

Changing Patterns of Blood Donors: Demographic Trends and Impact On Transfusion-Transmitted Infections

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Abstract

Background: In low- and middle-income nations, where transfusion-transmissible infections (TTIs) continue to cause avoidable morbidity and mortality, ensuring transfusion safety is still a major concern. The World Health Organization (WHO) emphasizes that the safest supply of blood is 100% voluntary non-remunerated blood donation (VNRBD). Nonetheless, a sizable percentage of donations in India still come from replacement donors. The purpose of this study is to evaluate TTIs between replacement and volunteer donors in 2023, 2024, and an intervention period from May to September 2025, during which a vigorous voluntary donor recruiting drive was carried out. **Material and Methods:** This retrospective cross-sectional study evaluated 21,607 donations in 2023, 20,374 in 2024, and 7,209 donations from May to September 2025. Donors were divided into two categories: replacement and volunteer. In accordance with NACO recommendations, ELISA and fast diagnostic techniques were used to screen all units for HIV, HBV, HCV, syphilis, and malaria. Chi-square tests were used to compute and compare prevalence rates. Trends over time were analyzed and placed in the perspective of both domestic and foreign literature. **Findings:** The prevalence of TTI was consistently lower among voluntary donors. The prevalence was 0.83% among replacement donors and 0.20% among voluntary donors in 2023. The rates were 0.30% in 2024 compared to 0.93%. The prevalence dropped from 1.17% to 0.57% in 2025 as a result of an increase in voluntary donors. HBV remained the most prevalent infection (110 in 2023, 111 in 2024, and 34 in 2025), followed by HCV, while HIV remained stable. Syphilis cases rose from 2 in 2023 to 8 in 2025. Although voluntary donations rose to nearly half of all donations in 2025, the overall prevalence increased to 0.90% due to persistent infections among replacement donors. **Conclusion:** Despite progress in voluntary recruitment, replacement donors continue to contribute to TTIs disproportionately. Phasing out replacement donors, expanding HBV vaccination, introducing NAT, and sustaining voluntary recruitment drives are crucial to meeting the WHO's goals of a safe blood supply.

Keywords: Voluntary donors; Replacement donors; Transfusion-transmissible infections; Blood safety; HBV; India.

Received: 25 September 2025

Revised: 10 October 2025

Accepted: 29 October 2025

Published: 29 December 2025

INTRODUCTION

Blood transfusion is a vital lifesaving procedure but comes with the inherent risk of transmitting infectious agents. Globally, transfusion-transmissible infections (TTIs) such as hepatitis B virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), syphilis, and malaria continue to be major causes of illness and death.[1] The World Health Organization (WHO) has consistently emphasized the need for a system based entirely on voluntary, non-remunerated blood donation (VNRBD), as evidence indicates that voluntary donors are the safest source of blood.[2] The HIV epidemic of the 1980s significantly transformed global blood transfusion practices. High-income countries adopted nucleic acid testing (NAT), donor deferral policies, and extensive voluntary donor recruitment, reducing residual risks to as low as 1 in 2 million transfusions.[3] In contrast, many low- and middle-income countries, including India, continue to face challenges due to reliance on replacement donations, limited voluntary donor pools, and lack of advanced screening technology.[4] In India, HBV is endemic, with a prevalence estimated between 2% and 4%.[5] HCV prevalence is lower but rising, partly

due to unsafe injections.[6] While HIV prevalence is decreasing, it remains a concern, and syphilis and malaria sporadically appear in blood screening.[7] Donor motivation and behavior significantly influence transfusion safety. Voluntary donors, driven by altruism, tend to donate repeatedly, honestly disclose risk behaviors, and follow deferral guidelines.[8] Replacement donors often donate under pressure to provide blood for relatives, which may lead to concealed high-risk behaviors, raising the chance of TTIs.[9] Multiple Indian studies have shown a higher prevalence of TTIs among replacement donors compared to voluntary donors. For instance, Makroo et al. in Delhi identified HBV as the most common infection, with higher prevalence

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DOI:
10.21276/amit.2025.v12.i3.277

How to cite this article: Shasi V, Latha B, Murali R. Changing Patterns of Blood Donors: Demographic Trends and Impact On Transfusion-Transmitted Infections. Acta Med Int. 2025;12(3):XX-XX.

among replacement donors.[10] Similar results were found in Punjab, Haryana, and Maharashtra.[11–13] Nonetheless, few studies have examined changes in prevalence over several years or the effects of specific initiatives such as voluntary recruitment campaigns. This study aims to compare TTI prevalence among voluntary and replacement donors in 2023, 2024, and during a voluntary recruitment drive from May to September 2025. Through analysis of annual and donor-type-specific trends, this research intends to inform blood transfusion policies in India.

MATERIALS AND METHODS

Study Design: A retrospective cross-sectional study was conducted in the Department of Transfusion Medicine, Government Mohan Kumaramangalam Medical College, Salem, Tamil Nadu, India. Data from January–December 2023, January–December 2024, and May–September 2025 were analysed.

Study Population: A total of 21,607 donations in 2023, 20,374 in 2024, and 7,209 in May–September 2025 were included in the analysis. Donors were aged 18–65 years, with a minimum weight of 50 kg and a haemoglobin level of ≥ 12.5 g/dL. Donors with a history of high-risk sexual behaviour, recent illness, drug use, pregnancy, lactation, or prior deferral were excluded as per NACO guidelines.^[14]

Donor Classification: Donors were classified into two categories: voluntary and replacement. Voluntary donors donated without expectation of return, while replacement donors were family/friends donating on behalf of patients. **Screening:** All units were screened for HIV (4th-generation ELISA), HBV (HBsAg ELISA), HCV (anti-HCV ELISA), syphilis (RPR/VDRL), and malaria (rapid diagnostic test or smear study). Reactive units were discarded, and donors were confidentially informed and referred for medical care.

Data Analysis: Prevalence of TTIs was calculated per 100 donations. Comparisons between voluntary and replacement donors were made using chi-square tests. Trends across years were analysed. Statistical analysis was conducted using SPSS v26, with $p < 0.05$ considered significant. **Ethical Considerations:** Confidentiality of donors was maintained.

Donor counselling was provided before and after donation.

RESULTS

Donor Demographics: Of the 21,607 donations made in 2023, 30.1% were voluntary and 69.9% were replacement. A comparable allocation of 20,374 gifts (30.7% voluntary, 69.3% replacement) was made in 2024. 7,209 gifts were received between May and September of 2025; recruitment efforts were responsible for a significant rise in voluntary donors (48%). Less than 6% of donors were female, and over 94% of donors were male.

The overall prevalence of TTI was 0.64% in 2023, 0.72% in 2024, and 0.90% in 2025. The increased trend was driven by replacement donors. The prevalence of voluntary donors was 0.20% in 2023, 0.30% in 2024, and 0.57% in 2025, while that of replacement donors was 0.83%, 0.93%, and 1.17% ($p < 0.01$).

Infection Distribution: The most common illness in every year was HBV (110 in 2023, 111 in 2024, and 34 in 2025). The number of HCV cases rose from 22 in 2023 to 27 in 2024, and an additional 20 cases were recorded in 2025. HIV did not change (5 in 2023, 7 in 2024, 3 in 2025). The number of cases of syphilis increased (2 in 2023, 5 in 2024, and 8 in 2025). There was no evidence of malaria. **Interpretation:** The presence of replacement donors maintained a high overall prevalence in 2025 despite a significant increase in the number of voluntary donors. The hazards of depending on replacement donors were highlighted by their disproportionate contribution to infections.

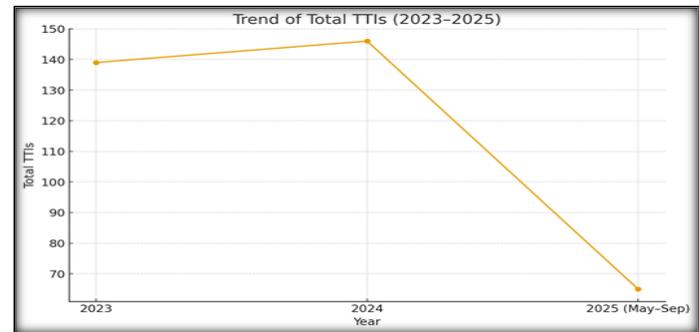


Figure 1: Trend of Total TTIs (2023–2025)

Table 1: Year-wise Donor Demographics and TTI Prevalence

Year	Total Donations	Voluntary	Replacement	TTIs
2023	21607	6508	15099	139
2024	20374	6261	14113	146
2025 (May–Sep)	7209	3660	3749	65

Table 2: Distribution of TTIs by Infection Type

Year	HBV	HCV	HIV	Syphilis	Malaria
2023	110	22	5	2	0
2024	111	27	7	5	0
2025 (May–Sep)	34	20	3	8	0

Table 3: Voluntary vs Replacement Donor TTIs and Prevalence

Year	Voluntary TTIs	Replacement TTIs	Voluntary Prevalence (%)	Replacement Prevalence (%)
2023	14	125	0.2	0.83
2024	19	127	0.3	0.93
2025 (May–Sep)	21	44	0.57	1.17

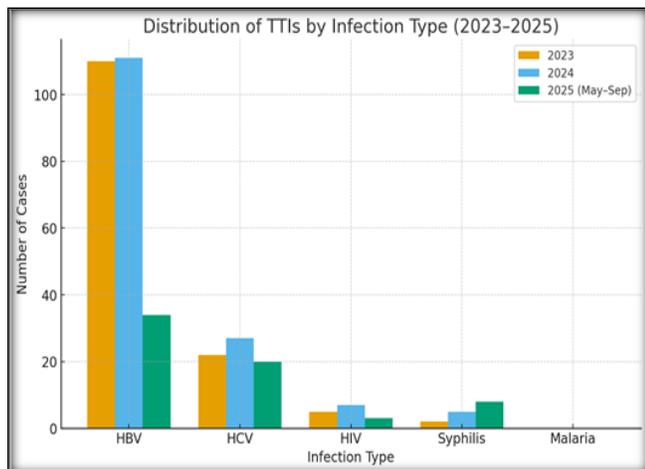


Figure 2: Distribution of TTIs by Infection Type (2023–2025)

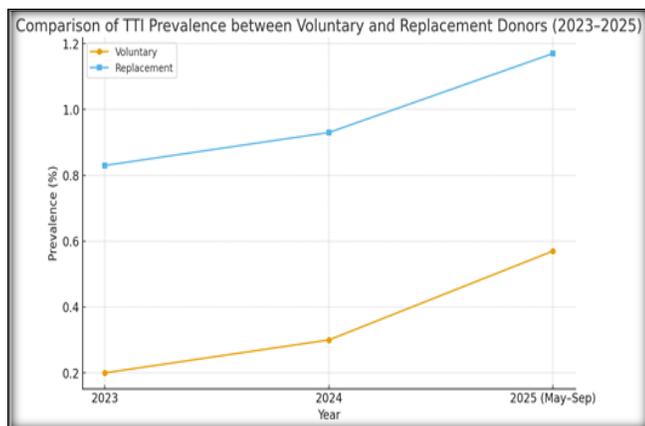


Figure 3: Comparison of TTI Prevalence between Voluntary and Replacement Donors (2023–2025)

DISCUSSION

In comparison to replacement donors, voluntary donors continuously have a reduced prevalence of TTIs, according to data from this three-year study. These results align with earlier research from both India and other countries. Comparing Research from India: According to Makroo et al., replacement donors in Delhi had a greater frequency of TTIs, with HBV predominating. [10] Similar results were also found by Giri et al. in Maharashtra and Arora et al. in Haryana. [11, 12] Our results, which show an overall prevalence of 0.6–0.9%, are consistent with these findings. A research conducted in Chandigarh found a slightly higher frequency of 1.1%, which may be related to the endemicity of HBV in the area. [13] Comparison with International Studies: Due to 100% voluntary donation and NAT, TTI prevalence has drastically decreased in high-income nations, falling below 0.1%. [3]

On the other hand, TTI prevalence in sub-Saharan Africa is said to be 2–5%, primarily because of HIV and HBV. [15] Prevalence rates are comparable to those in India in South Asian nations like Bangladesh and Pakistan, where replacement donation is still widespread. [16] Infection-Specific Trends: Due to HBV's endemicity in India, it was consistently the most prevalent TTI.

Adult vaccination rates remain low, contributing to the persistence of. [5] HCV showed a slow increase, reflecting broader epidemiological patterns. [6] The low HIV prevalence was consistent with the performance of national programs. [7] Other studies have also observed a comeback of STIs, which could be reflected in the spike in syphilis incidence. [17] Voluntary vs. Replacement Donors: WHO's position on 100% voluntary donations was supported by the fact that voluntary donors were safer. [2] This is explained by behavioral factors: voluntary donors are less likely to hide risks, follow safer lives, and are more likely to be repeat donors. Replacement donors might conceal risky behaviors and provide under duress, which would increase infections. [9] Implications: Our results highlight the necessity of doing away with replacement donors. The extension of HBV immunization, the adoption of NAT, community education, and ongoing volunteer donor recruitment drives should be the main goals of policy.

By broadening the pool of potential donors, increasing the number of female donors may also improve safety. Strengths and Limitations: The study's multi-year analysis and big sample size are advantageous. Its retroactive design, reliance on serology without NAT, and single-center scope, however, are its limitations. Only five months of 2025 were examined. Prospective Paths: Future research should evaluate long-term trends, the cost-effectiveness of NAT in India, and the effects of national voluntary recruiting drives. The results of our study are consistent with behavioral theories of health involvement. According to the Health Belief Model, voluntary contributors see more advantages and fewer obstacles to giving, frequently considering it a civic duty.

Replacement donors, on the other hand, may make riskier donations since they are driven more by immediate need than by charity. TTI risks may be further decreased by addressing these psychosocial factors through donor education and counseling. The economic aspect is another crucial concern. Despite its apparent convenience, replacement donation has hidden costs because it increases the danger of infection and requires the disposal of reactive units. In addition to being a waste of resources, these discarded units put additional psychological strain on substitute donors who might later find out they are infected. Clinical and financial inefficiencies are decreased when voluntary mechanisms are strengthened. Globally, effective examples from nations like Thailand and Brazil show that governments can move entire countries to 100% voluntary donation through collaborations with civil society, public education, and donor recruitment. India can draw lessons from these examples by institutionalising voluntary donor recruitment as a public health priority, much like polio eradication and immunisation campaigns.

CONCLUSION

This expanded three-year analysis confirms that voluntary donors are consistently safer than replacement donors. The 2025 voluntary recruitment campaign increased voluntary donations, but overall TTI prevalence rose due to infections among replacement donors. Eliminating replacement donors, expanding HBV vaccination, implementing NAT, and sustaining voluntary recruitment are critical steps toward achieving the WHO's goal

of safe, sufficient, and sustainable blood supplies in India. The evidence presented leaves little doubt that the future of transfusion safety in India lies in the steady elimination of replacement donations. The benefits of voluntary donation extend beyond infection control, as they foster a culture of altruism, build trust in the healthcare system, and ensure a stable blood supply in emergencies. Achieving 100% voluntary donation is not merely a target but a necessity for public health resilience. As India advances toward universal health coverage, integrating blood safety into broader health system strengthening is essential. Ultimately, the transition to an entirely voluntary donor base, supported by vaccination, advanced screening technologies, and robust donor education, will safeguard patients and enhance the credibility of the national transfusion service.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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