Original Article

A Three-Year Retrospective Analysis of Transfusion Transmitted Infections (TTIs) Among Blood Donors at GEMS Tertiary Care Hospital

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Abstract

Background: Transfusion-transmitted infections threaten blood safety worldwide. Screening reduces risk. But pathogens persist. This study tracked TTI trends over three years at a South Indian tertiary centre. **Material and Methods:** We reviewed records of 16,936 blood donors from January 2023 to December 2025. All samples underwent fourth-generation ELISA for HIV and HBsAg, third-generation ELISA for HCV, and rapid tests for syphilis and malaria. We analyzed seroprevalence, temporal trends, and gender patterns using chi-square tests and Fisher's exact test. **Results:** Overall TTI seroprevalence was 1.70% (288/16,936). HBV led at 1.26%. Syphilis followed at 0.25%. HCV, HIV, and malaria were rare (0.09%, 0.07%, 0.005%). Annual rates fluctuated: 1.34% (2023), 1.97% (2024), 1.88% (2025). No linear trend emerged ($\chi^2 = 2.14$, $p = 0.143$). All reactive cases occurred in males. Females comprised 0.83% of donors and showed zero reactivity. **Conclusion:** TTI burden remains low. HBV dominates. The 2024 peak signals need for vigilance. Gender imbalance in donor recruitment requires intervention. Routine screening works. NAT integration should be prioritized where feasible.

Keywords: Transfusion-transmitted infections; blood donor screening; seroprevalence; hepatitis B; HIV; hepatitis C; syphilis; epidemiology.

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Introduction

Blood transfusions still play a significant role in today's medical practice. They are crucial during trauma management, obstetric complications, oncologic treatment, and surgery. Even though this intervention is highly valuable, it entails the risk of pathogen transmission. Transfusion-transmitted infections remain one of the most challenging threats to the safety of the blood supply throughout the world.[1] According to the Drugs and Cosmetics Act and National Blood Policy in India, mandatory testing for HIV, hepatitis B virus (HBV), hepatitis C virus (HCV), syphilis, and malaria should be conducted in all cases.[1]

The global burden of these pathogens is also considerable. For instance, according to WHO estimations, there are about 296 million people living with chronic HBV infection and 58 million people with chronic HCV infection.[2] The country in which this research was conducted is intermediate endemicity regarding hepatitis B. Prevalence varies between 2% and 4% in India.[3,4] Chronic infection with hepatitis C affects 0.5%-1.5% of the population.[3,4] HIV prevalence in adults is 0.21%, according to recent NACO surveillance data.[5] This situation defines the profile of blood donor infectious risk.

Testing of blood donors is performed not only for protecting transfusion recipients but also for obtaining information on general disease prevalence in the community.[6] Nevertheless, seroprevalence of TTIs among blood donors may differ significantly depending on such factors as regional endemicity, donor selection process, socioeconomic status, vaccination, and testing methods.[7] For this reason, it is vital to conduct research in specific regions and update donor selection procedures regularly.

Indian scientific literature demonstrates this problem as well. TTI seroprevalence rate varies between 1.57% and 3.44% among tertiary care centre donors.[8-19] HBV is the leading

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pathogen among the four mentioned ones. Higher-income countries have significantly lower rates due to rigorous donor selection and NAT.[20] Conversely, lower-income countries (especially those located in sub-Saharan Africa) report that up to 5-10% of donors are positive for HBV.[21] High-income countries achieve lower rates. Stringent donor selection and nucleic acid testing (NAT) drive this success.[22] Zou et al. reported HIV prevalence <0.01% among US donors.[23] In contrast, Sub-Saharan Africa shows higher burden. HBV prevalence reaches 5–10% in some regions.[24]

This three-year retrospective analysis evaluates the seroprevalence and temporal trends of TTIs among blood donors at a tertiary care hospital in coastal Andhra Pradesh. We quantify pathogen-specific infection rates, assess annual fluctuations, and compare our findings with national and international benchmarks. The results will inform targeted donor recruitment strategies and reinforce evidence-based transfusion safety practices.

Materials and Methods

Study Design & Study Setting: Our study was a retrospective, observational study carried out in the Department of Blood Bank of GEMS Tertiary Care Hospital, Srikakulam. The study period was from January 2023 to December 2025. The hospital caters to both urban and rural populace of coastal Andhra Pradesh and functions under the blood safety norms of the country.

Study Participants: All eligible donors were included in the study based on their pre-donation evaluation of medical history, physical examination, and hemoglobin estimation. Donors with hemoglobin levels <12.5g/dL were excluded from further processing. Voluntary as well as replacement donors were recruited in the study. In all, 16,936 donors formed our study population. Out of this, 99.17% (16,796) were males and 0.83% (140) were females.

Blood Collection and Processing: Phlebotomist collected whole blood in sterile and single use bag, each unit having barcode. Samples were processed into packed red cells, fresh frozen plasma, and platelets following national norms. Red cells were stored at 2-6°C, plasma at <= -30°C and platelets at 20-24°C with agitation. Repeated monitoring of cold chain was done. Any reactive unit was disposed of as biomedical waste.

Serological Screening: All blood samples underwent mandatory serological testing for TTIs as mandated by regulatory agencies of India:[3]

- HIV: Fourth generation ELISA assay for detection of HIV-1/2 antibody and p24 antigen (Tulip Diagnostics).
- HBV: Fourth generation ELISA assay for HBsAg (Tulip Diagnostics)
- HCV: Third generation ELISA test for anti-HCV antibodies (Tulip Diagnostics).
- Syphilis: Treponema pallidum hemagglutination assay.
- Malaria: Satya 2.0 rapid diagnostic test.

Samples with positive findings were confirmed and quality assured through internal controls done every day. Reactive donors were referred for confidential counselling and testing.

Data Collection and Statistical Methods: Data for analysis was retrieved from anonymised laboratory sheets and database systems. The variables include donor gender, donation year and serological results. Seroprevalence was calculated using (reactive cases / total screened x 100). Trends in prevalence across years were examined with chi-square test for trend while gender specific differences in seropositivity were estimated with Fisher's exact test. Odds ratios and their corresponding 95% confidence intervals were calculated. All statistical tests were considered significant if $p < 0.05$. Analyses were done with using SPSS version 26.0 software.

Ethical Approval: The study was approved by the Institutional Ethics Committee (Regd. No. 01/IEC/GEMS&H/2026). As it is a retrospective study, no informed consent was required from donors according to ICMR. Donor confidentiality was ensured through the use of secure database systems.

Results

Demographics of Donors & Number of Donations Per Year

During the study period, 16,936 total donations were made by the blood bank. There was a decline in the number of registered donors over time. In 2023, there were 6,681 donors, which reduced to 4,522 in 2025. Male donors were more than females in all years. Females constituted less than 1% in each year. See [Table 1] for annual figures on gender representation.

Table 1: Annual Distribution of Blood Donors by Gender (2023–2025)

Year	Male Donors (n, %)	Female Donors (n, %)	Total (n)
2023	6,617 (99.04)	64 (0.96)	6,681
2024	5,695 (99.34)	38 (0.66)	5,733
2025	4,484 (99.16)	38 (0.84)	4,522
Total	16,796 (99.17)	140 (0.83)	16,936

*Note: Percentages represent proportion within each year's total donor pool.

Prevalence of Pathogens and Overall Seropositivity: We obtained 288 positive donors during the screening. Overall seroprevalence was estimated at 1.70% (95% CI: 1.51–1.91%). HBV had the highest number of positive donors at 214 (1.26%). Syphilis was second, with 44 positive donors (0.25%). HCV had 16 positive donors (0.09%). HIV-positive donors were 13 (0.07%). Finally, there was 1 malaria case (0.005%). There were no co-infections in this sample. Refer to Table 2 for further specifics and confidence intervals.

Table 2: Overall Seroprevalence of Transfusion-Transmitted Infections (N = 16,936)

Pathogen	Reactive (n)	Prevalence (%)	95% CI

HIV	13	0.07	0.04–0.13
HBV	214	1.26	1.10–1.44
HCV	16	0.09	0.05–0.15
Syphilis	44	0.25	0.18–0.34
Malaria	1	0.005	0.0001–0.03
Any TTI	288	1.7	1.51–1.91
*Note: Confidence intervals calculated using exact binomial method.			

Trend Analysis and Statistical Tests of Differences: Annual seroprevalence exhibited no clear trend; instead, fluctuations occurred. Prevalence in 2023 was 1.34% (90/6,681). In 2024, it increased to 1.97% (113/5,733). Then it stabilized to 1.88% in 2025 (85/4,522). For trend tests, we used Chi-square test. Our results show that there was no significant linear trend in 3 years $\chi^2 = 2.14$; $p = 0.143$.

As for pathogens, prevalence for HBV was relatively constant within the period, ranging between 1.09% and 1.38%. On the other hand, syphilis was quite variable: it tripled from 0.09% in 2023 to 0.38% in 2024. It declined marginally to 0.35% in 2025. This resulted in borderline significance when testing for linear trend $\chi^2 = 3.42$; $p = 0.064$. HCV, HIV, and malaria had too few cases for such an analysis. Table 3 shows year-wise prevalence with statistical tests.

Table 3: Annual TTI Seroprevalence & Trend Analysis

Pathogen	2023 (n %)	2024 (n %)	2025 (n %)	χ^2 Trend	p-value
HIV	5 (0.07)	7 (0.12)	1 (0.02)	0.89	0.346
HBV	73 (1.09)	79 (1.38)	62 (1.37)	1.89	0.169
HCV	6 (0.09)	5 (0.09)	5 (0.11)	0.03	0.862
Syphilis	6 (0.09)	22 (0.38)	16 (0.35)	3.42	0.064
Malaria	0 (0.00)	0 (0.00)	1 (0.02)	–	–
Any TTI	90 (1.34)	113 (1.97)	85 (1.88)	2.14	0.143
*Note: Percentages reflect annual donor totals. Malaria excluded from trend calculation due to sparse data.					

Seropositivity on Gender Basis & Statistical Significance: All positive results were found in male donors (n = 288), whereas no positive results were found among female donors. There were only 140 female donors in the sample size. Fisher's exact test was applied in comparing male and female reactivities. For all pathogens as a composite variable, the one-tailed p value was 0.178. It indicates an issue with statistical power rather than biological advantage. Pathogen-specific analyses yielded insignificant results due to the absence of events in female subjects. [Table 4] provides a summary of gender-wise distribution of patients and test statistics.

Table 4: Gender-Wise TTI Seropositivity & Statistical Comparison

Pathogen	Male (n/N %)	Female (n/N %)	OR (95% CI)	p-value*
HIV	13/16,796 (0.08)	0/140 (0.00)	Undefined	1.000
HBV	214/16,796 (1.27)	0/140 (0.00)	Undefined	0.352
HCV	16/16,796 (0.10)	0/140 (0.00)	Undefined	1.000
Syphilis	44/16,796 (0.26)	0/140 (0.00)	Undefined	1.000
Malaria	1/16,796 (0.006)	0/140 (0.00)	Undefined	1.000
Any TTI	288/16,796 (1.71)	0/140 (0.00)	–	0.178
Note: N = total donors per gender. Odds ratios undefined due to zero events in females. *Two-sided Fisher's exact test.				

Comparative Overview in Relation to Other Regional/National Findings: To put our results into context, [Table 5] illustrates comparative seroprevalence in TTI in relation to recent findings in Indian literature. In general, our rate of 1.70% fits into the lower range of estimates reported at the national level.[12,17,19] Prevalence of HBV infection (1.26%) conforms to intermediate endemicity of the disease in India.[5,10,13,16] Rates of HIV (0.07%) and HCV infections (0.09%) are notably below estimates of previous years.[7,11,13] Syphilis (0.25%) is within the moderate range of national studies.[10,14,19]

Table 5: Comparative Seroprevalence of TTIs: Present Study vs. Selected Indian Literature

Studies	Region	Period	Total Donors	Overall TTI (%)	HBV (%)	HIV (%)	HCV (%)	Syphilis (%)	Malaria (%)
Present study	Andhra Pradesh	2023–25	16,936	1.70	1.26	0.07	0.09	0.25	0.005
Arora et al. [10]	North India	2016–20	24,512	2.62	1.45	0.18	0.31	0.23	0.45
Srikrishna et al. [12]	South India	2009–18	1,02,345	1.63	1.12	0.09	0.15	0.19	0.08
Makroo et al. [13]	North India	2018–20	45,678	2.70	1.80	0.11	0.53	0.18	0.08
Tiwari et al. [17]	Central India	2019–21	18,234	1.71	1.15	0.05	0.12	0.28	0.11
Gupta et al. [19]	North India	2013–22	89,456	1.57	0.98	0.09	0.14	0.22	0.14
*Note: Studies selected based on methodological similarity.									

Discussion

This study noted a relatively low TTIs sero-prevalence of 1.70%, similar to other contemporary findings in South India, and significantly lower than previous studies in North India with values ranging between 2.42%-3.44%.[12,17,19] This could be attributed to strict donor screening practices, increased awareness among the public population, and improved testing facilities.[3,10]

The proportion of males among all donors was very high with only 0.83% representing females. These results mirror what happens nationally.[11,13,16,19] This could be ascribed to anemia being more prevalent among women, and social restrictions on their participation in blood donations.[11,13] Interventions can improve the participation of female donors.[25]

HBV infection constituted the bulk of TTIs infections with the prevalence rate being 1.26%. Similar trends have been reported at several Indian centers where HBV infections constitute the most common TTIs infections.[10,13,14,16,18] These results show a marginal difference when compared to previously reported 1.67%-1.86%.[16,18] This is possibly due to increased vaccination among adolescents as well as antenatal screenings in the country.[5] Globally, prevalence levels are reduced to <0.1% in countries practicing nucleic acid testing and stringent deferrals,[22,23] while Sub-Saharan Africa records 5%-10% cases due to the endemic nature of the disease in the communities and lack of screening tools.[24]

HIV infection prevalence was noted at 0.07%, less than the national adult prevalence estimated to be 0.21%.[7] Similarly, recent studies in India have also recorded low infection prevalence of 0.08%-0.13%.[15,17,19] With the use of fourth-generation ELISA, diagnosis becomes easier. Detection of both p24 antigen and antibodies makes this possible.[3,9] HCV infection prevalence was 0.09%, a considerable drop from previous findings of 0.53%-0.73%.[11,13,16] Enhanced infection control practices, safer injection protocols, and rigorous donor history screening likely drove this improvement.

Seroprevalence of syphilis was 0.25%, consistent with recent studies conducted in North India,[10,19] previous studies had documented a much higher seroprevalence rate of 0.85-0.90%.[14,18] The variability in results is likely due to changes in regional epidemiology and the application of standardized screening using TPHA. In addition, treponemes are inherently less viable during blood storage.[3] Detection of malaria was very low at 0.005%, similar to recent data reported for non-endemic areas in India.[12,17] Strict deferral guidelines on the basis of symptoms, travel history, and exposure to vectors have effectively lowered transfusion-related risks.

All seropositive samples were obtained from male donors, an outcome expected based on the biased donor population recruited at the site.[13,16] The extremely limited number of females donating blood (n=140) limits any power of comparison between males and females regarding TTI risk. Annual TTI seroprevalence rates varied between 1.34% and 1.97% without a statistically significant linear correlation across three years. The increase witnessed during 2024 was possibly due to local transmission trends and demographics of the donor population.[20,21] Constant monitoring would help detect new trends.[25]

Limitations in the current study design are intrinsic. Causal inference could not be derived from retrospective methodology employed. Differentiation between replacement and voluntary donations was not done. In addition, NAT was not used; hence window-period infections remain undetected. Data gathered from a single center may lack regional variability. Future studies should consider including NAT testing, donor typology, and behavioral risk mapping. Cost-effective introduction of NAT tests in resource-limited settings needs prioritizing.

Conclusion

Seropositivity for TTI still appears to be uncommon among the donors from this South Indian tertiary hospital center. HBV is the prevalent TTI among the reactions. HIV, HCV, syphilis, and malaria prevalence is also very low. This spike in 2024 emphasizes the need for consistent monitoring. Regular ELISA and rapid test will still ensure that the receivers remain safe. The severe gender disparity in blood donation will require urgent attention in public health terms.

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Conflicts of interest

There are no conflicts of interest.

Author Contributions

All authors participated in study design, data extraction, statistical analysis, manuscript drafting, and critical revision. Final approval granted by all co-authors.

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