed by a phase of pathogen expansion characterized by a high risk of transmission. The residual risk, defined as the probability of transfusing an infected but undetected blood unit, therefore represents a key indicator of blood transfusion safety system performance.

Although transfusion safety is a national priority in Senegal, recent regional data on TTI prevalence remain limited. Most available studies focus on Dakar or other major cities, leaving a knowledge gap for regions such as THIES, where reliance on replacement or family donor remains high. The present study provides updated and localized data on the prevalence of major TTI (HBV, HCV, HIV, syphilis) among blood donors, which are essential for evaluating the effectiveness of screening strategies and guiding regional transfusion safety policies.

2. Materials and Methods

2.1. Study Design and Setting

An observational, cross-sectional, descriptive epidemiological study was conducted at the Blood Bank of the THIES Regional Hospital Center, Senegal, over a six-month period from January to June 2024.

2.2. Populations and Eligibility Criteria

The study population consisted of voluntary non-remunerated and replacement blood donors aged 18 to 65 years who were deemed eligible for blood donation following a pre-donation medical interview and who provided free and informed consent.

Donors were excluded if they presented a medical contraindication identified during clinical screening or if their blood samples were insufficient, hemolyzed, or unsuitable for serological analyses. All eligible blood donors presenting during the study period (January–June 2024) were consecutively included in the study.

2.3. Data Collection

Data were collected using a standardized data collection form completed for each donor. The following information was recorded:

1) sociodemographic characteristics (age and sex);
2) donation status (first-time, regular and replacement or family donor (RFD);
3) blood group;
4) results of serological screening tests for HIV, HBV, HCV, and syphilis.

2.4. Sample Collection and Processing

Blood samples were collected by trained personnel in accordance with national blood transfusion guidelines. For each donor, one unit of 450 mL of venous whole blood and one 4 mL EDTA (Ethylendiaminetetraacetic Acid) tube were collected. Samples were centrifuged at 3,500 revolutions per minute (rpm) for 5 minutes to separate plasma, which was subsequently used for serological analyses.

2.5. Serological Screening of TTI

Serological screening for transfusion-transmissible infections (TTI) was performed in accordance with national recommendations using locally validated rapid immunochromatographic tests, with systematic internal quality control.

Human immunodeficiency virus (HIV): Screening for HIV-1/2 infection, including p24 antigen and antibodies, was initially performed using the Determine™ HIV Early Detect combined assay (reported sensitivity 100% and specificity

99.72%, according to the manufacturer). Reactive samples were confirmed using Multisure™ HIV-1/2 (reported sensitivity 100%, 95% confidence interval [CI]: 99.54–100%; specificity 99.12%, 95% CI: 98.62–99.48%) and SD Bioline HIV-1/2 (reported sensitivity 100% and specificity 99.8%). A test result was considered positive when both test and control bands were visible and negative when only the control band appeared.

Hepatitis B virus (HBV): Screening for hepatitis B surface antigen (HBsAg) was performed using the Wondfo® HBsAg rapid test (reported sensitivity 96.2% and specificity 99.3%). A result was considered positive when both test and control bands were present. In case of an indeterminate HBsAg result, the donor sample was systematically retested using two additional rapid diagnostic tests (RDTs). When uncertainty persisted, the sample was referred to the National Reference Laboratory for molecular confirmation by real-time PCR for HBV DNA detection.

Hepatitis C virus (HCV): Detection of anti-HCV antibodies was carried out using the Wondfo® anti-HCV rapid test (reported sensitivity 99% and specificity 99.8%), with interpretation identical to that used for HBsAg testing.

Syphilis Testing: Initial screening was performed using the non-treponemal Rapid Plasma Reagin (RPR) Card Test (ASI RPR), a qualitative and semi-quantitative flocculation assay with >98% sensitivity and >99% specificity. Reactive samples were confirmed using the Treponema pallidum Hemagglutination Assay (TPHA, BIORAD), following standard diagnostic algorithms.

All laboratory analyses were conducted under controlled environmental conditions, and test results were interpreted within the time limits specified by the manufacturers.

2.6. Statistical Analysis

Data were entered into Microsoft Excel and analyzed using R statistical software. Categorical variables were summarized as frequencies and percentages, while continuous variables were described using means ± standard deviations or medians, as appropriate. Prevalence was calculated using the following formula:

Prevalence (%) = (number of positive cases / total number of donors) × 100.

Bivariate associations between donor characteristics and serological positivity were assessed using the chi-square test or Fisher's exact test, depending on the expected cell counts.

Multivariable associations between transfusion-transmissible infections (HBsAg, HIV, HCV, and syphilis) and donor characteristics were evaluated using binary logistic regression models to estimate adjusted odds ratios (ORs) with their 95% confidence intervals (95% CI). Conventional logistic regression was applied when the number of events was sufficient (≥ 20 cases). For rare outcomes (< 20 cases), penalized logistic regression using Firth's method was employed to reduce small-sample bias and to prevent complete or quasi-complete data separation.

All models were adjusted for donor type and sex, when relevant. A two-sided p-value < 0.05 was considered statistically significant.

2.7. Quality Assurance

An external quality assessment (EQA) program is organized annually by the National Blood Transfusion Center of Dakar. In addition, internal competency and proficiency tests for laboratory staff are routinely conducted under the supervision of the laboratory manager.

2.8. Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Free and informed consent, either verbal or written, was obtained from each donor prior to blood collection. Data confidentiality was ensured through anonymization of data collection forms and exclusive use of the data for scientific purposes.

3. Results

3.1. Sociodemographic and Clinical Characteristics

A total of 2,599 blood donors were enrolled. The study population was predominantly male (76.9%), with a sex ratio of 3.33. The mean age was 30.6 ± 10.0 years, and the mean body weight was 73.5 ± 13.4 kg. The most frequent blood group was O Rh-positive (53.6%), followed by A Rh-positive (19.8%) and B Rh-positive (15.7%). Replacement or family donors (RFD) accounted for 61.8% of the participants, while regular donors and first-time donors represented 22.7% and 15.4%, respectively (Table 1).

Table 1. *Sociodemographic characteristics, blood groups and donor type (N= 2599).*

Variable	Category	n (%) / Mean ± SD
Sex	Female	600 (23.1)
	Male	1999 (76.9)
Age (years)		30.6 ± 10.0

Variable	Category	n (%) / Mean ± SD
Weight (kg)		73.5 ±13.4
Blood group	A negative	39 (1.5)
	A positive	515 (19.8)
	B negative	38 (1.5)
	B positive	409 (15.7)
	AB negative	8 (0.3)
	AB positive	64 (2.5)
	O negative	134 (5.2)
	O positive	1,392 (53.6)
Donor type	replacement or family donor	1,607 (61.83)
	regular donor	591 (22.74)
	first-time donor	401 (15,43)

3.2. Prevalence of TTI

The overall prevalence of TTI was 7.9% (205 infected donors). The observed prevalence of individual TTI was:

1) Hepatitis B (HBsAg): 7.1% (n = 185), including 0.1% indeterminate results
2) Syphilis: 0.4% (n = 10)
3) HIV: 0.2% (n = 5)
4) Hepatitis C (anti-HCV): 0.2% (n = 5)

One case of HIV-syphilis co-infection was identified in a first-time donor (Table 2).

Table 2. *Prevalence of TTI among blood donors (N= 2599).*

Infection	Result	n (%)
Syphilis	Negative	2589 (99.6)
	Positive	10 (0.4)
Hepatitis B (HBsAg)	Negative	2412 (92.8)
	Positive	185 (7.1)
	Indeterminate	2 (0.1)
Hepatitis C (anti-HCV)	Negative	2,593 (99.8)
	Positive	5 (0.2)
HIV	Negative	2,594 (99.8)
	Positive	5 (0.2)

3.3. Factors Associated

Syphilis: No statistically significant association was observed with sex, donor type, or blood group ($p > 0.05$), likely due to the low number of positive cases.

Hepatitis B (HBsAg): Significant associations were observed with sex and donor type:

1) Sex: HBsAg positivity was higher among male donors (86%) compared with the overall male proportion (76.9%; $p = 0.002$).
2) Donor type: replacement or family donors were overrepresented among HBsAg-positive donors (72% vs. 61.8%; $p = 0.011$).
3) Blood group: no significant association was found ($p = 0.30$).

Table 3. *Distribution of donor characteristics according to HBsAg status (N= 2599).*

Variable	Category	HBsAg positive n (%)	HBsAg negative n (%)	HBsAg indeterminate n (%)	Total n (%)	p-value
Sex	Female	25 (14)	575 (24)	0 (0)	600 (23)	0.002*
	Male	160 (86)	1837 (76)	2 (100)	1,999 (77)	

Variable	Category	HBsAg positive n (%)	HBsAg negative n (%)	HBsAg indeterminate n (%)	Total n (%)	p-value
Donor type	replacement or family donor	133 (72)	1472 (61)	2 (100)	1607 (62)	0.011*
	Regular	26 (14)	565 (23)	0 (0)	591 (23)	
	First-time	26 (14)	375 (16)	0 (0)	401 (15)	

*Chi-square test; $p < 0.05$ considered statistically significant

Hepatitis C (anti-HCV): Due to the very low number of positive cases (n = 5), no statistically significant associations were identified.

HIV: Seropositivity was significantly associated with donor type (p = 0.005). All HIV-positive donors were either first-time donors (60%) or regular donors (40%), with no cases among replacement/family donors.

Table 4. Distribution of donor characteristics according to HIV serostatus (N = 2599).

Variable	Category	HIV positive n (%)	HIV negative n (%)	Total n (%)	p-value
Sex	Female	0 (0.0)	600 (23)	600 (23)	0.6
	Male	5 (100)	1,994 (77)	1999 (77)	
Donor type	replacement or family donor	0 (0.0)	1607 (62)	1,607 (62)	0.005*
	Regular	2 (40)	589 (23)	591 (23)	
	First-time	3 (60)	398 (15)	401 (15)	

Overall, this study revealed a substantial burden of hepatitis B among blood donors in Thies, particularly among male and replacement or family donors, while HIV, HCV, and syphilis prevalences remained low. First-time donors were disproportionately affected by HIV infection, emphasizing their role as a higher-risk group. These findings highlight the critical importance of donor profiling, targeted prevention strategies, and continuous epidemiological surveillance to enhance transfusion safety.

3.4. Multivariable Analysis of HBsAg and HIV Seropositivity

In multivariable analysis, HBsAg seropositivity was significantly higher among male donors and replacement/family donors. For HIV infection, replacement donors had a significantly lower odds of seropositivity compared with regular donors, while first-time donors showed higher, but non-significant, odds. Estimates for HIV were imprecise due to the very low number of positive cases, as reflected by wide confidence intervals.

Table 5. Multivariable-adjusted odds ratios for the association between donor characteristics and HBsAg and HIV seropositivity.

Infection	Variable	Category	Adjusted OR	95% CI	p-value	Model
HBsAg (n = 185 positive)	Donor type	Regular donor (Ref.)	—	—	—	Logistic
		Replacement/family donor (CCA)	1.92	1.26 – 3.01	0.003	
		First-time donor (DN)	1.63	0.93 – 2.88	0.087	
	Sex	Female (Ref.)	—	—	—	
		Male	1.95	1.29 – 3.09	0.003	

Infection	Variable	Category	Adjusted OR	95% CI	p-value	Model
HIV (n = 5)	Donor type	Regular donor (Ref.)	—	—	—	Firth
		Replacement/family donor (CCA)	0.07	0.00 – 0.85	0.036	
		First-time donor (DN)	2.15	0.48 – 15.2	0.30	
	Sex	Female (Ref.)	1.00	—	—	
		Male	5.43	0.6 – 718	0.20	

4. Discussion

This study provides updated and region-specific data on transfusion-transmissible infections (TTI) among blood donors at the Thies Regional Hospital Blood Bank, Senegal. Despite progress in transfusion safety, hepatitis B virus (HBV) remains the predominant TTI, while HIV, hepatitis C virus (HCV), and syphilis prevalence are comparatively low. These findings highlight persistent epidemiological disparities across regions and donor categories and underscore the need for targeted interventions.

4.1. Donor Demographic Profile

The donor population was predominantly male (77%), consistent with patterns observed across sub-Saharan Africa [13, 14]. Biological factors (menstruation, pregnancy, breastfeeding) and sociocultural norms may limit female participation in blood donation. The mean donor age was 30.6 years, aligning with previous studies identifying young adults as the most active donors [13]. Replacement or family donors (RFD) represented over 60% of donors, reflecting reliance on this group during urgent clinical needs. However, their intermittent contribution raises concerns regarding blood supply stability. First-time and regular donors accounted for 15.3% and 22.9% of donors, respectively, highlighting the importance of donor retention strategies to ensure a safe and consistent blood supply.

4.2. Prevalence of Transfusion-transmissible Infections

HIV prevalence among donors was 0.2%, slightly below the national average of 0.31% (Spectrum 2022) [15], suggesting continued progress in regional HIV awareness, prevention, and screening efforts. Syphilis prevalence was 0.4%, higher than that reported in regions such as Ziguinchor (0.04%) [14], reflecting local epidemiological heterogeneity.

HBV, assessed via HBsAg positivity, affected 7.1% of donors, a prevalence lower than that reported in Ziguinchor (10.5%) [14] but comparable to Dakar (8.39%) [16]. The higher proportion observed among RFD (8.48%) may reflect increased exposure to risk factors or limited prior screening. Strengthening HBV vaccination programs and integrating systematic HBV screening into blood collection campaigns remain critical priorities. Senegal introduced the hepatitis B vaccine into the Expanded Programme on Immunization (EPI) in 2004 and added a birth dose in 2016 [17]. Despite progress, vaccination coverage disparities persist between urban and rural areas [18], and achieving the WHO-recommended 90% birth-dose coverage remains essential to reducing new HBV infections by 90% [19].

HCV prevalence was low (0.1%), slightly higher than in Ziguinchor (0.08%) [14] but lower than Dakar (0.56%) [16]. Cases were mainly observed among male and first-time donors, highlighting the need for continued vigilance. Historical data from sub-Saharan Africa indicate that improved donor selection and screening strategies have contributed to substantial declines in HBV and HCV prevalence over time [17].

4.3. Influence of Donor Status (Strengthened Interpretation)

First-time donors exhibited higher seropositivity for HIV (0.75%) and syphilis (1.25%) compared with regular donors, underscoring their disproportionate contribution to transfusion-transmission risk. This finding is consistent with evidence from a meta-analysis by Kasraian et al., which reported a markedly higher HIV prevalence among first-time donors (2702 per 100,000 donations) compared with regular donors (1214 per 100,000 donations) [20]. This difference is primarily explained by the fact that regular donors constitute a pre-selected population with previously documented seronegativity, repeated screening, and greater awareness of risk behaviors.

In contrast, first-time donors are more likely to include individuals who have never been tested, some of whom may be in the early stages of infection, including the diagnostic window period. In addition, first-time donors particularly replacement donors may underreport high-risk behaviors due to social pressure or the urgency of donation, and in some cases may use blood donation as a means of accessing HIV testing ("test-seeking donation"). Together, these factors explain the higher HIV prevalence observed among first-time donors and confirm that this group represents the principal source of residual HIV risk in transfusion settings. These

findings emphasize the critical importance of donor retention strategies, reinforcement of pre-donation risk assessment, and the promotion of voluntary non-remunerated repeat donation to enhance transfusion safety.

4.4. Implications for Transfusion Safety

These results reinforce the necessity of systematic TTI screening prior to each donation and the strengthening of donor recruitment and retention strategies. The high proportion of RFD and first-time donors highlights the importance of continuous risk assessment, community sensitization, and targeted prevention programs tailored to local epidemiological contexts.

Regional comparisons indicate persistently high HBV prevalence across West and Central Africa, including Côte d'Ivoire (12.5%) [21], Mali (13.9%) [22], the Democratic Republic of Congo (9.2%) [23], and Mauritania (10.9%) [24]. Syphilis prevalence in Thies exceeds that reported in several regions, while HIV prevalence (0.2%) remains comparable to Dakar (0.18%) [16] but higher than that reported at the Military Hospital in Rabat, Morocco (0.15%) [25], underscoring the importance of sustained epidemiological surveillance.

4.5. Study Limitations

This study has several limitations. The six-month study period does not allow assessment of seasonal variations, and the single-center design limits national generalizability. Rapid diagnostic tests, while operationally suitable, may be less sensitive than ELISA or molecular assays [26]. Indeterminate HBsAg results were not fully characterized, potentially affecting HBV prevalence estimates. Finally, the absence of nucleic acid amplification testing (NAT) limits accurate estimation of residual transfusion risk, particularly during the diagnostic window period.

5. Conclusions

This study estimated the prevalence of serological markers of TTI among blood donors at the Regional Hospital Center of THIES over a six-month period in 2024. HBsAg prevalence (7.1%) highlights the persistent burden of hepatitis B, while HIV (0.19%), HCV (0.19%), and syphilis (0.4%) prevalence remained relatively low but support the need for continued vigilance in systematic screening.

The findings underscore the need to strengthen transfusion safety through improved donor selection, enhanced awareness of infectious risks, and continuous updating of screening strategies. Rigorous biological qualification of donations is essential to ensure the safety of blood products for both patients and healthcare workers.

Despite its monocentric design and limited observation period, this study provides valuable localized epidemiological data. Multicentric and longitudinal studies are recommended to map TTI across Senegal and monitor trends over time.

Finally, the integration of sensitive, accessible, and context-adapted screening technologies, combined with capacity building for healthcare personnel, represents a strategic priority for sustainably improving transfusion safety. These data provide a practical decision-making tool for health authorities and a solid evidence base for guiding public health policies on blood donation and prevention of transfusion-transmissible infections.

Abbreviations

CI	Confidence Interval
CNLS	National Council for the Fight against AIDS (Conseil National de Lutte Contre le Sida)
DN	First-time Donor
EDTA	Ethylenediaminetetraacetic Acid
ELISA	Enzyme-Linked Immunosorbent Assay
EPI	Expanded Programme on Immunization
HBsAg	Hepatitis B Surface Antigen
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HIV	Human Immunodeficiency Virus
NAT	Nucleic Acid Testing
OR	Odds Ratio
PCR	Polymerase Chain Reaction
Ref.	Reference Category
RFD	Replacement or Family Donor
RPR	Rapid Plasma Reagin
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SD	Standard Deviation
TPHA	Treponema Pallidum Hemagglutination Assay
TTI	Transfusion-Transmissible Infections
UIDT	Iba Der THIAM University of THIES
WHO	World Health Organization

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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