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Original Article

Pathology Section

Seroprevalence of Transfusion Transmitted Infections among Healthy Voluntary Blood Donors: A Cross-sectional Study from Northern Kashmir Valley, India

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ABSTRACT

Introduction: Blood transfusion is an effective treatment that saves millions of lives globally; however, Transfusion Transmissible Infections (TTIs) pose a potentially life-threatening risk. It is estimated that each unit of blood transfusion carries nearly a 1% risk of complications, including TTIs. Developed countries have significantly reduced the risk of TTIs through effective blood donor selection and advanced testing methodologies. In contrast, TTIs remain a considerable challenge to safe blood transfusion in developing countries, including India.

Aim: To determine the seroprevalence of TTIs among apparently healthy voluntary blood donors at Government Medical College, Baramulla, Jammu and Kashmir, India.

Materials and Methods: A cross-sectional study was conducted to determine the seroprevalence of TTIs among donors who donated blood at the Blood Centre, Department of Pathology, Government Medical College, Baramulla, Jammu and Kashmir, India between April 2021 and March 2025. Donated blood units were screened for five TTIs: Human Immunodeficiency Virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), syphilis, and malaria. Each blood unit was tested by ELISA for HIV, HBV, and HCV, while syphilis and malaria were screened using rapid antigen diagnostic tests. All reactive blood units were discarded as per the standard operating procedures of the blood centre. Results were expressed in numbers and percentages.

Results: Out of 14,154 voluntary blood donors, 13,973 (98.72%) were male and 181 (1.28%) were female. A total of 95 donors (0.67%) tested seropositive for TTIs. Notably, all TTI-positive cases were observed among male donors. The prevalence rate was highest for HCV at 60 (0.42%), followed by HBV at 22 (0.16%), syphilis at 11 (0.08%), HIV at 2 (0.01%), and malaria at 0 (0%). The highest percentage of TTI cases was noted in the 21-30 years age group with 54 (56.84%) cases, followed by the 31-40 years age group with 32 (33.68%) cases.

Conclusion: The increasing trend of HCV seropositivity among apparently healthy voluntary blood donors is a major concern. To combat TTIs, public awareness regarding the benefits of voluntary blood donation, adoption of modern screening techniques such as Nucleic Acid Testing (NAT) and Chemiluminescence Assays (CLIA), along with thorough donor evaluation, rigorous post-donation counselling, and follow-up alerts are strongly recommended.

Keywords: Hepatitis B virus, Hepatitis C virus, Human immunodeficiency virus, Malaria, Syphilis, Voluntary donors

INTRODUCTION

Blood transfusion is a critical component of clinical treatment and is one of the most widely used therapeutic interventions worldwide [1]. However, unsafe transfusion practices can expose patients to serious TTIs, including HIV, HBV, HCV, syphilis, and malaria [2]. TTIs may remain silent in the host, particularly during the window period when antibody and antigen levels are too low to be detected by current screening techniques, posing a potential threat to recipients [3]. Since donors may carry infectious diseases even when asymptomatic, these infections can significantly contribute to disease prevalence within the community [4]. The risk posed by TTIs is a major public health challenge, especially in developing countries like India, where factors such as a high burden of infectious diseases, limited screening resources, and dependence on replacement donors increase vulnerability [5].

India, with its large population and diverse healthcare infrastructure, faces considerable challenges in ensuring blood safety. The seroprevalence of TTIs varies widely across different regions [6]. In certain rural areas with limited access to advanced technologies, the risk of TTI transmission is even more concerning. Although highly sensitive detection methods exist, false-negative results may still occur due to asymptomatic carriers, donations during the window period, viral genetic variability, and technical errors. Therefore, preventing TTIs remains one of the most significant challenges in transfusion medicine [7]. As per the Ministry of Health and Family Welfare (Government of India), under the Drugs and Cosmetics Act, 1945 (Amendment 2020), all blood donors must be screened for five major infections: HIV-1 and HIV-2, HBV, HCV, syphilis, and malaria [8]. These infections are of major concern due to their prolonged viraemia, long latency period, and potential to cause chronic, life-threatening conditions [9].

HIV, HBV, and HCV are among the most common blood-borne viruses responsible for global morbidity and mortality [10]. According to the WHO, the global prevalence of HCV is 854.09 per 100,000 population. Chronic hepatitis, cirrhosis, and hepatocellular carcinoma have been strongly associated with chronic HCV infection [11]. The prevalence of HCV varies widely between 0.2% and 40% across different regions of the world [12]. HCV infections are estimated to affect nearly 170 million people worldwide [13]. Hepatitis B transmitted through blood has infected millions globally, with approximately 400 million individuals chronically infected [14]. Blood transfusion accounts for about 15% of all HIV-infected patients [15]. HCV and HBV infections are common among people living with HIV due to shared modes of transmission. Co-morbidities such as liver disease caused by HCV or HBV are a significant concern in HIV-infected individuals [16].

Therefore, evaluation of TTIs is crucial for assessing the safety of the blood supply and monitoring the effectiveness of currently employed screening procedures [17].

This study was undertaken to evaluate the overall seroprevalence and trends of TTIs over a period of four years. It also aimed to determine yearly seropositivity rates and their distribution across different age groups. The objective of the present study was to determine the seroprevalence of TTIs among different age groups over four years in apparently healthy voluntary blood donors at Government Medical College, Baramulla, Jammu and Kashmir, India.

MATERIALS AND METHODS

A cross-sectional observational study was conducted at the Blood Centre (Blood Bank), Department of Pathology, Government Medical College, Baramulla, North India, between 1st April 2021 and 31st March 2025. Blood was collected in sterile blood collection equipment following standard venipuncture procedures. Approval for the study was granted by the Institutional Review Board (No.: GMC/BLA/IRB/2025/Cert/03).

Inclusion criteria: Individuals aged 18 to 65 years who were physically healthy and weighed a minimum of 45 kg, with a haemoglobin level of at least 12.5 g/dL for women and 13.5 g/dL for men, were eligible to donate blood. The maximum age for first-time donors was 60 years, and for repeat donors, 65 years. Eligibility criteria were based on the Standard Operating Procedures (SOPs) of the Blood Centre, as outlined in the Blood Donor Selection and Referral Guidelines [18].

Exclusion criteria: Individuals engaged in high-risk activities, asthmatics using steroids, and patients receiving anticoagulation therapy were excluded. The exclusion criteria followed the SOPs of the Blood Centre in accordance with the Blood Donor Selection and Referral Guidelines [18].

Study Procedure

Healthy blood donors were screened by trained faculty using a detailed medical history and physical examination based on the Blood Centre SOPs and the Guidelines for Blood Donor Selection and Referral. A bilingual questionnaire (English and Urdu), prepared as per the annexure of the guidelines [18], was provided to donors to collect information regarding name, age, gender, date of birth, marital status, occupation, email address, contact number, and residential address. Questions related to general health, dietary habits, sleep quality, history of jaundice, cardiac or renal disease, sexually transmitted diseases, high-risk behaviour, current febrile illness, tattoos, alcohol intake, and drug use were included. A qualified counsellor advised donors regarding health concerns and the blood donation procedure. Donors deemed suitable and willing to donate provided informed consent. After evaluation, each donor was assigned a unique identification number.

Blood collection: For serological testing, 2 mL of venous blood was collected in a plain vacutainer, allowed to clot at room temperature, and centrifuged under aseptic conditions. For malaria screening, 2 mL of EDTA-anticoagulated blood was collected.

Immunoanalysis: Separated serum was used for TTI testing. The tests included HIV, HBV, HCV, and syphilis. Antibodies to HIV-1 and HIV-2 were detected using 4th-generation Medsource ELISA kits. Hepatitis B surface antigen (HBsAg) and HCV antibodies were detected using 3rd-generation Medsource ELISA kits. Syphilis screening was performed using MAXLINE rapid plasma reagin (RPR) kits manufactured by Avecon.

Serological testing equipment included ELISA Washers (Tulip, BIORAD), VDRL Shaker (BRIGHT), Incubator (SEDKO), Centrifuge (REMI), and Blood Centre Refrigerator (TERUMO PENPOL). Malaria screening was performed using CLEAR SCAN rapid test kits (Recombigen), which detect *Plasmodium falciparum* and *Plasmodium vivax* antigens using whole blood.

Tests were performed according to the manufacturers' instructions using both positive and negative controls. In-house controls were run simultaneously with each reagent lot. Seroreactive blood units were discarded in accordance with Biomedical Waste Management Rules [19].

STATISTICAL ANALYSIS

The data were collected in an Excel datasheet and analysed.

RESULTS

Among the 14,154 voluntary blood donors from the general population who donated blood over a span of four years, 13,973 (98.72%) were male donors, while 181 (1.28%) were female donors. A total of 95 donors (0.67%) tested positive for TTIs. Notably, all TTI-positive cases were male [Table/Fig-1].

Sex	Number of donors	Percentage	Positive for TTI
Male	13973	98.72	95
Female	181	1.28	00
Total	14154	100	95

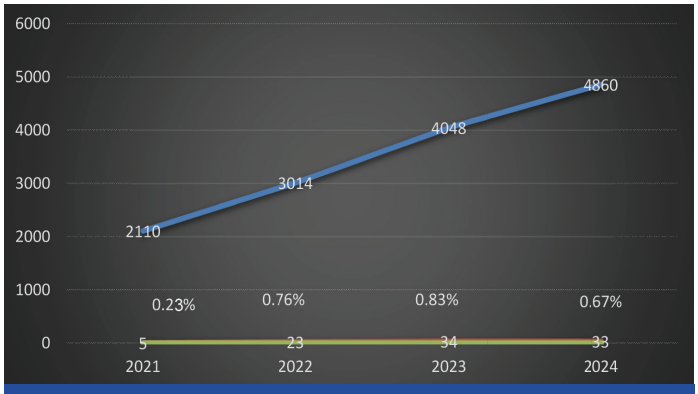
[Table/Fig-1]: Total voluntary donors during four years period.

Based on age distribution, the youngest donor was 18 years old and the oldest was 65 years old. The age group of 21-30 years exhibited the highest percentage of TTI-positive cases, with 54 individuals (56.84%). This was followed by the age group of 31-40 years, accounting for 32 cases (33.68%) [Table/Fig-2]. The overall seroprevalence rate during the study period was 0.67%.

Age group (years)	TTI positive cases	Percentage of positive cases
18 to 20	03	3.15
21 to 30	54	56.84
31 to 40	32	33.68
41 to 50	06	6.31
51 to 65	00	0

[Table/Fig-2]: Age group of TTI positive cases.

Year-wise seroprevalence for 2021, 2022, 2023 and 2024 was 5 (0.23%), 23 (0.76%), 34 (0.83%), and 33 (0.67%), respectively [Table/Fig-3]. The highest seropositivity was recorded for HCV at 60 (0.42%), followed by HBV at 22 (0.16%), syphilis at 11 (0.08%), and HIV at 2 (0.01%). No cases of malaria were identified during the study period. Over the four years, the seroprevalence pattern indicated that hepatitis C infection was the most prevalent, followed by hepatitis B and syphilis [Table/Fig-4].



[Table/Fig-3]: Year wise distribution of seropositive donors.

Type of TTI	Total positive cases	Total no. of blood units screened	Percentage of positive cases
HCV	60	14154	0.42
HBV	22		0.16
HIV	02		0.014
Syphilis	11		0.08
Malaria	00		0
Total	95		0.67

[Table/Fig-4]: Seroprevalance of different TTIs cases over four years period.

DISCUSSION

The TTIs continue to pose a major challenge, contributing significantly to morbidity and mortality worldwide. In the current study, an attempt was made to determine the seroprevalence of five major TTIs—HIV, HBsAg, HCV, syphilis and malaria. The study population predominantly consisted of males aged 18-40 years, with 98.72% male donors and 1.28% female donors. A total of 95 donors (0.67%) were TTI-positive, and all positive cases were males. The seropositivity rates for HCV, HBV, HIV and syphilis were 0.42%, 0.16%, 0.01% and 0.08%, respectively. No malaria cases were detected. The age group of 21-30 years had the highest number of TTI-positive cases (56.84%), followed by the 31-40 years group (33.68%).

In the present study, the overall prevalence of TTIs was 0.67%, which was lower than the findings of Sandeep CR et al., and Panigrahi R et al., who reported seroprevalence rates of 1.07% and 2.17%, respectively, in tertiary care hospitals in India [20,21]. A significantly higher prevalence was reported by Singago E et al., from Malawi (10.7%) [22], and by Manzoor I et al., from Pakistan (9.94%) [23]. The elevated seroprevalence in these populations may be attributed to the high prevalence of hepatitis C, which accounted for 7.69% in their study, in contrast to 0.42% in the present study.

Hepatitis B is the most common TTI reported in many Indian studies. In the present study, the seroprevalence of HBsAg was 0.16%, which was lower than that reported by Patel NH et al., (0.52%) [24] and Panigrahi R et al., from Odisha (1.99%) [21]. The decreasing trend in HBsAg seropositivity may be attributed to the effective implementation of the national hepatitis B immunisation programme and increased public awareness. In contrast, a study from Tanzania reported an 8.8% seropositivity for HBsAg, likely reflecting socio-economic factors [25].

In the present study, the seroprevalence of HCV (0.42%) was higher than that of HBV (0.16%), which aligns with the findings of Mondal et al., who reported HCV (0.66%) to be more prevalent than HBsAg (0.45%) [26]. Present study findings were similar to those of Srivastava M et al., who also reported an HCV prevalence of 0.42% in Madhya Pradesh [27]. Arif SH et al., reported 1.27% HCV positivity among donors [28]. In contrast, Stokx J et al., from Mozambique found no HCV infections [29].

The higher number of HCV present in our study may be due to changing risk-behaviour patterns, lack of vaccination, and limited awareness about routes of transmission. Globally, it is estimated that 53% of people who inject drugs are living with HCV, making them a high-risk population for transmission and infection. Systematic surveillance is crucial for monitoring HCV progression. As no effective vaccine is currently available, improving awareness and reducing high-risk behaviours are essential steps toward achieving the WHO goal of eliminating HCV by 2030 [30].

The seroprevalence of HIV in the present study was 0.01%, which was lower than reports from other parts of India—Patel NH et al., (0.08%) from Gujarat, Makroo RN et al., (0.24%) from Delhi, and Leena M and Mohd S, (0.27%) from Andhra Pradesh [24,31,32]. Literature indicates a gradual decline in HIV seroprevalence over the years, likely due to successful implementation of the National AIDS Control Programme (NACO), which focuses on public awareness, early diagnosis, and treatment services [33]. In the present study, the seroprevalence of syphilis was 0.08%, similar to the findings of Angampally K et al., who reported 0.07% from Telangana [34]. Chandra T et al., reported a lower prevalence (0.01%) [35], while Kumar A et al., from Uttarakhand reported a higher rate (1.05%), possibly due to lack of awareness among donors in tribal regions [36].

The current study recorded no malaria cases. This was consistent with findings from Patel NH et al., Pachori S et al., and Joshi S et al., who observed 0% malaria prevalence in Jaipur, Gujarat and Madhya Pradesh, respectively [24,37,38]. In contrast, Mukherjee S et al., reported a 0.12% prevalence in Western Odisha [39]. A Nigerian study by Uneke CJ et al., identified malaria positivity in 41% of donors, reflecting Nigeria's heavy malaria burden due to climatic conditions, socio-economic factors and high mosquito density [40].

The majority of seropositive donors in present study belonged to the 21-40 years age group (90.52%). All seropositive cases were males. In general, the younger population tends to contribute more to blood donation, and several studies have shown that most blood donors are under 30 years of age [41]. Literature indicates that women contribute less to blood donation than men due to various factors, including physiological conditions such as anaemia, lactation and pregnancy [42]. In a study by Sandeep CR et al., on the seroprevalence of TTIs among blood donors, 52.6% of seropositive donors were from the 18-30 years age group [20]. A study conducted by Sethi B et al., from Uttarakhand reported that first-time donors had a higher seroprevalence of TTIs [43]. Similarly, Andrade Neto JL et al., from Brazil documented a higher prevalence of TTIs among first-time donors [44].

In most Indian studies, the donor's educational status and its association with TTI seroprevalence have not been explored. However, a study by Li C et al., in China noted that lower educational status was associated with a higher risk of TTIs [45]. In the present study, it was observed that individuals who had completed or were pursuing a bachelor's degree had the highest rate of TTIs. This may be due to a skewed distribution, as a large proportion of donors in present study population were students pursuing undergraduate studies. The seroprevalence pattern of the present study was compared with data from other Indian states and other countries [Table/Fig-5] [2,20,21,24,37,38,46,47].

S. No.	Authors and publication year	Place of study	HBV	HCV	HIV	Syphilis	Malaria	Total prevalence
1	Present study, 2026	Baramulla, Kashmir Valley, India	0.16%	0.42%	0.01%	0.08%	00%	0.67%
2	Patel NH et al., 2024 [24]	Gujarat, India	0.52%	0.14%	0.08%	1.32%	0.00%	1.32%
3	Pachori S et al., (2020) [37]	Jaipur, India	1.82%	0.31%	0.23%	0.04%	0.01%	2.4%
4	Joshi S et al., 2025 [38]	Uttarakhand, India	0.73%	0.15%	0.12%	2.06%	0.0%	3.05%
5	Sandeep CR et al., (2022) [20]	Haryana, India	0.49%	0.50%	0.03%	0.05%	0.009%	1.07%
6	Panigrahi R et al., (2025) [21]	Odhisa, India	1.99%	0.066%	0.092%	0.22%	0.005%	2.17%
7	Hroob AM et al., (2020) [46]	Jordan	0.37%	0.13%	0.01%	0.03%	NR	0.54%
8	Kebede E et al., (2020) [47]	Ethiopia	4.2%	0%	0.26%	1.82%	NR	6.25%
9	Zhao Y et al., 2025 [2]	China	0.40%	0.19%	0.08%	0.40%	NR	1.07%

[Table/Fig-5]: Comparison of seroprevalence of TTIs from other states of india and the other countries.
NR= Not Reported

Limitation(s)

A limitation of the study was that, being cross-sectional in design, it did not allow for the assessment of associations between TTIs and socio-demographic factors.

CONCLUSION(S)

In the present study, blood donor samples were screened through serological testing. Although TTI trends vary annually, the considerable prevalence highlights the need for further research to identify primary risk factors and develop effective intervention strategies. Reducing the diagnostic window period through Nucleic Acid Testing (NAT), increasing public awareness, promoting voluntary blood donation, and improving female donor participation can substantially reduce the risk of TTIs in the population. The predominance of HCV among blood donors is a concerning indicator of chronic infection within the community, especially considering that blood donors are generally perceived as a healthy population. The findings of the present study are expected to assist policymakers in formulating appropriate action plans and enhancing governance in blood transfusion services.

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