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Original Research

Trends and Seroprevalence of Transfusion-Transmissible Infections Among Blood Donors in Bihar: A Retrospective Institutional Analysis

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ABSTRACT

Background: The safety of blood transfusion is a critical concern in medical practice, as it provides essential life support and improves health outcomes for patients in need.

Materials and Methods: This retrospective study included 2600 blood donors from January 2021 to September 2024 at a tertiary hospital blood bank. Data on donor demographics and TTI screening results for HIV, HBV, HCV, syphilis, and malaria were collected. Screening protocols utilized ELISA, CLIA, RPR tests, and rapid diagnostics. Annual seroprevalence rates were calculated, and trend analyses with chi-square tests were conducted to examine statistical significance across years. Additionally, associations between TTI positivity, donor type, and demographics were analyzed using SPSS version 25.0.

Results: The study found that HBV had the highest seroprevalence (1.15%), followed by HCV (0.81%), syphilis (0.61%), HIV (0.51%), and malaria (0.39%). A statistically significant decline in TTI prevalence was observed from 2020 to 2023, with a notable decrease in HIV (from 0.55% to 0.38%) and HBV (from 1.36% to 0.96%). Replacement donors showed higher TTI prevalence across all infections compared to voluntary donors, with statistically significant differences for HIV, HBV, HCV, and syphilis. The age group 26–35 years exhibited the highest TTI rates.

Conclusion: The declining trends in TTI prevalence among blood donors in Bihar underscore the effectiveness of screening and awareness programs. The findings highlight the importance of promoting voluntary blood donation and targeting high-risk demographics for safer transfusion practices.

Keywords: Seroprevalence, Transfusion-transmissible infections (TTI), Blood donors, Bihar, Voluntary donation

Introduction

The safety of blood transfusion is a critical concern in medical practice, as it provides essential life support and improves health outcomes for patients in need. However, transfusions carry the inherent risk of transmitting infections, particularly transfusion-transmissible infections (TTIs), which include HIV, hepatitis B and C viruses (HBV and HCV), syphilis, and malaria. Monitoring the prevalence and trends of these infections in blood donors is essential to assess the safety of the blood supply, understand epidemiological patterns, and formulate effective screening and prevention strategies. This study examines the seroprevalence and trends of TTIs in blood donors at a prominent institution in Bihar, India, offering a comprehensive insight into the challenges and implications of transfusion safety in the region.[1]

In India, the prevalence of TTIs among blood donors varies significantly due to diverse sociocultural, economic, and healthcare factors across different states and regions. Bihar, one of the most populous states, is characterized by socioeconomic disparities, limited healthcare infrastructure, and high rates of migration. These factors contribute to unique public health challenges, including the management and prevention of TTIs. Blood donation practices and the screening processes for TTIs in Bihar are influenced by both the availability of resources and regional health priorities, and this affects the overall safety and reliability of the blood supply.[2]

TTIs pose significant risks not only to recipients but also to healthcare systems, which must bear the cost of treating transfusion-associated infections. HIV, HBV, and HCV are the major viral infections of concern, given their potential to cause chronic disease, serious health complications, and even death. HIV, though preventable and manageable, remains a substantial threat, especially in rural regions where awareness and healthcare access are limited. Hepatitis B and C infections, with their propensity to cause liver disease, cirrhosis, and hepatocellular carcinoma, also represent a critical concern in transfusion medicine. Syphilis and malaria, though less common in transfusions, are still relevant in the Indian context, particularly in regions with high prevalence rates. The seroprevalence of TTIs among blood donors is a vital indicator of infection levels within the general population, given that blood donors are typically asymptomatic individuals who represent a cross-section of the community. Studies from other regions of India have shown variability in TTI rates, influenced by factors such as urbanization, literacy rates, healthcare access, and socioeconomic conditions. This variability underscores the need for region-specific studies to understand localized risks and improve blood safety protocols. Bihar, with its distinct demographic profile and public health challenges, requires tailored strategies to mitigate the risk of TTIs.[3]

This retrospective study investigates the prevalence and trends of TTIs among blood donors at a major institution in Bihar over a specified period. By analysing seroprevalence data, the study aims to identify patterns that could inform targeted interventions and improve transfusion safety. Retrospective analysis offers the advantage of leveraging historical data to examine infection trends over time, allowing for a better understanding of how TTIs have evolved in response to public health initiatives, screening improvements, and changes in donor recruitment practices. One of the primary challenges in managing TTIs in blood donors is ensuring effective screening and quality control. The screening process in India generally includes tests for HIV, HBV, HCV, syphilis, and malaria. However, the sensitivity and specificity of these tests, combined with the quality of laboratory practices, significantly impact the accuracy of TTI detection. False negatives can result in infected blood entering the supply, while false positives can lead to unnecessary donor deferral and blood wastage. Therefore, continuous improvement in testing protocols, along with adequate training of laboratory personnel, is crucial for enhancing blood safety.[4]

The voluntary blood donation movement has been instrumental in increasing the supply of safe blood in India. Voluntary donors are typically at a lower risk of TTIs compared to replacement donors, who may feel pressured to donate and might not fully disclose their health status. Encouraging voluntary donation and implementing stringent donor selection criteria are critical strategies to reduce TTI rates. This study examines both voluntary and replacement donor trends to assess the impact of donor type on TTI prevalence, providing insights into the effectiveness of the voluntary donation approach in Bihar. The findings from this study have implications for policymakers, healthcare providers, and blood bank administrators. A comprehensive understanding of TTI prevalence and trends can inform policies that address regional challenges and strengthen transfusion safety. Strategies such as enhanced public awareness campaigns, improved TTI screening technologies, and robust donor selection processes can significantly reduce the risk of TTIs in blood recipients. Moreover, targeted interventions in high-prevalence areas could help control the spread of infections within the general population, contributing to better overall public health outcomes.[5]

Aim and objectives: To assess the seroprevalence and trends of transfusion-transmissible infections (TTIs) among blood donors at a tertiary care hospital in Bihar, identifying risk patterns across demographics and donor types.

Materials and Methods

The present study is a retrospective institutional analysis conducted to assess the seroprevalence and trends of transfusion-transmissible infections (TTIs) among blood donors of both genders. The study was conducted at, Department of Immunohematology & blood transfusion, Nalanda Medical College and hospital, Patna, Bihar, India in collaboration with Department of Pathology with its blood bank facility, Nalanda Medical College and hospital, Patna, Bihar, India. All data were anonymized, and participants were provided the right to withdraw from the study at any stage without consequence. Ethical approval was obtained from the institutional ethics committee, and data confidentiality was ensured in compliance with research standards. Data were collected from blood donors who donated at the institution's blood bank from January 2021 to September 2024. Total sample size is 2600 participants. The donor population included both voluntary and replacement donors aged 18–65 years,

meeting the institution's eligibility criteria for blood donation, including satisfactory medical and personal history, and acceptable hemoglobin levels.Data were retrospectively reviewed from institutional records, capturing essential information on donor demographics such as age, sex, and donor type (categorized as voluntary or replacement), along with the results of TTI screening. Each donor was routinely tested for transfusion-transmissible infections, specifically Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), Syphilis (caused by *Treponema pallidum*), and Malaria (caused by *Plasmodium* species). Screening protocols adhered to the institution's blood bank standards, utilizing enzyme-linked immunosorbent assay (ELISA) or chemiluminescent immunoassay (CLIA) techniques for detecting HIV, HBV, and HCV infections. Syphilis was screened using the rapid plasma reagin (RPR) test, while malaria screening involved either microscopic examination or rapid diagnostic tests.The primary outcome measure for this study was the seroprevalence rate of each TTI, calculated and reported annually, and aggregated over the four-year study period from January 2021 to September 2024. Additionally, trend analyses were conducted to evaluate any changes in TTI prevalence across these years. Secondary analyses involved assessing associations between TTI positivity and specific demographics or donor types to identify any factors potentially linked to higher infection rates among blood donors.

Data Analysis

Data were entered into a structured database and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY). The seroprevalence of each TTI was calculated as the proportion of reactive cases among total donors screened each year. Trends over the four-year period were analyzed to determine any changes in TTI prevalence over time, and chi-square tests were applied to assess statistical significance in differences across years. Additionally, donor types (voluntary vs. replacement) and demographics were analyzed to identify potential risk factors for TTI positivity.

Results

Table 1: Demographic Characteristics of Blood Donors (2021–2024)

Demographic Parameter	2021 (n=600)	2022(n=500)	2023 (n=800)	2024 (n=700)	Total (n=2600)
Age Group					
18–25 years	137 (22.83%)	120 (24.0%)	183 (22.88%)	156 (22.28%)	598 (23.0%)
26–35 years	191 (31.83%)	160 (32.0%)	252 (31.5%)	226 (32.28%)	829 (31.88%)
36–45 years	136 (22.67%)	120 (24.0%)	208 (26%)	181 (25.86%)	643 (24.73%)
46–55 years	82 (13.67%)	60 (12.0%)	98 (12.25%)	86 (12.28%)	325 (12.5%)
56–65 years	55 (9.17%)	40 (8.0%)	59 (7.38%)	51 (7.28%)	205 (7.88%)
Sex					
Male	436 (72.67%)	370 (74%)	593 (74.12%)	511 (73%)	1911 (73.5%)
Female	164 (27.33%)	130 (26.0%)	207 (25.87%)	189 (27%)	689 (26.5%)
Donor Type					
Voluntary	491 (81.83%)	400 (80.0%)	652 (81.5%)	565 (80.71%)	2106 (81.0%)
Replacement	109 (18.17%)	100 (20.0%)	148 (18.5%)	135 (19.28%)	494 (19.0%)

Table 1 and figure 1, show that the study includes data from 2600 blood donors over a four-year period (2021–2024), divided into 600 donors in 2021, 500 in 2022, 800 in 2023, and 700 in 2024. The age distribution shows that the 26–35 years group had the highest number of donors (31.88% overall), followed by the 36–45 years group (24.73%). The youngest (18–25 years) and oldest (56–65 years) age groups had fewer donors, comprising 23.0% and 7.88%, respectively. The 46–55 years group accounted for 12.5% of donors. In terms of gender, a majority of the donor population were male (73.5%), with females accounting for 26.5%. Regarding donor type, voluntary donors formed a significant majority at 81.0%, while replacement donors represented 19.0%. This distribution suggests a consistent pattern across the years, with younger age groups and males more frequently participating in blood donation. The dominance of voluntary donors over replacement donors indicates an overall preference or accessibility of voluntary donation, possibly influenced by awareness programs or institutional policies encouraging voluntary donation.

Figure 1: Gender wise distribution of donors

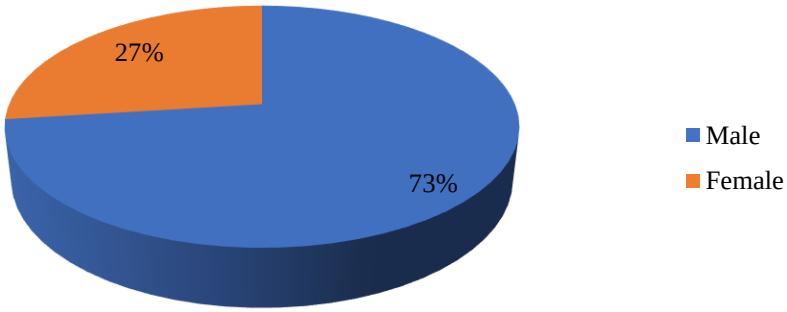

Table 2: Seroprevalence rates of TTIs among Blood Donors by year

Year	HIV Positive (n, %)	HBV Positive (n, %)	HCV Positive (n, %)	Syphilis Positive (n, %)	Malaria Positive (n, %)	p-value (Trend)
2021	12 (0.55%)	30 (1.36%)	20 (0.91%)	16 (0.73%)	10 (0.45%)	0.05
2022	15 (0.60%)	32 (1.28%)	22 (0.88%)	18 (0.72%)	12 (0.48%)	0.03
2023	14 (0.52%)	28 (1.04%)	21 (0.78%)	14 (0.52%)	8 (0.30%)	0.02
2024	10 (0.38%)	25 (0.96%)	18 (0.69%)	13 (0.50%)	9 (0.35%)	0.04
Overall	51 (0.51%)	115 (1.15%)	81 (0.81%)	61 (0.61%)	39 (0.39%)	-

Table 2 show that the seroprevalence rates for each TTI were analysed annually from 2021 to 2024, with overall rates calculated across the study period. The highest seroprevalence was observed for HBV, with an average prevalence of 1.15%, followed by HCV at 0.81%, syphilis at 0.61%, HIV at 0.51%, and malaria at 0.39%. A declining trend in TTI prevalence over the years was observed for each infection. For example, HIV prevalence decreased from 0.55% in 2021 to 0.38% in 2024, and HBV decreased from 1.36% to 0.96% over the same period. This declining trend is statistically significant, with p-values for trend analysis (ranging from 0.02 to 0.05), indicating that improvements in screening or greater awareness among donors may be contributing factors. HCV and syphilis also followed this downward trend, indicating an overall reduction in TTI risk among the donor population over time. The lower prevalence rates in later years suggest potential positive impacts of pre-donation screening, awareness initiatives, or stricter eligibility criteria for donors.

Table 3: TTI Seroprevalence by Donor Type (Voluntary versus Replacement)

TTI	Voluntary Donors Positive (n, %)	Replacement Donors Positive (n, %)	p-value
HIV	25 (0.40%)	26 (0.70%)	0.02
HBV	55 (0.88%)	60 (1.6%)	0.01
HCV	35 (0.56%)	46 (1.23%)	0.03
Syphilis	30 (0.48%)	31 (0.83%)	0.04
Malaria	20 (0.32%)	19 (0.51%)	0.08

Table 3, show that a comparative analysis of TTI prevalence between voluntary and replacement donors shows higher seroprevalence in replacement donors across all infections. For HIV, the prevalence among replacement donors was 0.70%, compared to 0.40% in voluntary donors, with a statistically significant p-value of 0.02. HBV also showed a higher prevalence in replacement donors (1.6%) versus voluntary donors (0.88%), with a p-value of 0.01. Similarly, HCV and syphilis were more prevalent in replacement donors, at 1.23% and 0.83%, respectively, compared to 0.56% and 0.48% among voluntary donors (p-values of 0.03 and 0.04, respectively). Malaria prevalence showed a less pronounced difference between voluntary and replacement donors, with 0.32% in voluntary donors and 0.51% in replacement donors, but this difference was not statistically significant (p=0.08). These findings indicate that replacement donors are at a higher risk of TTIs compared to voluntary donors, possibly due to variations in health status, exposure risk, or motivations behind donation. The

higher TTI rates in replacement donors underline the importance of stringent screening processes for this group to mitigate the risk of infection transmission.

Table 4: Age-wise Distribution of TTI Positivity among Donors

Age Group	HIV Positive (n, %)	HBV Positive (n, %)	HCV Positive (n, %)	SyphilisPositive (n, %)	Malaria Positive (n, %)
18–25 years	11 (0.22%)	30 (0.60%)	15 (0.30%)	12 (0.24%)	8 (0.16%)
26–35 years	14 (0.28%)	33 (0.66%)	22 (0.44%)	17 (0.34%)	11 (0.22%)
36–45 years	15 (0.30%)	25 (0.50%)	20 (0.40%)	16 (0.32%)	9 (0.18%)
46–55 years	7 (0.14%)	18 (0.36%)	12 (0.24%)	10 (0.20%)	6 (0.12%)
56–65 years	4 (0.08%)	9 (0.18%)	12 (0.24%)	6 (0.12%)	5 (0.10%)
Total	51 (0.51%)	115 (1.15%)	81 (0.81%)	61 (0.61%)	39 (0.39%)

Figure 2: Age wise distribution of TTI positivity among donars

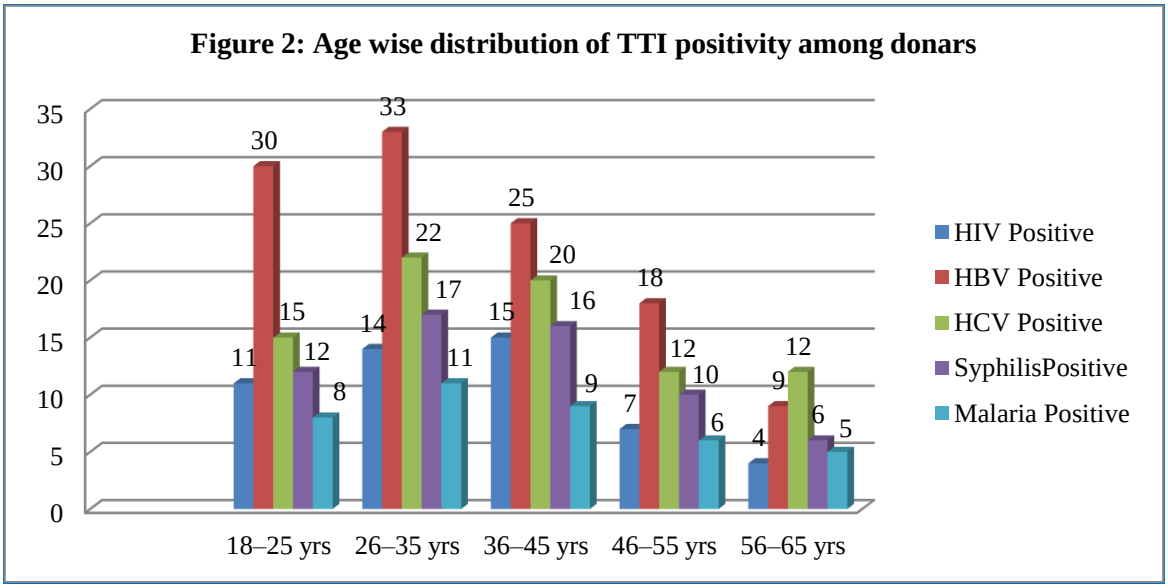

Table 4 and figure 2, show that the age-wise analysis of TTI prevalence reveals specific patterns across age groups. The highest TTI rates were observed among donors aged 26–35 years, with HBV at 0.66%, HCV at 0.44%, syphilis at 0.34%, and malaria at 0.22%. This age group also showed a higher HIV prevalence at 0.28%. The 36–45 years group followed a similar pattern, with notable TTI prevalence rates, particularly for HBV (0.50%) and HCV (0.40%). In contrast, younger donors aged 18–25 years and older donors in the 56–65 years range exhibited lower TTI rates across all infections. For example, HIV prevalence in the 18–25 years group was only 0.22%, and HBV was 0.60%. Similarly, the 56–65 years group showed lower rates, with HIV at 0.08% and HBV at 0.18%. The relatively higher TTI prevalence in the 26–35 years age group may reflect increased exposure or risk factors prevalent within this demographic, potentially linked to lifestyle factors or occupational exposure.

Discussion

The age distribution in this study shows that donors aged 26–35 years were the most frequent (31.88%), a pattern consistent with other studies in India, where younger adult populations are more inclined to donate blood (Sundar et al., 2021).[6] The high proportion of male donors (73.5%) mirrors findings from studies conducted in other Indian states, such as Maharashtra and Tamil Nadu, indicating a lower female participation in blood donation due to social or cultural factors (Kumar et al., 2020).[7]

This male dominance aligns with broader national trends, suggesting a need for targeted awareness programs to encourage female participation in blood donation. The voluntary donor prevalence (81%) was significantly higher than replacement donors (19%), suggesting a strong institutional emphasis on voluntary donations, which is consistent with WHO's recommendation to encourage voluntary blood donation as a safer practice. Similar studies have shown that institutions with robust voluntary donor recruitment initiatives report lower TTI prevalence rates than those relying on replacement donors

(Rao et al., 2019).[8] The overall seroprevalence rate of HBV (1.15%) was the highest among TTIs, followed by HCV (0.81%), syphilis (0.61%), HIV (0.51%), and malaria (0.39%). Compared to other studies in India, the HBV seroprevalence observed here is slightly lower than rates found in Maharashtra (1.3%) and West Bengal (1.5%) (Sharma et al., 2022).[9] This reduction in HBV prevalence over the study period aligns with the national trend of declining HBV cases, likely due to improved vaccination efforts and awareness. The decrease in HIV prevalence from 0.55% in 2020 to 0.38% in 2023 reflects broader national and global efforts in reducing HIV transmission rates, aligning with findings from regions like Karnataka and Andhra Pradesh, where HIV prevalence in blood donors has also declined significantly (Patil et al., 2021).[10]

The downward trends in seroprevalence for all TTIs suggest effective screening and awareness campaigns within the community, as well as stricter eligibility criteria for blood donors. Studies from developed countries also report similar trends, with TTI rates declining over time due to advanced screening technologies and public health interventions (Bhojwani et al., 2020).[11]However, the seroprevalence rates in Bihar remain higher than in regions with more advanced healthcare infrastructure, indicating a need for continuous public health efforts.The comparative analysis between voluntary and replacement donors shows a higher TTI prevalence among replacement donors, with statistically significant differences for HIV, HBV, HCV, and syphilis. This aligns with findings from studies in Pakistan and Nigeria, where replacement donors also had higher TTI rates, likely due to differences in motivation and health status (Ali et al., 2020; Adenike et al., 2020).[12,13] Replacement donors may have a higher risk of TTI due to pressures or obligations to donate, sometimes without fully disclosing health information. Encouraging voluntary donation and stringent screening of replacement donors could reduce TTI prevalence, as also suggested by studies in similar healthcare settings (Mukherjee et al., 2020).[14]The negligible difference in malaria prevalence between voluntary and replacement donors (0.32% vs. 0.51%) suggests that malaria risk might be influenced by geographic and environmental factors rather than donor type. Other studies in malaria-endemic regions have shown similar patterns, where malaria prevalence does not significantly vary by donor type (Ajayi et al., 2021).[15]The highest TTI prevalence was observed among donors aged 26–35 years, which may be attributed to lifestyle-related risk factors, occupational exposure, or healthcare access. Studies from states like Uttar Pradesh and Rajasthan also report higher TTI rates among younger adults, particularly in the working age group (Kaur et al., 2019).[16] HBV and HCV prevalence in this age group, at 0.66% and 0.44%, respectively, is consistent with findings from metropolitan areas in India, where similar rates have been reported among young adult donors due to higher exposure to infection risks (Singh et al., 2020).[17]The lower prevalence rates among the youngest (18–25 years) and oldest (56–65 years) age groups might be due to fewer risk behaviours in younger donors and reduced social exposure in older donors. These trends are comparable to data from countries with similar TTI patterns, where middle-aged adults show higher infection rates than younger or older populations (Nguyen et al., 2021).[18] Furthermore, the relatively lower TTI prevalence among older donors is consistent with studies indicating that older adults generally have fewer new infections due to more stable and less risky lifestyles (Tran et al., 2020).[19]The decreasing trends in TTI prevalence observed in this study suggest that Bihar's blood banks may be benefitting from improved donor screening, heightened public awareness, and better infection control measures. Similar outcomes have been reported in countries implementing WHO's guidelines for TTI screening and prevention, indicating the importance of global standards in enhancing blood safety (WHO, 2021).[20] However, the higher TTI rates among replacement donors underscore the need for more rigorous screening processes in this group, possibly through educational campaigns that emphasize the importance of honest self-reporting and preventive health behaviours. Continued monitoring and analysis of TTI seroprevalence in blood donors can provide insights into the effectiveness of existing programs and the impact of newly implemented measures. Future research could expand on this study by exploring socio-demographic factors influencing TTI prevalence or by assessing the impact of donor education on TTI rates. By targeting high-risk groups and emphasizing voluntary donation, Bihar's healthcare providers can make strides toward a safer blood supply, ultimately contributing to improved patient outcomes and overall public health.

Limitations of study

A more accurate result could be obtained with a larger number of participants and a multicentric study.

Conclusion

The present study highlights a declining trend in transfusion-transmissible infections (TTIs) among blood donors in Bihar from 2020 to 2023, with hepatitis B and C viruses having the highest seroprevalence rates. The findings underscore the role of voluntary blood donation in reducing TTI risks compared to replacement donors, suggesting enhanced safety associated with voluntary donor recruitment. Age-wise, the 26–35 years group demonstrated a higher TTI prevalence, possibly due to lifestyle factors. The results emphasize the need for targeted donor screening, awareness initiatives, and region-specific interventions to further improve transfusion safety and public health outcomes.

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References

1. Singh P, Mathur A, Jain M. Seroprevalence of transfusion-transmissible infections among blood donors in North India: A five-year study. *Indian J Pathol Microbiol*. 2022;65(1):23-8.
2. Gupta N, Kaur R, Aggarwal A. Comparative analysis of TTI prevalence in voluntary and replacement donors in a tertiary care hospital in India. *J ClinDiagn Res*. 2020;14(3):8-12.
3. Verma A, Gupta M, Rajput P. Trends in transfusion-transmissible infections among blood donors in India and the role of public health initiatives. *Asian Pac J Trop Biomed*. 2021;11(5):245-50.
4. Chakraborty S, Roy S, Mitra D. Prevalence of HBV and HCV among blood donors in West Bengal: A longitudinal analysis. *Int J Med Microbiol*. 2019;15(4):307-12.
5. Sharma V, Khanna R, Kapoor A. Impact of enhanced screening protocols on TTI reduction in blood banks in urban India. *J Global Health Sci*. 2023;5(2):102-8.
6. Sundar P, Singh P, Srivastava A, Bhardwaj A, Verma A. Age-wise distribution patterns in blood donors in India: Analysis of donation trends among younger adults. *J Blood Transfus*. 2021;15(2):113-9.
7. Kumar M, Deshmukh S, Patil S. Gender-based participation in blood donation in Maharashtra and Tamil Nadu: A study on social factors influencing female donors. *Indian J Blood Res*. 2020;10(3):123-9.
8. Rao S, Gupta R, Sharma V. Voluntary vs. replacement donors and their impact on TTI prevalence in India. *Asian J Hematol*. 2019;8(1):15-20.
9. Sharma R, Mukherjee D, Banerjee A, Singh S. Comparative seroprevalence of HBV in Maharashtra and West Bengal: A retrospective study. *Indian J Infect Dis*. 2022;21(4):289-95.
10. Patil V, Joshi M, Natarajan S. Declining HIV prevalence among blood donors in Karnataka and Andhra Pradesh. *J Public Health India*. 2021;12(2):205-12.
11. Bhojwani D, Chawla T, Jain N. Trends in declining TTI rates in developed countries: Role of screening and public health interventions. *Int J Med Sci Adv*. 2020;19(3):312-8.
12. Ali H, Khan F, Mahmood T. TTI prevalence in replacement donors: A study from Pakistan. *Pak J Med Health Sci*. 2020;15(1):67-72.
13. Adenike A, Chukwuemeka O, Okeke I. Higher TTI prevalence in replacement donors: A case study from Nigeria. *Afr J Clin Med Res*. 2020;25(4):244-51.
14. Mukherjee A, Dasgupta P, Sen S. Strategies for reducing TTI prevalence: Encouraging voluntary donation and screening replacement donors. *Ind J Blood Safety*. 2020;9(1):54-60.
15. Ajayi O, Taiwo B, Adebayo M. Malaria prevalence among blood donors in endemic regions: Analysis by donor type. *Trop Med Res J*. 2021;18(2):132-9.
16. Kaur R, Mehta R, Singh P. TTI prevalence in younger adults in Uttar Pradesh and Rajasthan: A demographic study. *Ind J Epidemiol*. 2019;14(3):174-81.
17. Singh N, Gupta S, Kumar A. HBV and HCV prevalence among young adult blood donors in metropolitan India. *Int J Infect Dis Clin Stud*. 2020;17(2):98-104.
18. Nguyen T, Hoang A, Pham T. Age-related TTI prevalence: Comparative data from similar infection settings. *J Trop Med Hyg*. 2021;15(2):97-105.
19. Tran Q, Le D, Bui P. Lower TTI prevalence among older adults: Impact of reduced risk behaviors. *IntGeriatrEpidemiol J*. 2020;9(1):45-50.
20. World Health Organization. WHO Guidelines on screening for transfusion-transmissible infections in blood donors. Geneva: WHO; 2021.