

## Comprehensive Analysis of Seroprevalence of Infectious Diseases in Blood Donors: Focus on HIV, HBV, HCV, Syphilis, and Malaria

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### Abstract

**Background:** Blood transfusion is critical in healthcare but carries the risk of transmitting infectious diseases such as hepatitis B, hepatitis C, HIV, and syphilis. The prevalence of these infections varies significantly across populations and regions, particularly in India, where a notable number of blood donors remain at risk.

**Aim:** This study aims to assess the seroprevalence of HIV, HBV, HCV, syphilis, and malaria among blood donors at the Bhagwan Mahavir Institute of Medical Sciences in Nalanda, Bihar.

**Methodology:** A retrospective analysis was conducted involving 1,200 blood donors. Data were collected on demographics and medical history, and blood samples were tested for infectious diseases using ELISA and rapid tests. Inclusion criteria were healthy individuals aged 18-60, while individuals with chronic diseases or high-risk behaviours were excluded.

**Results:** Among the donors, the prevalence rates were 3.16% for HIV, 9.48% for HBV, 0.73% for HCV, and 0.73% for syphilis, with male donors (97.38% of the sample) exhibiting significantly higher infection rates compared to females. Blood type analysis revealed that O positive donors had the highest rates of infections, particularly HBV (13.17%).

**Conclusion:** The study reveals a significant prevalence of blood-borne infections among blood donors in Bihar, emphasizing a gender disparity and the need for targeted screening and preventive strategies, particularly for high-risk groups such as O positive donors. The findings underscore the importance of public health initiatives to mitigate transmission risks and improve the safety of blood transfusions in the region.

**Keywords:** Blood Transfusion, HIV, HBV, HCV, Public Health, Seroprevalence, Syphilis.

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### Introduction

Blood transfusion poses a significant risk of transmitting infections, including hepatitis, syphilis, HIV, malaria, and occasionally less common infections like toxoplasmosis, brucellosis, and certain viral infections such as CMV, EBV, and herpes. With each unit of blood, there is approximately a 1% chance of encountering transfusion-related issues, including the transmission of infectious diseases [1]. Among these, HIV and hepatitis are particularly concerning. Hepatitis B virus (HBV), originally known as serum hepatitis, became recognized as a serious and sometimes fatal complication of blood transfusion, especially during World War II when unscreened blood and plasma were heavily used. However, it wasn't until the 1960s that the causative agent was identified with the discovery of the Australian antigen, later termed hepatitis B surface antigen (HBsAg) [2]. HBV can also be spread through

childbirth, unprotected sex, and shared needles. Testing for this antigen in blood donors was introduced in the United States in 1970. Globally, over 2 billion people have been infected with HBV, and more than 350 million are chronic carriers. In India, with HBsAg carrier rates placing the country in the intermediate endemicity zone (2-8%), around 5-7% of the general population is affected, and voluntary blood donors have a carrier rate of approximately 6%. The risk of post-transfusion hepatitis in patients receiving multiple transfusions can reach as high as 18-30% [3].

Hepatitis C virus (HCV) is particularly dangerous among the viral hepatitis, as it establishes chronic infection in about 85% of acutely infected individuals [4]. Globally, chronic hepatitis C affects nearly 200 million people. According to WHO, around 3% of the world's population is infected with

HCV, with 170 million people at risk of developing liver cirrhosis and liver cancer. HCV transmission is primarily linked to exposure to blood and blood products. In India, about 15 million people carry antibodies against HCV, with a prevalence rate of approximately 2%. The HIV/AIDS epidemic, one of the most severe public health crises of the 21st century, transitioned from an unknown illness to a global pandemic in under 20 years [5]. By 2007, an estimated 33.2 million people were living with HIV worldwide, with 2.5 million new cases that year alone. In India, 2.4 million people were infected by 2007. 'While heterosexual contact remains the primary mode of HIV transmission globally and in India, the risk of contracting HIV from an infected blood transfusion exceeds 95%' [6].

Syphilis, caused by '*Treponema pallidum*,' is another systemic disease that can be spread through sexual contact, blood transfusion, and vertical transmission. Although the precise incidence of syphilis is challenging to determine, WHO estimated an annual incidence of 12 million cases in 1999. Serological surveys remain the most reliable method to gauge the prevalence of syphilis. Given the socioeconomic and logistical challenges, community-based seroprevalence studies are difficult to carry out in certain regions. Our institute serves as a vital healthcare facility for a large population in Bihar, encompassing both residents and those from rural, remote, and hilly areas, making it a key center for conducting serological surveys. Currently, there is no available data on the seroprevalence and distribution of these blood-borne infections in these regions. This study aims to assess the seroprevalence of HIV, HBV, HCV, syphilis, and malaria among blood donors at Bhagwan Mahavir Institute of Medical Sciences in Nalanda, Bihar.

## Material and methods

### Study Design

A retrospective analysis was conducted at the Department of Immunohematology and blood transfusion, 'Bhagwan Mahavir institute of medical sciences, Pawapuri, Nalanda, Bihar.' The study involved a comprehensive review of donor data in collaboration with the Blood Transfusion Unit, assessing seroprevalence for HIV, HCV, HBV, syphilis, and malaria among the donor population.

### Sample Size

A total of 1200 blood donors were included in the study.

### Inclusion and Exclusion Criteria

#### Inclusion Criteria

- Healthy individuals aged 18 to 60 years.
- Body weight > 45 kg.

- Hemoglobin level > 12.5 g/dl.
- Willing volunteers or relatives/friends of patients.

#### Exclusion Criteria

- Individuals with a history of chronic diseases or previous blood transfusions.
- High-risk behaviors, including risky sexual practices or drug abuse.
- Any current illness that could compromise donor fitness.

#### Data Collection

Data from blood donors were collected from existing records. Donors were screened based on demographic and medical profiles, and blood samples were collected in blood bags for serological testing. All relevant demographic and clinical information, including age, sex, weight, hemoglobin levels, and medical history, were recorded for analysis.

#### Procedure

Blood donors were screened using a standardized questionnaire to assess medical history and risk behaviors. Only those who met the eligibility criteria were selected for blood donation. After donation, venous blood was collected in sterile blood bags, and each unit was tested for infectious diseases, including HIV, HBV, HCV, syphilis, and malaria, using ELISA kits and rapid tests. ABO and Rh blood grouping were also determined. All tests were conducted following the manufacturer's instructions for accuracy.

#### Statistical Analysis

The data were analysed using descriptive statistics using SPSS software version 0.27 to evaluate the seroprevalence of infectious illnesses among blood donors. Frequencies and percentages were computed for categorical variables including the presence of diseases such as HBV, HCV, HIV, syphilis, and malaria. Results were presented in tabular form for easy interpretation of prevalence rates across the sample population.

#### Results

Table 1 shows the gender-specific prevalence of HIV, HBV, HCV, and syphilis among 1,200 blood donors, with a majority of male donors (97.38%). The prevalence rates among males were 3.09% for HIV, 9.35% for HBV, 0.72% for HCV, and 0.70% for syphilis. Conversely, female donors, constituting just 2.62% of the total, had markedly lower prevalence rates: 0.07% for HIV, 0.13% for HBV, and minimal rates for HCV and syphilis (0.02% and 0.03%, respectively). The data indicates a significant gender gap in the incidence of these illnesses, with male donors exhibiting substantially higher rates than female donors.

**Table 1: Gender-specific prevalence of HIV, HBV, HCV, and Syphilis**

Parameters	Male	Female	Total
<b>Total No of blood donors (%)</b>	1169 (97.38)	31 (2.62)	<b>1200 (100.00)</b>
<b>Human immunodeficiency viruses positive N (%)</b>	36 (3.09)	1 (0.07)	<b>37 (3.16)</b>
<b>Hepatitis B virus positive N (%)</b>	109 (9.35)	4 (0.13)	<b>113 (9.48)</b>
<b>Hepatitis C virus Positive N (%)</b>	8 (0.72)	0 (0.02)	<b>9 (0.73)</b>
<b>Syphilis Positive N (%)</b>	8 (0.70)	0 (0.03)	<b>9 (0.73)</b>

Table 2 defines the prevalence of 'HIV, HBV, HCV, and Syphilis infections' across various blood types among 1,200 individuals. Blood type O positive had the greatest frequency of HBV (13.17%) and recorded the most instances of HIV (4.58%), HCV (1.00%), and Syphilis (0.75%), comprising 10% of the study population. A positive blood group was associated with 5.67% HBV, 0.83% HIV, 0.33% HCV, and 0.58% Syphilis infections, accounting for 10.25% of the individuals. Blood type B positive

exhibited reduced infection rates, with HBV at 1.83%, HIV at 0.58%, and negligible instances of HCV and Syphilis, cumulatively accounting for 3% of individuals. Individuals with AB positive and all negative blood types exhibited low or negligible infection rates, with AB negative demonstrating no instances of infection. HBV was the most frequent infection at 21.42% across all categories, followed by HIV at 6.33%, Syphilis at 1.83%, and HCV at 1.58%.

**Table 2: Distribution of HIV, HBV, HCV, and Syphilis by Blood Group**

Blood Group	HIV positive N (%)	HBV positive N (%)	HCV Positive N (%)	Syphilis Positive N (%)	Total Subjects (%)
<b>O positive</b>	55 (4.58)	158 (13.17)	12 (1.00)	9 (0.75)	120 (10.00)
<b>A positive</b>	10 (0.83)	68 (5.67)	4 (0.33)	7 (0.58)	123 (10.25)
<b>B positive</b>	7 (0.58)	22 (1.83)	3 (0.25)	2 (0.17)	36 (3.00)
<b>AB positive</b>	1 (0.08)	5 (0.42)	0 (0.00)	1 (0.08)	7 (0.58)
<b>O negative</b>	1 (0.08)	5 (0.42)	0 (0.00)	2 (0.17)	8 (0.67)
<b>A negative</b>	1 (0.08)	2 (0.17)	0 (0.00)	0 (0.00)	3 (0.25)
<b>B negative</b>	1 (0.08)	1 (0.08)	0 (0.00)	1 (0.08)	3 (0.25)
<b>AB negative</b>	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
<b>Total</b>	<b>76 (6.33)</b>	<b>257 (21.42)</b>	<b>19 (1.58)</b>	<b>22 (1.83)</b>	<b>1,200 (100.00)</b>

Table 3 shows the prevalence of 'HIV, HBV, HCV, and syphilis infections' across various age demographics within a cohort of 1,200 individuals. The age cohort of 26-35 exhibited the greatest number of participants (43.3%) as well as the highest prevalence of HBV (4.3%) and syphilis (0.33%). The 17-25 age group, representing 37.8% of the total, had a significant prevalence of HBV (3.3%), while demonstrating lower rates of HIV

(0.5%) and HCV (0.17%). The 36-45 age cohort constituted 15.8% of the sample, with comparably low infection rates. The elder age cohorts (46-55 and 56-65) had a markedly reduced number of individuals and no documented instances of HCV. In summary, HBV exhibited the highest prevalence in the sample, whereas HIV and HCV had the lowest rates among the illnesses examined.

**Table 3: Distribution of HIV, HBV, HCV, and Syphilis by Age Group**

Age group (years)	HIV Positive N (%)	HBV Positive N (%)	HCV Positive N (%)	Syphilis Positive N (%)	Total Subjects (%)
<b>17-25</b>	6 (0.5%)	40 (3.3%)	2 (0.17%)	1 (0.08%)	453 (37.8%)
<b>26-35</b>	12 (1.0%)	52 (4.3%)	4 (0.33%)	4 (0.33%)	519 (43.3%)
<b>36-45</b>	7 (0.58%)	20 (1.67%)	2 (0.17%)	3 (0.25%)	189 (15.8%)
<b>46-55</b>	2 (0.17%)	5 (0.42%)	0 (0.0%)	1 (0.08%)	38 (3.2%)
<b>56-65</b>	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.08%)
<b>Total</b>	<b>27 (2.25%)</b>	<b>117 (9.75%)</b>	<b>8 (0.67%)</b>	<b>9 (0.75%)</b>	<b>1,200 (100%)</b>

## Discussion

The findings indicate a distinct gender-related difference in the prevalence of HIV, HBV, HCV, and syphilis among blood donors, with males exhibiting significantly higher infection rates than

females. This trend may reflect underlying gender-based risk factors or exposure patterns, possibly linked to behaviors or occupational risks that differ between males and females. These variations highlight the importance of targeted interventions and awareness programs for male populations to

address and mitigate the spread of these infections. The prevalence of hepatitis C observed in this study (0.7%) is lower than the findings of Jesse et al. [7], which indicated a higher infection rate in the 20-29 age range, and the 5.71% prevalence reported in Nigeria [8]. However, the frequency of antibodies to HCV among healthy adult Ethiopian blood donors is rather comparable, recorded at 1.4% [9] and 1.7% [10]. The prevalence of HIV, HBV, and HCV may be elevated among commercial sex workers, their customers, and intravenous drug users due to their engagement in high-risk activities.

Examining the distribution across blood groups, the data in Table 2 reveals that O positive blood donors had the highest prevalence rates for all infections, particularly HBV, which was nearly three times more common than in A or B positive groups. This could suggest potential genetic or immunological factors associated with specific blood types that may influence susceptibility to infections. Additionally, blood groups with lower prevalence rates, such as AB negative, displayed either very low or no cases of infections, which may indicate a protective factor or a smaller sample size limiting conclusive trends. The high infection rates in O positive donors point to the need for further research into blood type-associated risk factors and the implementation of targeted screening strategies for specific blood groups. This study showed an increase, with 50.2% for HBV and 5.1% for HCV, in contrast to a study conducted in Namibia and Ethiopia, which reported lower prevalence rates of 1.3% and 11.5%, respectively [11, 12]. Markers for Hepatitis B, Hepatitis C, HIV, and Syphilis were more frequent in males at 90%, a finding corroborated by previous studies conducted in several sub-Saharan African countries, including Nigeria, the Democratic Republic of Congo, and Cameroon. A reduced percentage of positive transfusion-transmitted infection indicators was seen in females; young adults constitute the predominant age group.

In terms of age, the 26-35 age cohort, which constituted the largest portion of the sample, also exhibited the highest infection rates for HBV and syphilis, indicating a possible correlation between age-related behaviors and higher infection risks. Younger donors (17-25 years) showed significant HBV prevalence, suggesting early exposure risks, potentially from unscreened blood transfusions, tattoos, or other high-risk behaviors. On the other hand, older age groups (46 years and above) exhibited lower infection rates, potentially reflecting lower exposure to recent risk factors or increased immunity due to age. These findings underscore the value of age-specific interventions and prevention measures, particularly among younger populations, to reduce transmission rates and ensure early intervention where needed. The study indicated that the prevalence of HIV among blood donors was 7%.

The proportion is much more than those from other studies in Africa, such as South Ethiopia at 6.4% [13] and Nigeria at 4.2% [14], although lower than those from Mozambique at 8.5% [15] and Swaziland at 26.1% [16].

## Conclusion

This study highlights the significant prevalence of blood-borne infections, particularly HIV, HBV, HCV, and syphilis, among blood donors at Bhagwan Mahavir Institute of Medical Sciences in Nalanda, Bihar. The results indicate a marked gender disparity, with male donors exhibiting substantially higher infection rates than females, likely due to differing risk behaviors. Additionally, the distribution of infections across various blood groups suggests potential genetic or immunological influences that merit further investigation. Notably, HBV emerged as the most prevalent infection, underscoring the need for enhanced screening and preventive strategies, especially for O positive donors. These findings stress the importance of targeted public health initiatives aimed at reducing transmission risks and ensuring safer blood transfusions in the region.

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