

## Seroprevalence of HIV, HBV, HCV, and Syphilis Among Blood Donors in Omdurman, Sudan (2019–2022): A Retrospective Study

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### Abstract

**Background:** Transfusion-transmitted infection (TTI) poses significant risks to blood transfusion safety and represents a major public health challenge in Sudan. However, current data on TTI prevalence among blood donors is limited. This study aimed to assess the prevalence of TTI among male blood donors at the Blood Bank of Nao Teaching Hospital, Omdurman, Sudan, from January 2019 to December 2022.

**Methods and Results:** A retrospective 4-year descriptive cross-sectional study was conducted using blood donation records to examine the prevalence of TTI, including human immunodeficiency virus (HIV), hepatitis B (HBV), hepatitis C (HCV), and syphilis. Data were analyzed for trends over the four-year period. The study identified a total TTI prevalence of 8.8% (302 of 3401 donors). Among TTI, HBV had the highest prevalence at 4.29%, followed by syphilis at 3.91%. HIV prevalence was 0.56%, and HCV prevalence was 0.12%. No cases of co-infection were reported. The overall TTI prevalence declined from 10.2% in 2019 to 6.9% in 2022.

**Conclusion:** The findings emphasize the importance of ongoing monitoring and improved screening measures to enhance blood safety in Sudan. The high prevalence of HBV and syphilis underscores the need for targeted public health campaigns to raise awareness and promote safe blood donation practices. (**International Journal of Biomedicine. 2026;16(1):95-100.**)

**Keywords:** transfusion-transmitted infection • HBV • HCV • HIV • syphilis

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### Abbreviations

CI, confidence interval; HBV, hepatitis B virus; HCV, hepatitis C virus; HIV, human immunodeficiency virus; TTI, transfusion-transmitted infection.

## Introduction

Blood transfusion is a vital therapeutic procedure and remains indispensable in countries such as Sudan, where the need for donated blood is heightened due to the widespread occurrence of infectious diseases like malaria, persistent nutritional deficiencies, and frequent obstetric emergencies. Despite its life-saving role, transfusion carries an inherent risk of transmitting infectious pathogens, including hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and syphilis. Current estimates suggest that around 1% of transfusion events may lead to complications, including transfusion-transmitted infection (TTI). Although advances in transfusion technology and laboratory diagnostics have improved blood safety, ensuring a consistently secure blood supply remains a major challenge in low-resource settings, where comprehensive, routine TTI screening is still not universally practiced.<sup>1</sup> Transfusion-transmitted infection—particularly those caused by HIV, HBV, HCV, and syphilis—continue to pose substantial public health threats across sub-Saharan Africa. Limited epidemiological data compounds this challenge, as the World Health Organization recommends systematic screening for all blood donors. In addition, infections with HIV, HBV, and *Treponema pallidum* are also transmitted through sex, resulting in rapid, pervasive dissemination through communities and compounding the problems caused by unsafe blood transfusion practices.<sup>2,3</sup> HIV and viral hepatitis continue to impose a considerable global health burden, affecting millions of people and occurring together in the liver at a rate that hastens injury and worsens clinical outcomes.<sup>4</sup> Sudan is a known high-endemic region for both HBV and HCV, with prevalence rates different among important groups such as donors and pregnant women.<sup>5,6</sup> Syphilis is another lingering public health issue, due to a strong connection with greater vulnerability to HIV; however, the availability of epidemiological data on its distribution in Sudan is limited.<sup>7</sup> Transfusion-transmitted infection is a serious issue for blood safety in Sudan due to the paucity of national surveillance at the national level. Accordingly, the burden of TTI is vital in identifying asymptomatic infection, improving donor screening techniques, and directing public health interventions. In this light, the current study aimed to establish the prevalence of HIV, HBV, HCV, and syphilis among blood donors who underwent visits to Nao Teaching Hospital, Omdurman, for the period 2019 to 2022.

## Materials and Methods

### Study Design

This study employed a retrospective, descriptive cross-sectional design conducted over a four-year period at the Blood Bank of Nao Teaching Hospital in Omdurman, Sudan. The study timeframe extended from January 2019 to December 2022, during which 3,401 male blood donors were screened. Relevant data were extracted from existing blood bank records. All donors provided written informed consent and completed a standardized questionnaire used

to assess their eligibility for blood donation. Confidentiality was strictly maintained for seropositive subjects, and consent procedures were obtained at the time of blood collection. The study included voluntary blood donors aged 18–65 years, weighing over 45 kg, and with hemoglobin levels above 13 g/dL. Donors were required to meet the Sudan National Blood Transfusion Protocol standards, including normal vital signs (blood pressure, temperature, pulse) and absence of significant medical or surgical history.

### Inclusion and Exclusion Criteria

Participants who fulfilled the eligibility criteria were included. Exclusion criteria encompassed individuals at high risk, such as those with chronic illnesses, substance abuse, pregnancy, dialysis dependence, donors deferred due to abnormal hemoglobin or blood pressure, and those with incomplete records.

### Data Collection and Laboratory Testing

Two milliliters of blood were collected from each donor using plain vacutainer tubes, and serum was separated for serological analysis. All samples were screened for HIV, HBV, HCV, and syphilis. HIV testing was performed using the HIV (Ag/Ab) ELISA kit (Fortress Diagnostics, UK) to detect both HIV-1 and HIV-2 antibodies. HBV detection was performed using the HS HBsAg ELISA kit (Fortress Diagnostics, UK), while HCV was screened using the microwell ELISA kit (ABIA, AB Diagnostic Systems, Germany). Syphilis antibodies were identified using the ABIA *Treponema* Ab ELISA test (ABIA, AB Diagnostic Systems, Germany).

Data were analyzed using IBM SPSS Statistics V22.0. The chi-square test was used to examine the relationship between certain diseases and different years. A *P*-value was set at less than 0.05 to be statistically significant.

## Results

The study included 3,401 voluntary male blood donors aged 18–65 years. Most were between 31 and 45 years old (37.5%), with the remainder distributed across the 18–30 and 46–65 age groups. Nearly half (45.0%) weighed 56–70 kg, and the majority had hemoglobin levels between 14.1 and 16 g/dL (52.5%). Blood group distribution showed group B as the most common (35.0%), followed by O (30.0%), AB (25.0%), and A (10.0%). Overall, donors met the required national standards for safe blood donation, as illustrated in Table 1.

Table 2 demonstrates the prevalence of TTI among seropositive donors from 2019 to 2022. Out of 3,401 donors, 302 TTI were detected (8.88%), with HBV being the most common (48.3%), followed by syphilis (44%), HIV (6.3%), and HCV (1.3%). Yearly TTI rates were 10.2% in 2019, 7.89% in 2020, 9.4% in 2021, and 6.9% in 2022, with HBV and syphilis predominating each year.

Table 3 summarizes the prevalence of specific TTI among 3,401 blood donors from 2019 to 2022. HIV was detected in 0.56% of donors, HBV in 4.29%, HCV in 0.12%, and syphilis in 3.91%. Yearly prevalence showed minor fluctuations: HIV ranged from 0.2% to 1%, HBV from 2.5% to 5.6%, HCV remained below 0.3%, and syphilis ranged from 2.5% to 4.4%, indicating that HBV and syphilis were the

most common infections, while HIV and HCV remained low throughout the period.

Table 4 presents the annual prevalence of TTI with 95% CI and adjusted true prevalence.

**Table 1.**

**Demographic data for study participants**

Characteristic	Category	Number (%)
Age (years)	18–30	1.020 (30.0%)
	31–45	1.275 (37.5%)
	46–65	1.106 (32.5%)
Sex	Male	3.401 (100%)
	Female	0 (0%)
Weight (kg)	45–55	815 (24.0%)
	56–70	1.530 (45.0%)
	>70	1.056 (31.0%)
Hemoglobin (g/dL)	13–14	1.020 (30.0%)
	14.1–16	1.785 (52.5%)
	>16	596 (17.5%)
Donation type	Voluntary	3.401 (100%)
	Unvoluntary	0 (0%)
ABO blood group	A	340 (10.0%)
	B	1.190 (35.0%)
	AB	851 (25.0%)
	O	1.020 (30.0%)

**Table 2.**

**Annual frequency of HIV, HBV, HCV, and syphilis cases among seropositive donors.**

Year	HIV	HBV	HCV	Syphilis	Total
2019	3 (1.9%)	85 (55.2%)	0 (0%)	66 (42.6%)	154 (10.2%)
2020	6 (11.3%)	17 (32.1%)	2 (3.8%)	28 (52.8%)	53 (7.89%)
2021	4 (10.3%)	16 (41%)	0 (0%)	19 (48.7%)	39 (9.4%)
2022	6 (10.7%)	28 (50%)	2 (3.6%)	20 (35.7%)	56 (6.9%)
Total	19 (6.3%)	146 (48.3%)	4 (1.3%)	133 (44%)	302 (8.88%)
P-value	0.08	0.02	0.71	0.00	

**Table 3.**

**Annual true prevalence of TTI among all blood donors.**

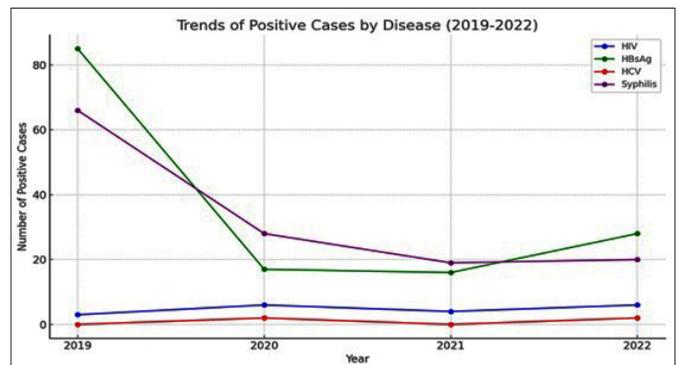
Year	Total number	HIV	HBV	HCV	Syphilis
2019	1507	3 (0.2%)	85 (5.6%)	0 (0%)	66 (4.4%)
2020	671	6 (0.9%)	17 (2.5%)	2 (0.3%)	28 (4.2%)
2021	415	4 (1%)	16 (3.9%)	0 (0%)	19 (4.6%)
2022	808	6 (0.7%)	28 (3.5%)	2 (0.2%)	20 (2.5%)
Total	3401	19 (0.56%)	146 (4.29%)	4 (0.12%)	133 (3.91%)
P-value	-	0.08	0.02	0.71	0.00

**Table 4.**

**Annual prevalence of TTI with 95% CI and adjusted true prevalence.**

Year	HIV % (95% CI)	HBV % (95% CI)	HCV % (95% CI)	Syphilis % (95% CI)
2019	0.20 [0.07–0.58]	5.64 [4.58–6.92]	0.00 [0.00–0.25]	4.38 [3.46–5.53]
2020	0.89 [0.41–1.94]	2.53 [1.59–4.02]	0.30 [0.08–1.08]	4.17 [2.90–5.97]
2021	0.96 [0.38–2.45]	3.86 [2.39–6.17]	0.00 [0.00–0.92]	4.58 [2.95–7.04]
2022	0.74 [0.34–1.61]	3.47 [2.41–4.96]	0.25 [0.07–0.90]	2.48 [1.61–3.79]

Figure 1 demonstrates the trend analysis, which shows that the positivity rates of the screening tests fluctuated over time. Blood transfusion-transmissible infections were 154/1507 (10.2%) in 2019, then decreased to 53/671 (7.89%) in 2020, increased to 39/415 (9.4%) in 2021, and decreased to 56/808 (6.9%) in 2022. From screened TTI, seropositivity for HBV and syphilis decreased from 2019 to 2021 and increased again from 2021 to 2022. However, HIV positivity rates gradually increased from 2019 to 2021 and decreased in 2022. HCV positivity was consistently low over the four years, with no positive cases in 2019 and 2021.



**Figure 1.** Trend of positive cases according to different years.

**Discussion**

Transfusion-transmitted infection continues to pose a significant challenge to safe blood transfusion practices. Each unit of blood carries an estimated 1% risk of transfusion-related complications, including TTIs, highlighting the critical importance of thorough donor screening to prevent potential biohazards.<sup>8</sup>

The present study examined the prevalence of TTIs among blood donors at the Blood Bank of Nao Teaching Hospital in Omdurman over a four-year period from 2019 to 2022. Notably, all donors included in this study were male. This predominance may be explained by several factors, including physiological differences between the sexes, cultural beliefs, pregnancy and lactation in women, and the higher prevalence of iron-deficiency anemia among female populations. Additionally, societal perceptions that men are

generally healthier than women likely contribute to the higher proportion of male donors.

Over the study period, the overall prevalence of TTIs among donors was 302 out of 3,401 (8.8%). This rate is higher than the 5.6% prevalence reported by Ahmed et al.<sup>2</sup> in Khartoum and exceeds international findings from Saudi Arabia (7.4%),<sup>10</sup> Ethiopia (5.43%),<sup>11</sup> Eritrea (3.6%),<sup>12</sup> and India (1.58%).<sup>13</sup> Conversely, the prevalence observed in this study is lower than that documented in Kosti (22.52%),<sup>14</sup> Port Sudan (20.1%),<sup>15</sup> and White Nile State (15.91%),<sup>16</sup> as well as studies in Ghana (16.1%)<sup>17</sup> and South Sudan (22.1%).<sup>18</sup>

The considerable variation in TTI prevalence across different regions may reflect differences in diagnostic techniques, the sensitivity and specificity of testing reagents, geographical and temporal variations in disease burden, and disparities in healthcare infrastructure and access. These findings underscore the ongoing need for rigorous donor screening, continuous monitoring of infection trends, and tailored public health interventions to enhance the safety of the blood supply in Sudan and comparable settings. Over the four-year study period, the prevalence of HIV among blood donors at Nao Teaching Hospital fluctuated, with an overall rate of 0.56%. This rate is lower than previously reported figures from Kosti (1.77%),<sup>14</sup> Port Sudan (1.4%),<sup>15</sup> White Nile State (2.61%),<sup>16</sup> Ghana (1.6%),<sup>17</sup> and South Sudan (6.7%).<sup>18</sup> Conversely, it is higher than the prevalence documented in Khartoum (0.4%),<sup>2</sup> Saudi Arabia (0.06%),<sup>10</sup> Ethiopia (0.34%),<sup>11</sup> India (0.16%),<sup>13</sup> and Eritrea (0.3%).<sup>12</sup>

Hepatitis B virus (HBV) remains one of the most widespread infectious diseases globally, with approximately two billion people having been infected at some point, and it is considered hyper-endemic in sub-Saharan Africa and parts of Asia.<sup>19</sup> Sudan has historically been classified as a high HBV endemic country, with a prevalence of 8% reported by the World Health Organization in 1996.<sup>20</sup> In the present study, HBV was the most prevalent TTI, affecting 4.29% of donors. This prevalence is lower than that reported in Kosti (6.07%),<sup>14</sup> Port Sudan (11.7%),<sup>15</sup> White Nile State (5.57%),<sup>16</sup> Khartoum (6%),<sup>2</sup> Saudi Arabia (6.1%),<sup>10</sup> and South Sudan (22.1%).<sup>18</sup> However, it exceeds the rates observed in Ethiopia (2.1%),<sup>11</sup> Ghana (3.1%),<sup>17</sup> India (0.77%),<sup>13</sup> and Eritrea (2%).<sup>12</sup> The prevalence of HCV in this study was notably low at 0.12%, considerably lower than figures reported in other regions, including Kosti (1.4%),<sup>14</sup> Port Sudan (0.4%),<sup>15</sup> White Nile State (1.4%),<sup>16</sup> and Khartoum (0.2%).<sup>2</sup> Neighboring countries also reported higher prevalence, such as Saudi Arabia (0.4%),<sup>10</sup> Ethiopia (0.8%),<sup>11</sup> Eritrea (0.7%),<sup>12</sup> Ghana (5%),<sup>17</sup> and South Sudan (8.9%).<sup>18</sup> In contrast, our finding is like the 0.11% rate reported in India.<sup>13</sup> These differences may be explained by variations in study populations, geographic factors, and laboratory screening methods. The relatively lower prevalence of HCV compared to HBV may reflect its more restricted transmission routes, primarily limited to blood-to-blood contact, whereas HBV can be transmitted through multiple pathways, including sexual contact and vertical transmission.

Syphilis continues to represent a major global public health concern, particularly in developing countries. In this

study, the prevalence of syphilis among blood donors was 3.91%, making it the second most common TTI observed. This rate is lower than those reported in Kosti (11.87%),<sup>14</sup> Port Sudan (6.6%),<sup>15</sup> White Nile State (5.72%),<sup>16</sup> Khartoum (5.4%),<sup>2</sup> and Ghana (6.4%).<sup>17</sup> Conversely, it exceeds prevalence rates reported internationally, including Saudi Arabia (0.34%),<sup>10</sup> Ethiopia (1.4%),<sup>11</sup> India (0.53%),<sup>13</sup> and Eritrea (0.6%).<sup>12</sup> These findings indicate that syphilis remains a significant concern in various regions, with differences in prevalence likely influenced by local transmission dynamics, healthcare infrastructure, and public health interventions.

Notably, no cases of co-infections were observed in the present study, in contrast to previous reports where co-infection rates ranged from 0.1% in Eritrea<sup>12</sup> to 1.67% in Kosti,<sup>14</sup> with intermediate rates reported in Port Sudan (1.1%),<sup>15</sup> White Nile State (0.59%),<sup>16</sup> and Khartoum (0.65%).<sup>2</sup>

Analysis of TTI trends from 2019 to 2022 revealed a general decline in seroprevalence, decreasing from 10.2% in 2019 to 6.9% in 2022, with a notable dip in 2020 (7.89%). This decline is likely related to the COVID-19 pandemic, which affected both donor turnout and the capacity of healthcare services to perform routine screenings. Similar patterns were observed internationally, such as in Saudi Arabia, where Minshawi et al.<sup>10</sup> reported a decline from 1.5% in 2019 to 0.9% in 2020, followed by a slight rise to 1.1% in 2021. In contrast, studies in Kosti<sup>14</sup> and Ghana<sup>17</sup> reported fluctuating trends, with temporary increases and decreases in TTI prevalence.

Specifically, HIV seroprevalence in our study increased from 0.2% in 2019 to 0.9% in 2020, peaking at 1.0% in 2021 before slightly declining to 0.7% in 2022. HBV prevalence declined steadily from 5.6% in 2019 to 2.5% in 2020, stabilizing at 3.9% in 2021 and 3.5% in 2022. HCV prevalence remained consistently low, ranging from 0% to 0.3%, resulting in an overall rate of 0.12%, reflecting effective screening and control measures. Syphilis rates remained relatively stable at approximately 4% from 2019 to 2021, with a slight decrease to 2.5% in 2022, suggesting improvements in donor screening and a reduction in transmission.

Overall, the fluctuations in TTI prevalence during 2020 and 2021 appear to have been largely influenced by the COVID-19 pandemic, which disrupted routine healthcare services and reduced donor participation. The resumption of normal healthcare operations and an increase in donor numbers by 2022 contributed to the stabilization of seroprevalence rates across all TTIs.

The observed variations in TTI prevalence across different studies can be attributed to multiple factors. Demographic characteristics, including age, gender, and sexual behaviors, along with differences in healthcare access, public awareness, education, cultural norms, and social stigma, play significant roles. Methodological differences, such as the type of screening tests used and the frequency of testing, also influence reported prevalence rates. Furthermore, regional disease outbreaks, public health policies, socioeconomic conditions, and the robustness of healthcare infrastructure contribute to these discrepancies. The COVID-19 pandemic likely affected prevalence estimates by reducing donor turnout and limiting routine

screening, as reflected in this study and others. Additionally, the retrospective design of this study and variations in study periods and donor numbers in previous investigations may have contributed to differences in TTI prevalence. Collectively, these factors help explain the wide range of prevalence rates reported across diverse regions and timeframes.

## Conclusion

This study identified a TTI prevalence of 8.8%, underscoring the persistent risk of blood transfusion in the region. Among the infections assessed, HBV was the most prevalent, affecting 4.29% of donors, followed by syphilis at 3.91%. The prevalence of HIV (0.56%) and HCV (0.12%) was comparatively low, and no cases of co-infections were observed. Additionally, the study observed a declining trend in TTI seroprevalence over the four-year period, emphasizing the critical role of continued vigilance and robust donor screening practices to ensure blood safety.

## Limitations and Future Directions

This study has several limitations that should be considered when interpreting the findings. Its single-center design and the inclusion of only male donors restrict the generalizability of the results to the broader Sudanese population, particularly female donors. Additionally, the retrospective nature of the study limited the availability of certain variables, and the screening protocol did not include other regionally relevant infections such as malaria. The absence of confirmatory testing and advanced diagnostic methods, such as nucleic acid testing (NAT), may also have affected the accuracy of TTI detection due to an overestimation of some TTI prevalence rates, particularly for HBV and syphilis. Therefore, future research should adopt a multi-center approach, include both genders, and incorporate more comprehensive screening panels with confirmatory and molecular methods. Expanding surveillance systems and integrating donor education and awareness programs are also recommended to strengthen blood transfusion safety in Sudan.

## Ethical Considerations

The study received ethical clearance from the research board at the Faculty of Medical Laboratory Sciences, Alzaiem Alazhari University. The study applied previously collected data, and no study participants were included at any point. Informed consent was not sought as the study was performed on secondary data; however, consent was obtained from the head of the Blood Bank.

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## Conflicts of Interest

The authors declare that they have no competing interests.

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