Original Article

Seroprevalence of Transfusion-Transmissible Infections and Associated Factors: A 5-Year Study Among Blood Donors in Haryana, India

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Abstract

Background: Transfusion-transmissible infections (TTIs) remain a significant concern for blood safety in developing countries. Monitoring TTI prevalence among blood donors reflects underlying community infection levels and supports safer transfusion practices. The study aimed at determining the seroprevalence, temporal trends, and demographic distribution of major TTIs (HBV, HCV, HIV, syphilis, malaria) among blood donors over a 5-year period.

Methods: A retrospective observational study was conducted at a licensed blood bank in Haryana, India, from September 2020 to August 2025. A total of 2,896 donors were screened using standard serological assays. Prevalence rates with 95% confidence intervals (CI) and χ^2 tests were applied to assess associations with demographic variables.

Result: The overall TTI seroprevalence was 1.87% (95% CI: 1.39–2.35). HBV was the most prevalent infection (1.00%), followed by HCV (0.69%), syphilis (0.14%), and HIV (0.03%). No malaria cases were detected. TTI positivity was significantly higher among males ($\chi^2 = 3.91$; $p = 0.048$). The 18–30-year age group accounted for 68.5% of TTI-positive donors. An apparent increase in HBV and HCV seropositivity was observed during 2024–2025. No co-infections were observed.

Conclusion: This study demonstrates a low but persistent TTI burden, with HBV and HCV predominating. Strengthened surveillance, improved donor selection, and consideration of nucleic acid testing (NAT) may further enhance transfusion safety.

Keywords: transfusion-transmissible infections; HBV; HCV; seroprevalence; blood donors; Haryana

Introduction

Blood transfusion is a critical therapeutic intervention; however, it carries an inherent risk of transmitting infectious agents from donor to recipient [1]. Transfusion-transmissible infections (TTIs) such as hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), syphilis, and malaria remain major concerns, particularly in low- and middle-income countries [2, 3].

The prevalence of TTIs varies markedly across India due to regional differences in donor demographics, community infection patterns, and diagnostic practices. Continuous monitoring of TTIs among blood donors serves as an important indicator of community infection trends and helps strengthen transfusion safety protocols [4, 5].

This study aims to evaluate the seroprevalence, temporal trends, and demographic distribution of major TTIs among blood donors over a 5-year period at a licensed blood bank in Haryana, North India.

Materials and Methods

Study design and setting: A retrospective observational study was conducted at the licensed blood bank in Haryana, India, from September 2020 to August 2025. The study was conducted in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

Study population: A total of 2,896 apparently healthy blood donors aged 18–60 years, weighing $\geq$45 kg, and with haemoglobin $\geq$12.5 g/dL were included. Donor eligibility criteria followed national blood transfusion guidelines and institutional SOPs. Approximately 65% of donors were voluntary donors and 35% were replacement donors. "Apparently healthy" donors were defined as individuals with no history of jaundice, high-risk behavior, recent tattoos, recent infections, blood transfusion, or major surgery; no fever in the preceding two weeks; and meeting all eligibility criteria as per national guidelines and institutional standard operating procedures.

Data collection: Demographic and serological data were extracted from blood bank registers. All donors underwent medical history screening, physical examination, and haemoglobin estimation.

Serological screening: Each donor sample was screened for: HBsAg (HBV): HEPALISA ULTRA (J. Mitra & Co. Pvt. Ltd.); sensitivity 100%, specificity 99.92%. Anti-HCV: HCV Microlisa (3rd-generation ELISA, J. Mitra); sensitivity 100%, specificity 97.4%. HIV-1/2 antibodies & p24 antigen: Microlisa HIV Ag & Ab (4th-generation ELISA, J. Mitra); sensitivity 100%, specificity 99.97%. Syphilis: Oscar Syphilis Rapid Test (*Treponema pallidum* IgG/IgM/IgA), manufactured by ARKRAY; 100% sensitivity and 99% specificity. Malaria antigen: Advantage Malaria Antigen Test (J. Mitra); sensitivity 97%, specificity 98%. Initially reactive samples were repeat-tested and confirmed using an alternative manufacturer's kit. Donor confidentiality was maintained.

Statistical analysis: TTI prevalence was calculated with 95% CI. Associations with gender and age were assessed using the χ^2 test. Temporal trends were evaluated using the Cochran–Armitage test for trend. A p-value $<$0.05 was considered statistically significant. Data were analysed using standard statistical software.

Ethical considerations: Institutional Ethics Committee approval was obtained prior to commencement of the study (IEC No: AFSMSRC/RP/2025-48). Donor anonymity was maintained and no personal identifying information was utilised.

Results

Donor demographics: Of the 2,896 donors screened, 98.38% were males and 1.62% females. Voluntary donors constituted approximately 65% of the donor pool, while replacement donors accounted for 35%. Year-wise donor distribution is shown in (Table 1).

Table 1: Year-wise distribution of blood donors (September 2020 – August 2025).

Year	Male	Female	Total	Percentage (%)
2020	45	1	46	1.59
2021	204	1	205	7.08
2022	341	2	343	11.85
2023	680	6	686	23.69
2024	846	16	862	29.77
2025	733	21	754	26.02
Total	**2849**	**47**	**2896**	**100**

Overall seroprevalence: Fifty-four donors tested positive for at least one TTI, yielding an overall prevalence of 1.87%. HBV was most common, twenty nine positive (1.00%), followed by HCV, twenty positive (0.69%), syphilis, four positive (0.14%), and HIV, one positive (0.03%). No malaria cases were detected. Figure 1 depicts the proportional distribution of TTIs.

Year-wise trends: An apparent increase in HBV and HCV cases was noted during 2024–2025 (Table 2). Year-wise comparison between individual years did not show consistent statistical significance; however, overall trend analysis using the Cochran–Armitage test demonstrated a significant upward trend ($p < 0.001$). Figure 2 shows the year-wise trend of TTI seroprevalence.

Gender-wise distribution: TTI positivity was higher in males, 54 out of 2849 male donors were positive (1.90%) and 0 out of 47 female donors tested positive (0%), (χ^2 = 3.91; p = 0.048).

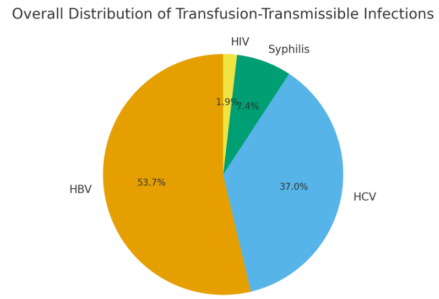

Figure 1: Overall distribution of TTIs (pie chart).

Table 2: Year-wise distribution of TTI-positive donors.

Year	HBV	HCV	HIV	Syphilis	Malaria
2020	0	0	0	0	0
2021	0	0	0	0	0
2022	2	1	0	0	0
2023	3	2	0	0	0
2024	12	9	0	2	0
2025	12	8	1	2	0
Total	**29**	**20**	**1**	**4**	**0**

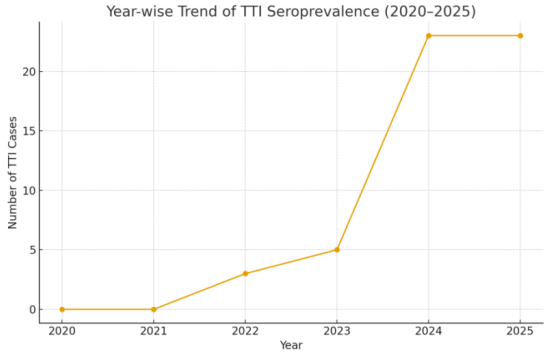

Figure 2: Year-wise trend of TTI seroprevalence.

Age-wise distribution: The highest proportion of TTI-positive cases (68.5%) occurred in donors aged 18–30 years (Table 3), with a statistically significant association ($p = 0.013$). Figure 3 illustrates the age distribution.

Table 3: Age-wise distribution of TTI-positive donors.

Age Group (Years)	HBV	HCV	HIV	Syphilis	Malaria	Total (%)
18–30	20	15	1	1	0	37 (68.5%)
31–40	7	3	0	1	0	11 (20.4%)
41–50	1	2	0	2	0	5 (9.3%)
51–60	1	0	0	0	0	1 (1.8%)
Total	**29**	**20**	**1**	**4**	**0**	**54 (100%)**

Discussion

The overall TTI seroprevalence (1.87%) aligns with previously reported rates from North India [4, 5]. The observed seroprevalence may also be influenced by the donor profile, as approximately 35% of donors were replacement donors, who are known to have a relatively higher risk of TTIs compared to voluntary donors. HBV emerged as the most prevalent infection, reflecting established epidemiological patterns [6].

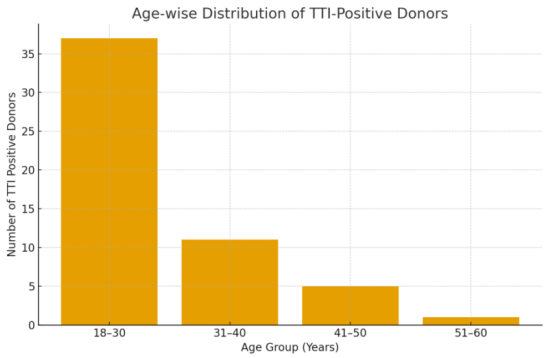

Figure 3: Age-wise distribution of TTI-positive donors.

An apparent increase in HBV and HCV positivity during 2024–2025 was observed. This finding should be interpreted cautiously, as it may reflect post-pandemic variations in donor recruitment patterns rather than a true epidemiological surge. A higher proportion of first-time and replacement donors during this period may have contributed to the observed increase [7, 8].

The predominance of HBV and HCV compared to HIV may be attributed to their higher endemicity and the presence of asymptomatic carriers in the general population. In contrast, the relatively low HIV & Syphilis prevalence may reflect the effectiveness of national screening programs and awareness initiatives, leading to better risk stratification and donor deferral [4, 9].

Despite Haryana being considered a malaria-endemic region, no malaria-positive cases were detected. This may be due to seasonal variability, effective donor deferral practices for febrile illnesses, and the possibility of low parasitemia levels that fall below the detection threshold of rapid antigen assays and because most of the donors were from semi-urban area where there are fewer mosquitoes, better housing, and effective preventive measures than the countryside [3, 4].

Higher TTI prevalence among younger donors underscores the need for targeted awareness initiatives and risk-reduction education. The absence of TTI positivity among female donors, although influenced by small sample size, aligns with existing literature showing lower risk exposures among women in India [6, 9].

The implementation of nucleic acid testing (NAT) has been shown to reduce the residual risk of TTIs by detecting infections during the serological window period. Although the overall prevalence in the present study is low, the potential benefit of NAT in enhancing blood safety, particularly in high-volume centers, may justify its consideration despite cost constraints [10].

Conclusion

TTIs continue to pose a challenge to transfusion safety, even in regions with relatively low prevalence. Strengthening donor selection, enhancing awareness, and considering advanced screening methods such as NAT can further reduce residual risk. Periodic surveillance and epidemiological assessments are important for maintaining high standards of transfusion safety.

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Competing Interests: None stated

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