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Orapuh Journal

ORIGINAL ARTICLE

Journal of Oral & Public Health

Epidemiological surveillance of blood donors at the University Clinics of Kinshasa, Kinshasa, DR Congo (2019–2022)

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ARTICLE INFO

Received: *19 March 2025*
Accepted: *28 April 2025*
Published: *30 May 2025*

Keywords:
Blood transfusion, blood-borne infections, HIV, HBV, HCV, syphilis, blood safety, Democratic Republic of the Congo

Peer-Review: *Externally peer-reviewed*

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To cite:
Lodi, O. L., Matondo, B. S., Ndona, Y. N., Melki, S., Ibana, J. K., & Lukusa, F. N. (2025). Epidemiological surveillance of blood donors at the University Clinics of Kinshasa, Kinshasa, DR Congo (2019–2022). *Orapuh Journal, 6*(5), e1247
https://dx.doi.org/10.4314/orapj.v6i5.47

ISSN: *2644-3740*

Published by Orapuh, Inc. (info@orapuh.org)

Editor-in-Chief: Prof. V. E. Adamu
Orapuh, Inc., UMTG PMB 405, Serrekunda, The Gambia, editor@orapuh.org.

ABSTRACT

Introduction

Blood safety in the Democratic Republic of the Congo (DRC) remains a major challenge due to the risk of transmission of blood-borne infections such as HIV, HBV, HCV, and *Treponema pallidum*. Despite efforts to improve screening practices, these infections persist among blood donors.

Purpose

To examine the evolution of the transmission of blood-borne infections among blood donors at the University Clinics of Kinshasa between 2019 and 2022.

Methodology

This retrospective study analysed data from 3,528 blood donors at the University Clinics of Kinshasa between 2019 and 2022. Donors were tested for serological markers of HIV, HBV, HCV, and *Treponema pallidum* using immunochromatographic tests and ELISA. Sociodemographic, clinical, and biological data were collected and analysed using SPSS version 26.

Results

A total of 3,920 blood donations were included, with a prevalence of 2.8% for HBV, 1.9% for HCV, 1.3% for HIV, and 0.8% for syphilis. Annual variations in blood-borne infections were observed. HBV prevalence increased from 3.5% in 2019 to 5.0% in 2021. For HCV, the prevalence decreased from 3.0% in 2019 to 1.1% in 2020 ($p < .05$). The prevalence of syphilis increased from 0.4% in 2019 to 1.0% and was statistically significant ($p < .05$). HIV prevalence varied from 1.2% to 1.8% during the study period.

Conclusion

Despite measurable improvements in screening methods and blood donor safety protocols, residual infection risk remains. It is crucial to improve screening procedures and establish continuous epidemiological monitoring. A multisectoral approach involving health authorities and the community is necessary to enhance blood safety in the DRC.

INTRODUCTION

Blood transfusion is an essential therapeutic intervention involving the administration of specific blood components to individuals requiring substitution (Nzengu-Lukusa et al., 2016). However, despite advances in transfusion safety, it remains associated with the risk of transmitting

infectious agents such as HIV, HBV, HCV, and *Treponema pallidum* (Belkacemi & Merad, 2020). This risk is primarily due to the serological window period—an early phase of infection during which biological markers remain undetectable (Pamatika et al., 2022). Additional contributing factors include viral variants, immune-silent donors, and laboratory errors. Although transfusion is not the main route for the spread of these infections (Nzaji & Ilunga, 2013), minimising the risk of transfusion-transmissible infections (TTIs) through rigorous donor selection and systematic screening for infectious markers remains essential (Adjei et al., 2006; Roback, 2002).

The prevalence of infectious markers varies significantly by region. According to the World Health Organization (2010), prevalence rates are low in high-income countries (HIV: 0.003%; HBV: 0.03%; HCV: 0.02%) but markedly higher in sub-Saharan Africa, reaching up to 15.4% for HBV in Niger (Sumbu et al., 2018; Loua & Nze Nkoure, 2010; Mbanya et al., 2010; Metsu et al., 2022; Tayou Tagny et al., 2007). In the Democratic Republic of Congo (DRC), the absence of continuous donor surveillance limits the evaluation of epidemiological trends. A previous study at the University Clinics of Kinshasa (CUK) reported high prevalence rates of HBsAg (4%), HCV (1.3%), and HIV (2.2%) (Sumbu et al., 2018).

Building on this prior research, the present study investigates longitudinal trends in TTIs (HIV, anti-HBc, anti-HCV, and *Treponema pallidum*) over a four-year period (2019–2022), providing insights into seroconversion rates and the detection challenges during the window period. Additionally, it explores age-related patterns to identify groups at higher risk of TTIs. The overarching aim is to assess donor recruitment and selection strategies to improve transfusion safety.

METHODS

Study Type

This is a retrospective, analytical study based on data from the blood bank of the University Clinics of Kinshasa (CUK), a tertiary hospital in the DRC, spanning from January 2019 to December 2022. The study utilised an exhaustive sampling approach, including all registered blood donors during the specified period. Given the retrospective design, explicit informed consent was not required; however, it was considered implied by the donors' participation and the use of anonymised data in compliance with ethical standards.

Inclusion Criteria

Participants included blood donors tested for serological markers of HIV, anti-HBc, anti-HCV, and *Treponema pallidum*, and who consented to the use of their anonymised data for research purposes.

Exclusion Criteria

Donors were excluded if they had incomplete serological results, missing biological data, or donations outside the study period.

Data Collection

Data were extracted from the blood bank registers and included:

- **Sociodemographic data:** Age, sex, and donor status (voluntary, family, or paid).
- **Clinical data:** Date and frequency of donations.
- **Biological data:** Serological test results for HIV, anti-HBc, anti-HCV, and *Treponema pallidum*; and the screening methods employed (rapid diagnostic tests [RDTs], ELISA, chemiluminescence immunoassay [CLIA]).

Following donation of either 450 mL or 250 mL of blood, a 20 mL sample was collected in two tubes—one with EDTA and one without an anticoagulant—for blood grouping and serological testing. Blood grouping was confirmed via the Globular Test and Serum Test to ensure accuracy.

All donations were screened for HBsAg, anti-HIV, and anti-HCV antibodies using a combination of ELISA, CLIA, and RDTs, in alignment with WHO transfusion safety recommendations (World Health Organization, 2010). Specifically, testing was conducted using the Mindray CL-900i analyser (Mindray, Nanshan, Shenzhen, China), which operates based on CLIA. As per the manufacturer, the performance of the Mindray CL-900i includes:

- **HIV detection:** Sensitivity of 100% (95% CI: 90.7–100) and specificity of 100% (95% CI: 97.0–100).
- **HBsAg detection:** Sensitivity of 97% and specificity of 100%.

- **HCV antibody detection:** Sensitivity of 99.8% and specificity of 99.7% (Nasrallah et al., 2024).

Testing for syphilis was performed using the Rapid Plasma Reagin (RPR) test, a charcoal flocculation assay conducted on serum or plasma. The sensitivity of the RPR test is highest during secondary and early stages of syphilis, potentially reaching 100%, though sensitivity may decline in primary or late stages (Park et al., 2020).

Statistical Analysis

Data were analysed using **SPSS version 26**. The following analyses were conducted:

- **Descriptive analysis:**
  - Frequencies and percentages for categorical variables.
  - Means and standard deviations for continuous variables.
- **Temporal analysis:**
  - Year-by-year variation in the prevalence of transfusion-transmissible infections (TTIs) from 2019 to 2022.

Ethical Considerations

The study adhered to ethical guidelines governing confidentiality and data protection.

- Ethical approval was obtained from the Ethics Committee of the University Clinics of Kinshasa.
- All data were anonymised and used solely for research purposes.
- No individual test results were disclosed to donors, in accordance with existing regulatory standards.

RESULTS

A total of 3,920 blood donations from 3,528 donors were included in the study, covering four years (2019 to 2022). **Table 1** shows that the majority of donations came from male donors (79.0% men vs. 21.0% women), and voluntary donors predominated the recruitment (60.9%). The primary screening method used was immunochromatography, accounting for 85.3% of the tests.

Table 2 describes variations in the seroprevalence of infectious markers based on donor age. The prevalence of hepatitis B increased with age, reaching its peak in donors aged 60 and older (4.93%). The seroprevalence of syphilis remained low across all age groups, with a peak in donors aged 60 and older (1.64%). For HIV, prevalence was highest among donors aged 60 and older (3.28%), followed by those aged 40–49 years (1.55%) and 30–39 years (1.38%). **Figure 1** summarises the seroprevalence trends over the four study years for each infection. According to **Table 3**, HBV seroprevalence remained relatively stable, ranging from 2.7% in 2020 to 3.6% in 2021 and 2022. Regarding HCV, a significant decrease was observed in 2020 (1.1%, $p < 0.05$). Syphilis prevalence showed a significant increase in 2021 (2.1%, $p < 0.05$), peaking in 2022 (1.0%, $p < 0.05$ compared to 2019). For HIV, seroprevalence remained relatively stable, fluctuating between 1.2% in 2020 and 1.8% in 2019, with no statistically significant differences between the study years.

Among all donors, only 245 were frequent donors (accounting for 637 blood donations). Across the donations made by these 245 donors, 218 consistently tested negative for hepatitis B, C, syphilis, and HIV. **Figure 2** illustrates the seropositivity status (positive or negative) for the 27 donors in whom seroconversion was detected.

Table 1:
General characteristics of blood donations included in the study

Category	Count	Percentage
Year		
2019	1294	33.0%
2020	824	21.0%
2021	1182	30.2%
2022	620	15.8%
Sex		
Men	3096	79.0%
Women	824	21.0%
Age groups (years)		
18–29	2096	56.1%
30–39	867	23.2%
40–49	452	12.1%
50–59	259	6.9%
≥ 60	61	1.6%
Donor type		
Voluntary	2389	60.9%
Family/replacement	1531	39.1%
Blood group		
A	296	20.4%

Category	Count	Percentage
B	281	19.4%
AB	44	3.0%
O	831	57.2%
Test used		
Immunochromatography	2519	85.3%
ELISA	434	14.7%

Table 2:
Distribution of blood donations according to seroprevalence by marker and age group

	Total donations	HBV		HCV		Syphilis		HIV	
Age group (years)		Positive donations	Seroprevalence (%)	Positive donations	Seroprevalence (%)	Positive donations	Seroprevalence (%)	Positive donations	Seroprevalence (%)
18-29	2096	44	**2.10**	36	**1.72**	17	**0.81**	26	**1.24**
30-39	867	32	**3.69**	22	**2.52**	7	**0.81**	12	**1.38**
40-49	452	22	**4.87**	9	**1.99**	6	**1.33**	7	**1.55**
50-59	259	7	**2.70**	4	**1.54**	1	**0.39**	2	**0.77**
≥ 60	61	3	**4.93**	3	**4.92**	1	**1.64**	2	**3.28**

Figure 1:
Prevalence trends of HBV, HCV, Syphilis, and HIV among blood donors (2019-2022)

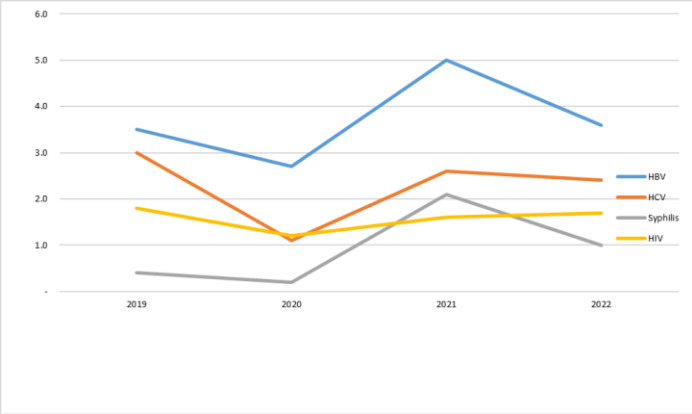
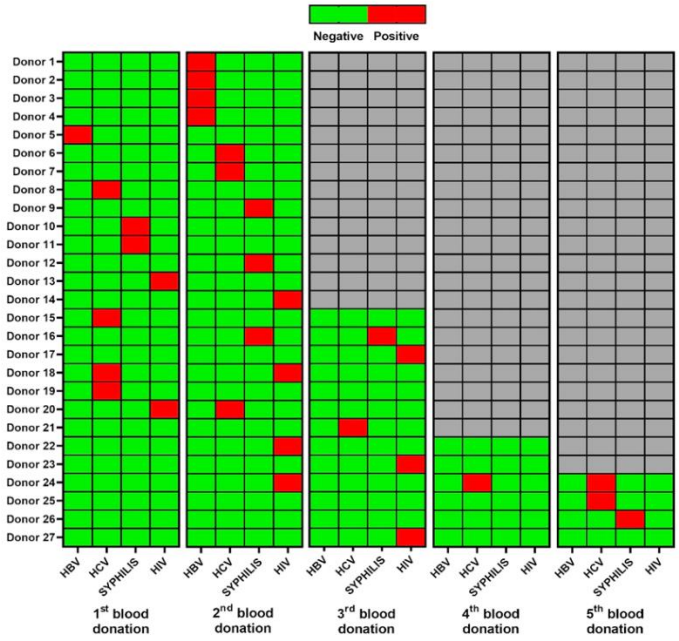


Table 3:
Distribution of blood donations according to seroprevalence during the study period

	2019 N= 1294		2020 N= 824		2021 N= 1182		2022 N= 620	
	Positive donations	Seropreval ence (%)	Positive donations	Seropreval ence (%)	Positive donations	Seropreval ence (%)	Positive donations	Seropreval ence (%)
HBV	41	3.5	18	2.7	3.6	5	110	3.6
HCV	36	3	7*	1.1*	20	2.6	11	2.4
Syphilis	5	0.4	1	0.2	16*	2.1*	32*	1.0*
HIV	21	1.8	8	1.2	12	1.6	8	1.7

*$p < 0.05$ compared to the reference year 2019

Figure 2:
Trend of the seropositivity status (positive or negative) for the 27 donors in whom seroconversion was detected



DISCUSSION

This study describes the evolution of the prevalence of transfusion-transmissible infections (TTIs) among blood donors at the Cliniques Universitaires de Kinshasa between 2019 and 2022. The results show annual variations in the positivity rates for HIV, HBV, HCV, and syphilis, reflecting both the persistent challenges and progress made in blood safety in the Democratic Republic of Congo (DRC). These findings align with a context in which blood transfusion remains an essential therapeutic intervention; however, the risk of infectious agent transmission remains a major concern, particularly in resource-limited settings.

Prevalence of TTIs

The overall prevalence rates observed in this study (2.8% for HBV, 1.9% for HCV, 1.3% for HIV, and 0.8% for syphilis) are comparable to those reported in previous studies conducted in the DRC and other sub-Saharan African countries. For instance, a 2018 study at the CUK reported prevalence rates of 4% for HBV, 1.3% for HCV, and 2.2% for HIV (Sumbu et al., 2018). These rates are significantly higher than those observed in high-income countries, where prevalence rates for these infections are below 0.1% (World Health Organization [WHO], 2010).

This disparity reflects differences in healthcare systems, resource availability, and prevention practices.

The high prevalence of HBV (2.8%) in our study is concerning, as it confirms that HBV remains the most frequent transfusion-transmissible infection in the DRC. This observation is consistent with WHO data, which estimates that the prevalence of HBV in sub-Saharan Africa is among the highest worldwide, reaching up to 7.2% (Rakotoniaina et al., 2013; WHO, 2010). Although HCV is less common than HBV, it still poses a significant risk, with a prevalence of 1.9% in our study. These findings highlight the need to strengthen prevention strategies, particularly HBV vaccination, which remains underutilized in the DRC.

Annual Variations

The annual variations in positivity rates, particularly the decrease observed in 2020, may be attributed to several factors. The COVID-19 pandemic had a significant impact on healthcare systems, including blood transfusion services (Bouhou et al., 2021). In 2020, a reduction in the number of donations was observed (824 donations compared to 1,294 in 2019), along with an increased proportion of family donors (51.7% compared to 41.4% in 2019). This trend could partly explain the decrease in positivity rates that year, as family donors are often perceived as being at lower risk compared to voluntary or paid donors (Tagny et al., 2008).

Conversely, the rise in positivity rates in 2021, particularly for HBV (3.6%) and syphilis (2.1%), underscores the persistent challenges in blood safety. This increase could be linked to the resumption of donation activities after the first wave of COVID-19, as well as a possible relaxation of donor selection measures during this period (O'Brien, 2022). These results highlight the need to maintain high standards for donor selection and screening, even during health crises.

Donor Profile

The majority of donors were men (79.0%), with an age range from 18 to 29 years (56.1%), consistent with trends observed in other studies in sub-Saharan Africa (Tagny et al., 2010). This male overrepresentation may be explained by sociocultural factors, such as the perception of blood donation as an act of courage or solidarity, more commonly associated with men. These findings are supported by a review of literature indicating that women are generally more altruistic in their donation motivations, while men tend to be more individualistic. Women also experience more adverse reactions during donation, which contributes to a lower frequency of regular donations (Bani & Giussani, 2010). A systematic review reported that compared to women, men are less likely to face medical deferrals or experience adverse reactions (Carver, Chell, Davison, & Masser, 2017).

Additionally, the high proportion of voluntary donors (60.9%) is a positive indicator, as voluntary donors are generally considered to have a lower risk of TTIs (Mayaki et al., 2013). However, Ahmed et al. (2007) reported that the prevalence of infectious markers (HIV, HBsAg, and anti-HCV) is higher among paid blood donors compared to other donor types. Some studies have also shown that family donors do not necessarily present a higher risk than voluntary non-remunerated donors (VNRDs) (Allain, 2011; Loua & Nze Nkoure, 2010; Mbanya et al., 2010).

When analysing infection rates by age group, it is notable that the seroprevalence of TTIs tends to increase with age. Several factors could explain this pattern. Behaviourally, older individuals may have had more cumulative exposure to risk factors over time, such as unprotected sexual practices (Negin, Rozea, & Martiniuk, 2014). Biologically, immune senescence may reduce the ability to clear infections effectively, leading to higher seroprevalence rates in older age groups (Lee et al., 2022).

Screening Methods

The combined use of immunochromatography and ELISA for TTI screening ensured reliable detection of infectious markers. However, the predominance of immunochromatography (85.3% of tests) raises concerns about the sensitivity and specificity of the methods used. While this method is rapid and cost-effective, it has limitations in detecting early-stage infections, particularly during the serological window period (Metsu et al., 2022; Niangaly, 2021; Tayou et al., 2007). Integrating more sensitive techniques, such as molecular testing (PCR), could further reduce the residual risk of transmission. For example, a study in South Africa demonstrated that adding nucleic acid testing (NAT) improved the detection

of infections not identified by conventional serological methods (Vermeulen et al., 2009; Vermeulin et al., 2012).

Implications for Blood Safety

The findings of this study highlight the persistence of a residual risk of TTIs despite efforts in donor selection and screening. To improve transfusion safety, the following measures are essential:

1. Implementation of nucleic acid testing (NAT): Introduce NAT, particularly for high-risk donors, to enhance detection of early-stage infections missed by conventional serological methods.
2. Strengthening HBV vaccination programs: Expand and promote HBV vaccination campaigns, especially targeting adolescents and young adults, to reduce the reservoir of HBV carriers in the general population.
3. Targeted education campaigns: Develop education initiatives specifically directed at older age groups, emphasising risk-reduction behaviours and the importance of regular screening.
4. Enhancing donor selection criteria: Refine donor selection protocols to incorporate detailed risk assessment tools, with particular attention to socio-behavioural risk factors associated with age, occupation, and past medical history.
5. Transition to a higher proportion of voluntary, non-remunerated donors: Strengthen strategies to recruit and retain voluntary, regular blood donors, as they are associated with a lower prevalence of TTIs compared to paid or replacement donors.
6. Quality assurance for rapid tests: Improve quality control of immunochromatographic methods by introducing periodic validation against ELISA or NAT results, ensuring that rapid tests meet minimum sensitivity and specificity standards.
7. Implementing a permanent epidemiological surveillance system to monitor TTI trends and adapt prevention strategies accordingly.

Strengths of the Study

This study has several strengths. It includes a large sample of blood donors (3,528 individuals and 3,920 donations), covering multiple years (2019–2022) and providing an analysis of the prevalence trends of transfusion-transmissible infections (HIV, HBV, HCV, Treponema pallidum) in the specific context of the DRC. The rigorous use of reliable screening methods (immunochromatography, ELISA) enhances the validity of the results. Additionally, the study offers a longitudinal perspective, allowing for observation of epidemiological trends. Furthermore, it was conducted in a university hospital reference centre, ensuring the local relevance of the data for public health and blood safety improvements.

Limitations of the Study

This study has some limitations. First, as a retrospective study based on registry data, it may be subject to biases related to data quality and completeness. Second, the absence of data on donor risk behaviours (e.g., injection drug use or high-risk sexual practices) limits the interpretation of the findings. Third, the lack of detailed predictor variables prevented the use of multivariate analysis to identify independent risk factors for infection. Fourth, due to data constraints, it was not possible to calculate 95% confidence intervals or odds ratios for prevalence rates. Lastly, the study period coincides with the COVID-19 pandemic, which may have influenced blood donation patterns and screening practices.

CONCLUSION

In conclusion, this study highlights a notable prevalence of TTIs among blood donors at the University Clinics of Kinshasa. The findings indicate an increasing prevalence of infections with age, particularly for hepatitis B (4.93% among donors aged 60 and above) and HIV (3.28% in the same age group). While the seroprevalence of HBV remained stable over time, HCV prevalence declined in 2020, whereas syphilis prevalence increased in 2021–2022. Among frequent donors, 27 cases of seroconversion were identified.

These results emphasize the need to strengthen donor recruitment, selection, and screening strategies, as well as to invest in more sensitive screening technologies. A multisectoral approach involving health authorities, healthcare professionals, and the community is essential to reduce the risk of TTIs and improve the safety of blood recipients.

Ethical Approval: Ethical clearance approval was obtained from the Ethics Committee of the University Clinics of Kinshasa

Conflicts of Interest: None declared.

ORCID iDs:

Lodi, O. L.: Nil identified
Matondo, B. S.: Nil identified
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Melki, S.: Nil identified
Ibana, J. K.: Nil identified
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