ORIGNAL ARTICLE OPEN ACESS

PREVALENCE OF INFECTIOUS DISEASES AMONG BLOOD DONORS: A STUDY BASED ON THE DATA FROM REGIONAL BLOOD CENTRE ABBOTTABAD

Muhammad Imran [1], Muhammad Wisal Irshad [2], Ihsan Ullah [3], Yaseen Naveed [4]

[1,2,3,4] Biotechnology and Genetic Engineering, Hazara University, Pakistan.

ABSTRACT

Objective: This study aimed to determine the prevalence of transfusion-transmissible infections (TTIs)—including Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and Syphilis—among blood donors at the Regional Blood Center in Abbottabad, Pakistan. The objective was to improve transfusion safety and guide the enhancement of donor screening protocols using Chemiluminescent Immunoassay (CLIA) and Nucleic Acid Amplification Testing (NAT).

Place and Duration: The research was conducted at the Regional Blood Center, Abbottabad, over a two-year period from January 2022 to December 2023.

Materials and Methods: A retrospective cross-sectional design was utilized, encompassing 30,379 screened blood donations. Donors were required to meet predefined health criteria, including a minimum weight of 50 kg, hemoglobin ≥12.5 g/dl, and stable vital signs. Screening for HBV, HCV, and HIV was conducted using CLIA and NAT, while Syphilis was tested through CLIA and Malaria through the Immunochromatographic Test (ICT). Demographic characteristics such as age, gender, and geographic origin were also recorded and analyzed.

Results: Among the total screened samples, the prevalence rates were: Syphilis 1.21% (n=368), HBV 0.83% (n=254), HCV 0.63% (n=193), HIV 0.10% (n=32), and Malaria 0.01% (n=5). The donor population consisted of 98.9% males and 1.1% females.

Conclusions: The study revealed a relatively low but notable prevalence of TTIs among blood donors, with Syphilis emerging as the most common infection. These findings emphasize the importance of continuous surveillance, enhanced screening technologies, and public awareness initiatives to strengthen blood safety and prevent transfusion-related infections in the region.

Keywords: Transfusion-transmissible Infections, Blood Donors, Hepatitis B, Hepatitis C, HIV, Syphilis, Abbottabad

How To Cite This Article: Imran M, Irshad MW, Ullah I, Naveed Y. Prevalence of Infectious Diseases among Blood Donors: A Study Based on the Data from Regional Blood Centre Abbottabad. *J Bacha Khan Med Coll.* 2025;6(2),74-81.

Corresponding Author: Yaseen Naveed
Biotechnology and Genetic Engineering, Hazara University, Pakistan.
Email: ynaveed142@gmail.com

Received: 28th July, 2025
Revision: 28th October, 2025
Accepted: 18th December, 2025
Published: 31st December,10th 31, 2025

INTRODUCTION

Transfusion of human blood and its components is a vital therapeutic intervention used globally for managing medical emergencies, surgical procedures, and hematological disorders. Despite its life-saving benefits, blood transfusion carries a potential risk of Transfusion-Transmissible Infections (TTIs), which can significantly compromise patient safety [(1,2)]. These infections, primarily including Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), Human Immunodeficiency Virus (HIV), and Syphilis, are transmitted through infected

blood or blood products and remain a major concern for healthcare systems worldwide [3,4]. According to the World Health Organization (WHO), maintaining the safety and adequacy of blood supplies is a key global health priority, as unsafe transfusions continue to pose risks in both developing and developed nations [4].

Globally, the burden of TTIs varies widely, influenced by factors such as socioeconomic conditions, public health infrastructure, donor selection criteria, and screening technology. Studies conducted in Ethiopia, Ghana, and India have demonstrated that although the seroprevalence of TTIs among donors has declined over time due to improved screening, these infections still represent a significant health challenge [1,2,3]. In a retrospective study at the North Gondar District Blood Bank, Ethiopia, Biadgo et al. (2017) reported notable rates of HBV and HCV infections among blood donors [1]. Similarly, Osei et al. (2017) found a substantial prevalence of hepatitis B infection in blood donors in Ghana, underscoring the need for continuous monitoring and strict screening policies [2]. Research from the Andaman and Nicobar Islands further highlighted the importance of retrospective analyses in identifying temporal trends in infection rates and enhancing donor screening strategies [3].

The WHO emphasizes that despite advancements in serological testing, the possibility of undetected infections during the "window period" remains a serious concern [4]. This challenge underscores the importance of employing more sensitive diagnostic methods, such as Nucleic Acid Testing (NAT), which can detect viral genomes even in early stages of infection, thereby improving transfusion safety [13]. Studies from Iraq, Angola, and China have demonstrated that the incorporation of NAT has significantly reduced the residual risk of TTIs among donors, leading to safer transfusion practices and reduced disease transmission [5,11,12]. In recent years, several investigations have been conducted worldwide to assess the seroprevalence and trends of TTIs among blood donors. In Basra, Iraq, Mohammed et al. (2023) reported a decreasing trend in viral TTIs following the implementation of advanced screening technologies [5]. Similarly, Quintas et al. (2023) in Luanda, Angola, observed notable co-infection rates among voluntary blood donors, highlighting the continued relevance of robust screening protocols in sub-Saharan regions [11]. In China, Ji et al. (2013) reported a gradual decline in the prevalence of HIV, HBV, and HCV among first-time blood donors, attributing it to enhanced awareness, donor selection, and improved testing [12]. These findings underscore that TTIs remain a dynamic public health issue, requiring sustained vigilance and technological advancement.

In Pakistan, the national blood transfusion system faces comparable challenges, particularly in ensuring uniform screening standards and access to modern diagnostic technologies. Regional studies have shown varying infection rates, with Hepatitis B and Hepatitis C remaining predominant among TTIs. The introduction of improved testing technologies and strict donor selection criteria has helped reduce infection prevalence, yet disparities between urban and rural blood collection centers persist [14].

Given these regional and global concerns, the present study was designed to assess the prevalence of transfusion-transmissible infections among blood donors at the Regional Blood Center, Abbottabad, which serves the Hazara Division of Khyber Pakhtunkhwa, Pakistan. The study aims to determine the frequency and distribution of HBV, HCV, HIV, syphilis, and malaria among donors and to evaluate the impact of existing screening practices on blood safety. Findings from this study will provide valuable insights for policymakers and healthcare professionals, supporting efforts to

strengthen donor screening strategies, implement advanced testing technologies such as NAT, and enhance overall transfusion safety within the region.

METHODOLOGY

Research Design, Setting and Duration

This study adopted a cross-sectional research design to assess the prevalence of transfusion-transmissible infections (TTIs) among blood donors at the Regional Blood Center, Abbottabad. Data were collected from blood donations conducted between January 2022 and December 2023. Blood samples were screened to detect infections such as Hepatitis B, Hepatitis C, HIV, Syphilis, and Malaria. Donor eligibility was determined based on standard physiological parameters: a minimum weight of 50 kg, body temperature near 37.5°C, pulse rate between 50–100 beats per minute, and blood pressure readings of 80/120 mmHg (ages 18–30) or 80/130 mmHg (ages 30–50). Hemoglobin levels ≥12.5 g/dl and hematocrit between 37%–45% were mandatory. Screening for Hepatitis B, Hepatitis C, HIV, and Syphilis was performed using Chemiluminescent Immunoassay (CLIA) and Nucleic Acid Amplification Testing (NAT), whereas Immunochromatographic Test (ICT) was used for Malaria detection. Donor demographic information (age, gender, and geographic origin) was also recorded to analyze trends in TTI prevalence.

Study Population

The study population comprised blood donors aged 18–50 years who donated blood at the Regional Blood Center, Abbottabad, during the defined period. While the majority of participants were residents of Abbottabad, donors from neighboring districts of the Hazara Division—including Haripur and Mansehra—were also represented. Eligibility criteria included meeting specific physiological standards related to weight, hemoglobin, and vital signs. Donors failing to meet these requirements were excluded to ensure the reliability of the results. Both first-time and regular donors were included in the study.

Sampling Technique

A convenience sampling method was employed to include blood donors who met the eligibility criteria. This non-probability approach ensured that only healthy individuals with no contraindications to blood donation were selected. Donors were required to maintain a minimum weight of 50 kg, a normal body temperature (~37.5°C), a pulse rate between 50–100 bpm, and appropriate blood pressure based on age. Hemoglobin levels (≥12.5 g/dl) and hematocrit values (37–45%) were also prerequisites. This sampling ensured that the participants reflected the typical donor population of the Regional Blood Center and the broader Hazara region.

Data Collection Method

Data for this study were obtained from both routine blood donation sessions conducted at the Regional Blood Center (RBC), Abbottabad, and from outreach blood donation camps organized across different districts of the Hazara Division, including Haripur and Mansehra, between January 2022 and December 2023. This dual-source data collection ensured the inclusion of a diverse and regionally representative donor population.

Upon arrival at the donation site, each potential donor underwent a pre-donation screening process conducted by qualified medical personnel. This process involved an initial registration and interview phase, during which demographic and personal health information was recorded, including name, age, gender, occupation, residential area, and prior donation history. Donors were then subjected to a brief physical examination to confirm their eligibility according to

national blood transfusion guidelines.

The physical assessment included:

- Measurement of body weight, which was required to be ≥50 kg.
- Body temperature check, ensuring values around 37.5°C.
- Pulse rate assessment maintained within the 50–100 beats per minute range.
- Blood pressure measurement, with acceptable limits being 80/120 mmHg for donors aged 18–30 years and 80/130 mmHg for those aged 30–50 years.
- Hemoglobin concentration testing, requiring levels of ≥12.5 g/dl, and hematocrit evaluation, with acceptable values between 37 and 45%.

Only donors meeting all eligibility criteria proceeded to the blood collection phase. Approximately 350–450 mL of whole blood was collected from each donor using sterile, single-use collection bags. Each blood sample was properly labeled with a unique identification code to ensure traceability while maintaining anonymity. Following collection, samples were immediately transported under controlled conditions to the RBC laboratory for screening of Transfusion-Transmissible Infections (TTIs). The following diagnostic tests were employed:

- Chemiluminescent Immunoassay (CLIA) for the detection of Hepatitis B surface antigen (HBsAg), anti-HCV antibodies, anti-HIV 1/2 antibodies, and Syphilis (Treponema pallidum antibodies).
- Nucleic Acid Amplification Testing (NAT) for Hepatitis B, Hepatitis C, and HIV, to enhance detection sensitivity and minimize false negatives during the serological "window period."
- Immunochromatographic Test (ICT) for Malaria, targeting *Plasmodium falciparum* and *Plasmodium vivax* antigens.

All testing procedures adhered to the Standard Operating Procedures (SOPs) established by the National Blood Transfusion Programme (NBTP) and the World Health Organization (WHO) Blood Safety Guidelines (WHO, 2024). The quality and reliability of test results were ensured through internal quality control (IQC) measures, periodic calibration of laboratory equipment, and cross-validation using known positive and negative control samples. After testing, results were recorded and compiled into an electronic database maintained by the Regional Blood Center. Donor information—including demographic details, screening results, and donation type (voluntary or replacement)—was entered and verified by data management staff to minimize transcription errors. Data were then anonymized before statistical analysis to ensure confidentiality and compliance with ethical standards.

This comprehensive data collection strategy enabled the inclusion of a large, demographically varied donor population, ensuring the accuracy, representativeness, and reliability of findings regarding the prevalence and trends of TTIs in the Hazara Division.

Data Analysis Procedure

Data were analyzed to determine the prevalence and distribution of TTIs among all screened donors. The prevalence rate for each infection (Hepatitis B, Hepatitis C, HIV, Syphilis, and Malaria) was calculated as the percentage of total screened sample. Additionally, the relative frequency of each infection among all TTI-positive cases was evaluated to assess the comparative burden of each disease. Results were summarized using descriptive statistics, including percentages and proportions.

RESULT

The analysis of transfusion-transmissible infections (TTIs) among a total of 30,379 screened blood donors revealed that Syphilis had the highest prevalence rate at 1.21% (n=368), followed by Hepatitis B Surface Antigen (HBsAg) at 0.83% (n=254), and Hepatitis C Virus (HCV) at 0.63% (n=193). The prevalence of Human Immunodeficiency Virus (HIV) was relatively low, accounting for 0.10% (n=32), while Malaria, detected using the Immunochromatographic Test (ICT) method, exhibited the lowest occurrence at 0.01% (n=5). These findings indicate that although the overall burden of TTIs among blood donors in the studied population is low, Syphilis and Hepatitis B remain the predominant infections of concern. The low rates of HIV and Malaria suggest effective donor selection and screening practices; however, the persistence of viral and bacterial pathogens underscores the need for continuous monitoring, improved screening technologies, and enhanced public awareness to ensure transfusion safety in the region.

Table 1: Prevalence of Transfusion-Transmissible Infections (TTIs) among Blood Donors

Transfusion-Transmissible Infection (TTI)	Total Screened	Positive Cases	Prevalence Rate (%)
Hepatitis B Surface Antigen (HBsAg)	30,379	254	0.83%
Hepatitis C Virus (HCV)	30,379	193	0.63%
Human Immunodeficiency Virus (HIV)	30,379	32	0.10%
Syphilis	30,379	368	1.21%
Malaria (ICT method)	30,379	5	0.01%

A total of 30,379 blood donations were screened at the Regional Blood Center in Abbottabad between 2022 and 2023. The donor population was overwhelmingly male, with 30,050 (98.9%) male donors and 329 (1.1%) female donors. The study employed Chemiluminescent Immunoassay (CLIA) and Immunochromatographic Test (ICT) to detect transfusion-transmissible infections (TTIs) including Hepatitis B, Hepatitis C, HIV, Syphilis, and Malaria. The demographic data and screening methodology ensured a representative assessment of the donor population across the Hazara division.

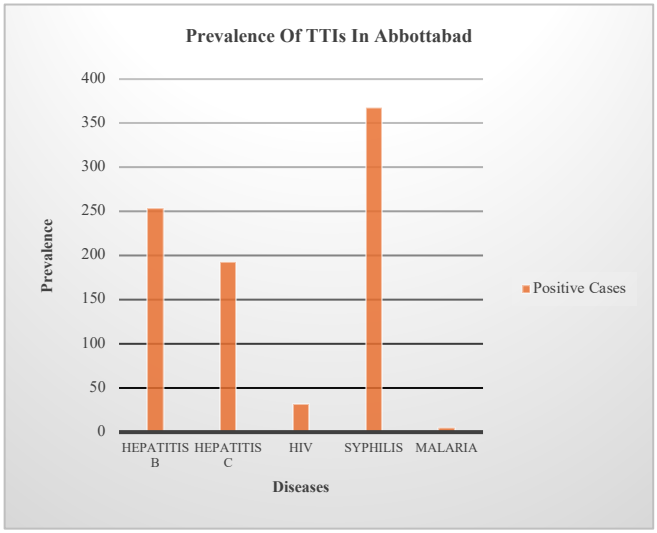

Figure 1: Prevalence Of TTIs In Abbottabad

The prevalence analysis revealed that Syphilis was the most common infection, with 368 positive cases (1.21%), followed by Hepatitis B Surface Antigen (HBsAg) at 0.83% (254 cases) and Hepatitis C Virus (HCV) at 0.63% (193 cases). The prevalence of HIV was comparatively low at 0.10% (32 cases), while Malaria, detected via ICT, was rare at 0.01% (5 cases). These findings highlight that, although the overall burden of TTIs among blood donors in the region is relatively low, Syphilis and Hepatitis B remain significant concerns. The study underscores the importance of continuous monitoring, strict adherence to screening protocols, and public awareness initiatives to further enhance the safety of blood transfusions in Abbottabad and surrounding areas.

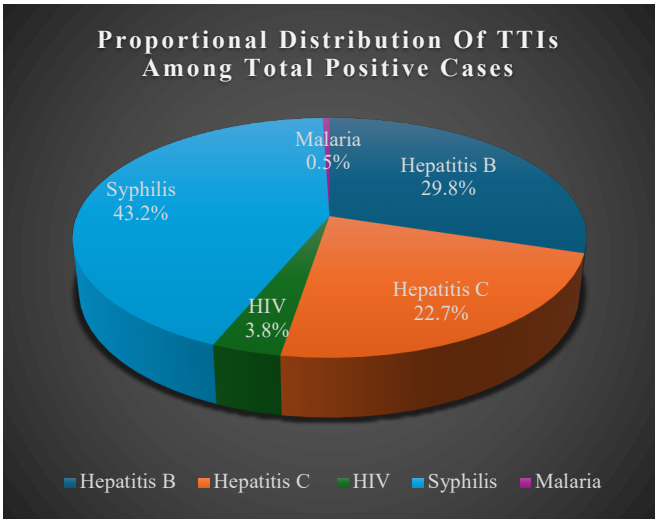

Figure 2: Proportional Distribution Of TTIs Among Total Positive Cases

DISCUSSION

The findings of this study provide valuable insight into the prevalence of transfusion-transmissible infections (TTIs) among blood donors in the Hazara division. The data revealed that *Syphilis* had the highest prevalence at 1.21%, followed by *Hepatitis B* (0.83%), *Hepatitis C* (0.63%), *HIV* (0.10%), and *Malaria* (0.01%). These figures are consistent with studies conducted in similar developing regions, reflecting a moderate but persistent public health concern related to TTIs [12,13]. The elevated prevalence of syphilis could be linked to its often asymptomatic early stages, allowing individuals to donate blood unknowingly while infected [14]. On the other hand, the comparatively lower prevalence of HIV and Malaria is encouraging but does not eliminate the need for continuous vigilance, as even a small number of positive cases may compromise transfusion safety [15].

The persistence of infections despite established screening practices indicates gaps in donor education and awareness regarding sexually transmitted and bloodborne infections. It also highlights potential deficiencies in pre-donation counselling or laboratory detection methods. Continuous public health surveillance and donor screening programs are thus essential for identifying high-risk groups and maintaining a safe blood supply.

The implications of these findings for blood donation safety are profound. Although the overall prevalence of TTIs is low, infections occurring during the *window period*—before they become detectable by standard serological tests—remain a significant challenge [16]. The Chemiluminescent Immunoassay (CLIA) used in this study is known for its high sensitivity and specificity; however, it cannot detect infections before antibody or antigen development. Consequently, incorporating *Nucleic Acid Testing (NAT)* could enhance early detection and reduce the risk of transfusion-related transmission [17,18].

Public health education also plays a vital role in promoting safer donation practices. Awareness campaigns emphasizing the importance of truthful donor histories, safe sexual behaviour, and regular health checkups can help lower infection rates among potential donors [19]. Even though the overall risk to the regional blood supply is currently minimal, strengthening donor selection criteria and enhancing screening sensitivity are necessary steps toward achieving a "zero-risk" transfusion system.

From a broader public health perspective, the continued presence of TTIs among donors—though at low levels—remains a concern due to the severe clinical consequences for transfusion recipients [20]. The *window period* problem represents a critical challenge that warrants investment in advanced diagnostic technologies such as NAT and multiplex assays. These tools can shorten the detection window and significantly reduce the likelihood of undetected infections entering the blood supply [19]. Furthermore, community-level education about TTIs, particularly hepatitis and syphilis, can reduce transmission rates beyond the blood donation setting, contributing to improved overall community

health [20]. Enhanced collaboration between blood transfusion centres and public health authorities can further aid in implementing preventive strategies and ensuring that screening systems remain updated with international standards.

The results of this study align with international literature but also demonstrate regional variations. The HIV prevalence of 0.10% closely mirrors data from Xi'an, China (0.02%) [14], while the rates of Hepatitis B (0.83%) and Hepatitis C (0.63%) are significantly lower than those reported in Angola, where figures reached 50.2% and 5.1%, respectively [16]. Similarly, syphilis prevalence (1.21%) was consistent with global averages, being much lower than African regions such as Angola (20%) but higher than China (0.31%) [17]. These differences can be attributed to variations in socioeconomic factors, public health policies, and donor selection procedures.

The application of CLIA in this research reflects a broader global trend toward adopting more sensitive screening technologies; however, as noted in previous studies, the *window period* remains a limitation. Integrating NAT testing could reduce residual risk by up to 96%, as evidenced by research conducted in India [21]. This approach underscores the need for ongoing improvements in screening technology and donor education to ensure safer transfusion practices in Pakistan.

This study is not without limitations. The CLIA screening technique, though highly sensitive, cannot detect infections during the early seronegative phase, potentially leading to underestimation of true prevalence rates. The absence of subgroup analysis—such as first-time versus repeat donors, or gender-based differences—also limits the depth of interpretation [13,15]. Moreover, the use of retrospective data may introduce record-based biases and affect data completeness. Future research should incorporate *Nucleic Acid Testing (NAT)* to reduce undetected infections and apply advanced statistical models to explore risk factors and demographic patterns. Expanding the study's scope across different regions in Pakistan would also provide a more comprehensive national picture of TTI trends.

CONCLUSION AND RECOMMENDATIONS

This study concludes that transfusion-transmissible infections (TTIs) among blood donors in the Hazara division are relatively low, with *Syphilis* (1.21%) being the most prevalent, followed by *Hepatitis B* (0.83%), *Hepatitis C* (0.63%), *HIV* (0.10%), and *Malaria* (0.01%). Despite these low rates, the challenge of detecting infections during the "window period" remains a concern. To enhance safety, the adoption of *Nucleic Acid Testing (NAT)* is recommended for earlier and more accurate detection. Public awareness programs and improved donor education should be strengthened to reduce infection risks. Continuous surveillance, updated screening protocols, and strict donor selection are essential to maintain a safe and reliable blood supply and ensure better public health outcomes.

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