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Prevalence and Risk Factors of Transfusion-Transmissible Infections Among Voluntary Blood Donors in North Shoa, Amhara Region, Ethiopia: A Cross-Sectional Study

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ABSTRACT

Background and Aim: Transfusion-transmissible infections (TTIs) pose a significant threat to patients requiring blood transfusion. The prevalence of TTIs among blood donors reflects the broader burden of infections within populations. Therefore, assessing the prevalence of TTIs among voluntary blood donors is crucial for informing effective prevention and control strategies in the community.

Study Design and Methods: A cross-sectional study was conducted from April 2022 to July 2022. Sociodemographic and related data were collected using a pre-tested structured questionnaire. A venous blood sample (5 mL) was drawn from each blood donor into sterile test tubes, and serum was separated through centrifugation. The serum samples were tested using enzyme-linked immunosorbent assays (ELISA) to detect hepatitis B Virus (HBV), hepatitis C virus (HCV), human immunodeficiency virus (HIV), and syphilis. Data analysis was performed using SPSS version 25 and summarized in tables and figures.

Results: A total of 538 participants were enrolled in the study, with an overall prevalence of transfusion-transmissible infections (TTIs) at 7.4% ($n = 40$). Syphilis exhibited the highest prevalence at 3% ($n = 16$), followed by HBV at 2% ($n = 11$). The prevalence of HCV and HIV was 1.3% ($n = 7$) and 1.1% ($n = 6$), respectively. Significant factors associated with HBV seroprevalence included the donation site at Debre Berhan [AOR = 24.18, 95% CI: 1.98–295.14, $p = 0.01$] and the presence of body tattoos [AOR = 19.1, 95% CI: 4.0–89.8, $p \leq 0.01$]. Male sex was significantly associated with syphilis infections [AOR = 3.78, 95% CI: 1.23–11.61, $p = 0.03$].

Conclusions: This study highlighted the high prevalence of TTIs among blood donors. To prevent and control the transmission of TTIs within the population, strict donor screening protocols, improved diagnostic methods, and enhanced awareness about infection transmission should be implemented.

1 | Introduction

Blood transfusion is an effective treatment for saving millions of lives worldwide each year [1]. However, getting safe blood and blood products remains a major challenge throughout the world, especially in developing countries [2–5]. The World Health Organization (WHO) recommends screening donated blood for transfusion-transmissible infections (TTIs) to assure the quality and safety of the blood before transfusions. Proper donor selection and screening of donated blood for TTIs decreased the transmission of these infections in the past two decades [6]. However, the safety of blood for transfusion in developing countries is still questionable due to the steady increase of viral infections among volunteer blood donors [7].

The prevalence rates of TTIs among volunteer blood donors in developing countries are much higher than those reported in developed countries [8]. Volunteer blood donors are generally regarded as a healthier part of any community, as blood banks usually have strict selection criteria. The number of donors infected with hepatitis and the risk factors associated with the disease among healthy individuals may reflect the magnitude of chronic TTIs such as HBV and HCV infection in the general population [8].

Globally, more than 81 million units of blood are donated each year. However, the presence of TTIs among asymptomatic donors is the major cause of transmitting infectious agents through blood transfusion [9]. Transfusion-transmissible infections have long-lasting effects on recipients, their families, and communities. Infected individuals serve as reservoirs for diseases and can transmit infections even during the asymptomatic phase, leading to the spread of infections within the community. The most prevalent viral infections from blood transfusions are HBV and HCV, both of which cause significant morbidity, mortality, and economic burden, making them major global health concerns [10]. African countries require the highest number of blood transfusions but also face the greatest challenges from TTIs. In Sub-Saharan Africa, about 12.5% of transfusion recipients are at risk of post-transfusion hepatitis [11]. While syphilis is less commonly transmitted through blood, its prevalence remains low [7]. Additionally, approximately 5%–10% of HIV transmissions in Africa are due to contaminated blood transfusions [3].

The safety of blood transfusions in low-income countries like Ethiopia remains uncertain due to factors such as the inability of laboratory tests to detect infections during the window period, a shortage of skilled professionals, poverty, rapid population growth, and unstable environments [12, 13]. However, the demand for blood transfusions in Ethiopia is high due to frequent road traffic accidents, surgical and obstetric blood loss, and internal armed conflicts [12, 14]. Although studies on TTIs among blood donors have been conducted in various parts of Ethiopia, no data are available for the study area. Understanding the prevalence of this is crucial for minimizing transmission within the community, as it varies across regions due to factors such as healthcare infrastructure, blood screening practices, infection rates, and local behaviors. Socioeconomic, cultural, and geographical factors also influence TTI prevalence, highlighting the need for localized strategies. This study aims to determine the prevalence and associated risk factors of TTIs among volunteer blood donors in North Shoa, Amhara Region, Ethiopia.

2 | Methods and Materials

2.1 | Study Area and Period

A cross-sectional study was conducted from April 2022 to July 2022 in the North Shoa Zone of the Amhara Region, Ethiopia. The study was based at the Debre Berhan Blood Bank, the only blood bank in the area, located in Debre Berhan Town, approximately 130 km from Addis Ababa, the capital of Ethiopia. Established in 2014, the blood bank serves 11 government hospitals, including Debre Berhan Comprehensive Specialized Hospital, Debre Berhan University Hakim Gizaw Hospital, Shoarobit Hospital, Arerti Hospital, Mehal Meda Hospital, Enat Hospital, Deneba Hospital, Mida Hospital, Debre Sina Hospital, Molale Hospital, and Ataye Hospital. Blood donations are collected from volunteer donors within a 140 km radius, with community mobilization efforts from various collection sites, including Debre Berhan town, Ataye town, Shoarobit town, Mehal Meda town, Arerti town, and Alem Ketema town.

2.2 | Sample Size and Sampling Technique

The sample size was determined by using a single population formula by considering a 95% confidence interval assuming seroprevalence of major blood infection among blood donors at Bahir Dar Felege Hiwot referral Hospital, Ethiopia of hepatitis B and C among blood donors was (4.5%) with precession of 2.25% [15].

$$N = \frac{(Z^2\alpha/2) \times p(1\text{-}p)}{d^2}$$

$$N = \frac{(1.96)^2 \times 0.045 \times (1 - 0.045)}{(0.0225)^2}$$

$$N = 326$$

By assuming a 10% nonresponse rate and using 1.5 design effects, the final sample size was 538.

$$NF = (\ N \times 10\% + 326) \times 1.5$$

$$NF = (326 \times 0.1 + 326) \times 1.5$$

$$NF = 358.6 \times 1.5 = 537.9 \sim 538$$

Where N = required sample size, $Z^2\alpha/2$ = critical value for normal distribution at 95% confidence interval, which equals 1.96 (Z value at alpha = 0.05), p = proportion of prevalence, d^2 = marginal error = 2.55%, and NF = final sample size

Simple random sampling was used to recruit the study participants. The sample size from each site was proportionally determined, and each study participants from each site were recruited using the lottery method (Figure 1).

2.3 | Study Setting and Population

All volunteer blood donors at each study site were the source population, and all randomly selected volunteer blood donors during the study period were the study population. Finally, volunteer blood donors who fulfilled the national blood donation criteria were included in the study area. Blood donors who did not meet the donation criteria (< 50 kg, < 18 years, > 65 years old, and unwillingness to give informed consent) were excluded from the study.

2.4 | Data and Sample Collection

After securing informed consent, sociodemographic, and risk factors data were collected by a pre-tested structured questionnaire. From all participants, 5 mL of venous blood was collected from blood donors using a sterile test tube.

2.5 | Laboratory Analysis

The donor bags were inspected for any signs of leakage, clotting, or hemolysis before processing. Using a sterile syringe, 5 mL of blood samples were aseptically drawn from donor bags into test tube and allowed to clot at room temperature for 30–60 min. After centrifugation at 3500 rpm for 10 min, serum was carefully collected, labeled, and stored at −20°C for further analysis.

2.6 | Hepatitis B Virus (HBV) Testing

Serum samples were tested for hepatitis B surface antigen (HBsAg) using the WANTAI HBsAg third-generation enzyme-linked immunosorbent assay (ELISA) (Beijing, China). Reactive samples were further confirmed using nucleic acid testing (NAT) with the Cobas TaqMan HBV Test v2.0, 6800/8800 systems (Roche Diagnostics, Germany).

2.7 | Hepatitis C Virus (HCV) Testing

HCV screening was performed using the WANTAI Anti-HCV third-generation ELISA (Beijing, China). Reactive samples were confirmed using the fully automated Cobas TaqMan HCV Test v2.0 6800/8800 systems (Roche Diagnostics, Germany).

2.8 | Human Immunodeficiency Virus (HIV) Testing

HIV-1 and HIV-2 infections were initially screened using the Microlisa HIV (Ag and Ab) fourth-generation ELISA (New Delhi, India). Reactive samples were confirmed using fully automated Cobas TaqMan HIV-1 Test v2.0, 6800/8800 systems (Roche Diagnostics, Germany).

2.9 | Syphilis Testing

Syphilis screening was conducted using the WANTAI anti-TP ELISA (Beijing, China), which detects antibodies against Treponema pallidum. Reactive samples were further confirmed using the Syphilis–RPR VDRL Slide Test Kit from Bio Lab Diagnostics (I) Private Limited (India).

2.10 | Data Processing and Analysis

The data was entered into Epi Data version 4.6 and exported to Statistical Package for Social Sciences (SPSS) version 25 for analysis. The descriptive statistics (median, percentages, or frequency) were calculated. The bivariate logistic regression analysis was used to observe the relationship between the

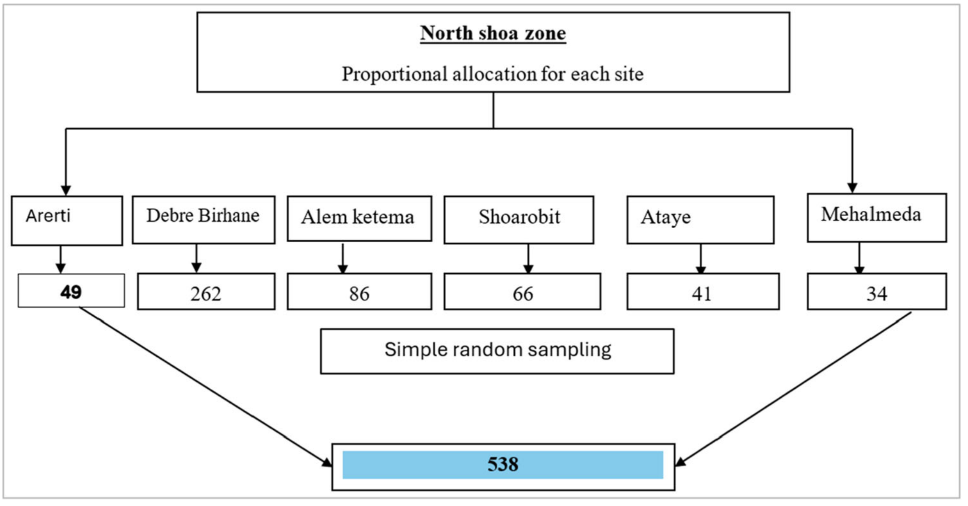

FIGURE 1 | Schematic presentation of sampling procedures employed to select volunteer blood donors in North Shoa Zone, Ethiopia (April 2022–July 2022).

dependent variable and independent variables. Variables that show a p-value ≤ 0.25 in bivraite logistic regression analysis were selected for further analysis using multivariate logistic regression models. Any variables that showed a p-value ≤ 0.05 by multivariate logistic regression models were considered as statistically significant using a 95% confidence interval.

3 | Results

3.1 | Sociodemographic Characteristics of Study Participants

A total of 538 volunteer blood donors participated in this study. Among them, the majority were male (n=326, 60.6%). The mean age of the participants was 22.67 ± 5.93 years. Most participants were aged 18–25 years ($n = 435$, 80.9%) and were single ($n = 437$, 81.2%). Majority of participants had completed primary or secondary education ($n = 393$, 63%). Most of the participants were students ($n = 351$, 65.2%), followed by government employees ($n = 105$, 19.5%), while farmers were the fewest participants ($n = 14$, 2.6%). Most of the participants came from urban areas ($n = 496$, 92.2%) (Table 1).

3.2 | Prevalence of Transfusion-Transmissible Infections

The overall prevalence of TTIs, including HIV, syphilis, HBV, and HCV was ($n = 40$, 7.4%). Syphilis had the highest prevalence at ($n = 16$, 3%), followed by HBV at ($n = 11$, 2%). The prevalence of HCV and HIV was ($n = 7$, 1.3%) and ($n = 6$, 1.1%), respectively (Table 2).

3.3 | Prevalence of Transfusion-Transmissible Infection by Sociodemographic Characteristics

3.3.1 | HBV Infections

The prevalence of HBV was slightly higher among male donors ($n = 9$, 2.8%) compared to female donors ($n = 2$, 0.9%). The highest number of positives was observed in the 18–25 age group ($n = 7$, 1.6%). HBV positivity was also higher among single individuals ($n = 7$, 1.6%) and students ($n = 7$, 2.0%). Urban residents accounted for a significant proportion of HBV cases ($n = 10$, 2.0%). Geographically, the highest rates of infection were recorded in Shoarobit ($n = 4$, 6.1%) and Mehal Meda ($n = 3$, 8.8%). Most HBV-positive donors ($n = 8$, 2.44%) lacked knowledge about HBV transmission. Additionally, HBV-positive donors reported a history of blood donation ($n = 5$, 2.5%) or body tattoos ($n = 5$, 17.2%), while ($n = 2$, 6.3%) had a history of malaria infection (Table 3).

3.3.2 | HCV Infections

The prevalence of HCV was comparable between males ($n = 4$, 1.2%) and females ($n = 3$, 1.4%). All HCV cases ($n = 7$, 1.6%) were observed among individuals aged 18–25 years. A higher prevalence of HCV infection was noted among students ($n = 6$, 1.7), married individuals ($n = 7$, 1.6%) and urban residents ($n = 6$, 1.2%). Geographically, the highest number of HCV infections was recorded in Debre Berhan ($n = 4$, 1.5%%). Additionally, a portion of HCV-positive participants reported a history of blood donation ($n = 3$, 1.5%) or body tattoos ($n = 3$, 10.3%). Most of the HCV-positive participants ($n = 4$, 1.2%) lacked knowledge about HCV transmission (Table 3).

3.3.3 | HIV Infections

The prevalence of HIV was reported among both male ($n = 4$, 1.2%) and female ($n = 2$, 0.9%) donors. HIV was more prevalent in the 18–25 age group ($n = 5$, 1.1%) and among single participants ($n = 4$, 0.9%). Most HIV-positive participants had an educational background in primary or secondary school ($n = 4$, 1.2%). All HIV-positive donors ($n = 6$, 1.2%) were urban residents. Additionally, a subset of HIV-positive donors ($n = 3$, 1.5%) reported a history of blood donation, and most ($n = 5$, 1.5%) lacked knowledge about HIV transmission (Table 3).

TABLE 1 | Sociodemographic characteristics of voluntary blood donors in North Shoa Zone, Amhara Region, Ethiopia (April 2022–July 2022; $N = 538$).

Variables	Categories	Frequency (%)
Sex	Male	326 (60.6)
	Female	212 (39.4)
Age categories	18–25 years	435 (80.9)
	26–34 years	79 (14.7)
	> 34 years	24 (4.5)
Marital status	Single	437 (81.2)
	Married	101 (18.8)
Occupational status	Students	351 (65.2)
	Private workers	68 (12.6)
	Government employed	105 (19.5)
	Farmers	14 (2.6)
Educational status	No formal education	6 (1.1)
	Complete primary and secondary	393 (63)
	Complete college above	193 (35.9)
Residence	Urban	496 (92.2)
	Rural	42 (7.8)
Site of donation	Arereti	49 (9.1)
	Debre Berhan	262 (48.7)
	Ataye	41 (7.6)
	Alem Ketema	86 (16.3)
	Shoarobit	66 (12.3)
	Mehal Meda	34 (6.3)

TABLE 2 | Prevalence of transfusion-transmissible infections among voluntary blood donors in North Shoa, Ethiopia (April 2022–July 2022).

Transfusion-transmissible infections	ELISA-reactive	NAT[a]/RPR[b]-confirmed	Prevalence[c]
Syphilis	16	16	3.0%
HBV	11	11	2.0%
HCV	7	7	1.3%
HIV	6	6	1.1%
Total	40	40	7.4%

[a]NAT for HBV, HCV, and HIV.
[b]RPR for Syphilis.
[c]Prevalence rates reflect NAT/RPR-confirmed cases only.

3.3.4 | Syphilis Infections

The prevalence of syphilis was higher among male participants ($n = 11$, 3.4%) compared to females ($n = 5$, 2.4%). The highest proportion of syphilis infections was observed among individuals aged 18–25 years ($n = 12$, 2.8%) and those who were single ($n = 12$, 2.7%). The highest prevalence of syphilis was observed in students ($n = 6$, 1.3%), private workers ($n = 5$, 7.4%), and government employed ($n = 5$, 4.8%). Most syphilis-positive participants had an educational background in college and above ($n = 9$, 4.7%) or primary and secondary school ($n = 7$, 2.1%). Geographically, the highest number was recorded at the Debre Berhan ($n = 6$, 2.3%). All syphilis-positive donors ($n = 16$, 3.2%) were urban residents. The prevalence of syphilis was high among participants who lacked knowledge ($n = 8$, 2.4%) and those who knew about syphilis transmission ($n = 8$, 3.8%). Additionally, most syphilis-positive donors ($n = 12$, 6.0%) reported a history of blood donation (Table 3).

3.4 | Factors Associated With HBV and Syphilis Infection Among Blood Donors

For syphilis infection, age was a notable factor, with the 18–25-year-old age group exhibiting the highest risk, reflected by a crude odds ratio (COR) of 5.6 (95% CI: 1.09–28.33, $p = 0.039$) and an adjusted odds ratio (AOR) of 4.18 (95% CI: 0.33–51.88). However, the association was not statistically significant. Additionally, body tattooing emerged as a critical behavioral risk factor. Donors with tattoos had a significantly higher likelihood of being HBsAg positive (AOR = 19.1, 95% CI: 4.0–89.8, $p \leq 0.01$). Among donation sites, Debre Berhan showed a remarkably elevated risk for HBV infection, with an AOR of 24.18 (95% CI: 1.98–295.14, $p = 0.01$), compared to other locations (Table 4).

For syphilis infection, the analysis revealed that male donors were significantly more likely to test positive compared to females. Males had an AOR of 3.78 (95% CI: 1.23–11.61, $p = 0.03$), indicating sex as a strong determinant. While age also played a role, the associations were less robust. The 18–25 age group had an AOR of 3.56 (95% CI: 0.62–20.51, $p = 0.14$), but this was not statistically significant. Education level showed a potential trend, with those having only primary or secondary education exhibiting higher odds of infection (AOR = 2.4, 95% CI: 0.77–7.45, $p = 0.12$), though this did not reach significance either (Table 5).

4 | Discussion

Transfusion-transmissible infections are a serious risk to individuals who need blood transfusions [1]. This study aimed to address the prevalence and associated risk factors of TTIs among volunteer blood donors in North Shoa, Amhara Region, Ethiopia.

In developing countries, timely blood transfusion is often a critical, life-saving intervention [16]. However, ensuring a sufficient supply of safe blood products poses a significant challenge due to the high prevalence of (TTIs) such as hepatitis B, hepatitis C, syphilis, and HIV [17]. These infections contribute to severe, chronic, and potentially life-threatening conditions, disproportionately affecting healthcare outcomes in resource-limited settings. Limited access to advanced screening technologies, inadequate donor recruitment practices, and poor public health infrastructure exacerbate the risk of TTIs [18]. Therefore, understanding the epidemiology and determinants of TTIs among blood donors is vital in these settings to guide the development of targeted prevention and control strategies, improve blood safety, and enhance public health outcomes.

In this study, the overall prevalence of TTIs was ($n = 40$, 7.4%). The finding is in line with the previous studies conducted in different areas of Ethiopia, like Hawassa (7.29%) [19], Dire Dawa (7.06%) [10], Gondar (6.55%) [20], and Bahir Dar (6%) [21]. However, it is lower compared to the report from Jijiga (11.5%) [9] and Wolaita Sodo (29.5%) [22]. The finding of this study is also lower than other studies conducted in other African countries like Eritrea (12.9%) [23], Burkina Faso (24.0%) [24], Cameroon (13.7%) [25], and Kenya (9.4%) [26]. On the contrary, the current prevalence is slightly higher compared to previous reports from Debre Tabor, Ethiopia (4.6%) [27], Eritrea (3.6%) [28], Ghana (4.06%) [29], India (4.36%) [30], and Pakistan (5.8%) [1]. The possible justification for the variation in the prevalence of TTIs might be sample size, lack of knowledge about transmission TTIs, and the method of screening test used. This high prevalence of TTIs among volunteer blood donors is a significant threat to blood safety, and thus, strict donor screening and awareness creation about the transmission of TTIs are essential in the study area.

In this study, the prevalence of HBV infection was slightly higher among male donors ($n = 9$, 2.8%) compared to females ($n = 2$, 0.9%), with the highest prevalence observed in the 18–25-year-old age group ($n = 7$, 1.6%). Similar findings were also reported in Gondar [12], Nekemte [31], and Debre Markos [32]. All of which

TABLE 3 | Distribution of transfusion-transmissible infections (HBV, HCV, HIV, syphilis) by sociodemographic and risk factors among voluntary blood donors in North Shoa, Ethiopia (April 2022–July 2022).

Variable	Categories	HBsAg		Anti-HCV		Anti-HIV		Anti- *Treponema pallidum*	
		Positive Number (%)	Negative Number (%)	Positive Number (%)	Negative Number (%)	Positive Number (%)	Negative Number (%)	Positive Number (%)	Negative Number (%)
Sex	Male	9 (2.8)	317 (97.2)	4 (1.2)	322 (99.8)	4 (1.2)	322 (98.8)	11 (3.4)	315 (96.6)
	Female	2 (0.9)	210 (99.1)	3 (1.4)	209 (98.6)	2 (0.9)	210 (99.1)	5 (2.4)	207 (97.6)
Age group	18–25	7 1.6)	428 (98.4)	7 (1.6)	428 (98.4)	5 (1.1)	430 (98.1)	12 (2.8)	423 (97.2)
	26–35	2 (2.5)	77 (97.5)	0 (0.0)	79 (100.0)	1 (1.3)	78 (98.7)	2 (2.5)	77 (97.5)
	> 35	2 (8.3)	22 (91.7)	0 (0.0)	24 (100.0)	0 (0.0)	24 (100.0)	2 (8.3)	22 (91.7)
Marital status	Single	7 (1.6)	430 (98.4)	0 (0.0)	101 (100.0)	4 (0.9)	433 (99.1)	12 (2.7)	425 (97.3)
	Married	4 (4.0)	97 (96.0)	7 (1.6)	430 (98.4)	2 (2.0)	99 (98.0)	4 (4.0)	97 (96.0)
Occupation	Students	7 (2.0)	344 (98.0)	6 (1.7)	345 (98.3)	2 (0.6)	349 (99.4)	6 (1.3)	345 (98.7)
	Private worker	0 (0.0)	68 (100.0)	1 (1.5)	67 (98.5)	2 (2.9)	66 (97.1)	5 (7.4)	63 (92.6)
	Government employed	4 (3.8)	101 (19.2)	0 (0.0)	105 (100.0)	2 (1.9)	103 (98.1)	5 (4.8)	100 (93.2)
	Farmer	0 (0.0)	14 (2.7)	0 (0.0)	14 (100.0)	0 (0.0)	14 (100.0)	0 (0.0)	14 (100.0)
Education status	No formal education	0 (0.0)	6 (100.0)	0 (0.0)	6 (100.0)	0 (0.0)	6 (100)	0 (0.0)	6(100)
	Completed primary and secondary	8 (2.4)	331 (97.6)	6 (1.8)	333 (98.2)	4 (1.2)	335 (98.8)	7 (2.1)	332 (97.9)
	Completed college and above	3 (1.6)	190 (98.4)	1 (0.5)	192 (99.5)	2 (1.0)	191 (99.0)	9 (4.7)	184 (95.3)
Residence	Urban	10 (2.0)	486 (98.0)	6 (1.2)	490 (98.8)	6 (1.2)	490 (98.8)	16 (3.2)	480 (96.8)
	Rural	1 (2.4)	41 (97.6)	1 (2.4)	41 (97.6)	0 (0.0)	42 (100.0)	0 (0.0)	42 (100.0)
Site of donation	Debere Berhan	1 (0.4)	261 (99.6)	4 (1.5)	258 (98.5)	1 (0.4)	261 (99.6)	6 (2.3)	256 (97.7)
	Alem ketema	2 (2.3)	84 (97.7)	2(2.3)	84 (97.7)	2 (2.3)	84 (97.7)	3 (3.5)	83 (96.5)
	Ataye	1 (2.4)	40 (97.6)	0 (0.0)	41 (100.0)	1 (2.4)	40 (97.6)	3 (7.3)	38 (92.7)
	Mehal Meda	3 (8.8)	31 (91.2)	0 (0.0)	34 (100.0)	0 (0.0)	34 (100.0)	0 (0.0)	34 (100.0)
	Arerti	0 (0.0)	49 (100)	1 (2.0)	48 (98)	1 (2.0)	48 (98)	0 (0.0)	49 (100.0)
	Shoarobit	4 (6.1)	62 (93.9)	0 (0.0)	66 (100.0)	1 (1.5)	65 (98.5)	4 (6.1)	62 (93.9)
Know about transmission	Yes	3 (1.42)	208 (98.58)	3 (1.4)	208 (98.6)	1 (0.47)	210 (99.53)	8 (3.8)	203 (96.2)
	No	8 (2.44)	319 (97.56)	4 (1.2)	323 (98.8)	5 (1.5)	322 (98.5)	8 (2.4)	319 (97.2)
History of donation	Yes	5 (2.5)	193 (97.5)	3 (1.5)	195 (98.5)	3 (1.5)	195 (98.5)	12 (6.0)	186 (94.0)

(Continues)

TABLE 3 | (Continued)

Variable	Categories	HBsAg		Anti-HCV		Anti-HIV		Anti- *Treponema pallidum*	
		Positive Number (%)	Negative Number (%)	Positive Number (%)	Negative Number (%)	Positive Number (%)	Negative Number (%)	Positive Number (%)	Negative Number (%)
	No	6 (1.8)	334 (98.2)	4 (1.2)	336 (98.8)	3 (0.8)	337 (99.2)	4 (1.2)	336 (98.8)
Frequency of donation	First	0 (0.0)	5 (100.0)	0 (0.0)	5 (100.0)	0 (0.0)	5 (100.0)	0 (0.0)	5 (100.0)
	Multiple	5 (2.6)	188 (97.4)	3 (1.6)	190 (97.4)	3 (1.6)	190 (97.4)	12 (6.2)	181 (93.8)
History of transfusion	Yes	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)
	No	11 (2.1)	525 (97.9)	7 (1.3)	529 (98.7)	6 (1.1)	530 (98.9)	16 (3.0)	520 (97.0)
History of chronic disease	Yes	0 (0.0)	8 (100.0)	1 (12.5)	7 (87.5)	0 (0.0)	8 (100.0)	1 (12.5)	7 (87.5)
	No	11 (2.1)	519 (97.9)	6 (1.1)	524 (98.1)	6 (1.1)	524 (98.1)	7 (1.3)	515 (98.7)
Body tattoo	Yes	5 (17.2)	24 (82.8)	3 (10.3)	26 (89.7)	0 (0.0)	29 (100.0)	2 (6.9)	27 (93.1)
	No	6 (1.2)	503 (98.8)	4 (0.8)	505 (99.2)	6 (1.2)	503 (98.8)	14 (2.7)	495 (97.3)
History of cupping	Yes	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)	0 (0.0)	2 (100.0)
	No	11 (2.1)	525 (97.1)	7 (1.3)	529 (99.6)	6 (1.1)	530 (98.9)	16 (3.0)	520 (97.0)
History of malaria infection	Yes	2 (6.3)	30 (93.8)	0 (0.0)	32 (100.0)	0 (0.0)	32 (100.0)	0 (0.0)	32 (100.0)
	No	9 (1.8)	497 (98.2)	7 (1.4)	499 (98.6)	6 (1.2)	500 (98.8)	6 (1.2)	500 (98.8)
History of tooth extraction	Yes	0 (0.0)	10 (100.0)	0 (0.0)	10 (100.0)	0 (0.0)	10 (100.0)	0 (0.0)	10 (100.0)
	No	11 (2.1)	517 (97.9)	7 (1.3)	521 (98.7)	6 (1.1)	522 (98.9)	16 (3.0)	512 (97.0)

TABLE 4 | Factors associated with hepatitis B virus infection among voluntary blood donors in North Shoa, Ethiopia (April 2022–July 2022).

Variables	Characteristics	HBsAg positive	COR (95%CI)	*p*-value	AOR (95% CI	*p*-value
Sex	Male	9 (2.8)	0.335 (0.72–1.568)	0.165	0.55 (0.10–2.91)	0.43
	Female	2 (0.9)	1		1	1
Age group	15–25	7 (1.6)	5.6 (1.09–28.33)	0.039	4.18 (0.33–51.88)	0.57
	26–35	2 (2.5)	3.5 (0.466–26.29)	0.22	1.98 (0.17–22.3)	0.29
	> 35	2 (8.3)	1		1	1
Marital status	Single	7 (1.6)	0.395 (0.11–1.37)	0.14	0.68 (0.01–4.67)	0.69
	Married	4 (4.0)	1		1	1
Site of donation	Arereti	1 (0.4)	5.2 (0.34–11.03)	0.98	10.6 (0.8–15.5)	0.99
	Debere Berhan	2 (2.3)	25.25 (2.55–250)	0.00	24.18 (1.98–295.14)	0.01
	Ataye	1 (2.4)	3.87 (0.38–39)	0.25	8.62 (0.55–133.6)	0.11
	Alem ketema	3 (8.8)	4.1 (0.64–25.4)	0.13	3.73 (0.48–28.5)	0.16
	Shoarobit	0 (0.0)	1.5 (0.32–7.12)	0.61	1.0 (0.14–7.98)	0.85
	Mehal meda	4 (6.1)	1	1		
Body tattoo	Yes	5 (17.2)	17.47 (4.98–61.23)	0.00	19.1 (4.0–89.8)	< 0.01
	No	6 (1.2)	1			1
History of malaria infection	Yes	2 (6.3)	3.68 (0.76–17.8)	0.11	1.2 (0.17–9.0)	0.54
	No	9 (1.8)	1	1	1	

Abbreviations: 1, Reference; AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio.

revealed a higher prevalence of HBV among male participants within the same age range. The highest prevalence among male donors may be attributed to behavioral risk factors, such as having multiple sexual partners, which increase the likelihood of HBV transmission. On the other hand, the lower prevalence of HBV among females could be partly explained by the smaller number of female participants in the current study, potentially skewing the observed rates.

The prevalence of HBV infection in the current study was ($n = 11$, 2.0%), which is lower than findings reported in other parts of Ethiopia, such as Nekemet (3.06%) [33], Jimma (3.6%) [34], Dessie (4.2%) [14], South Gondar (5.8%) [12], Debre Markose (4.7%) [32], Bahir Dar (3.9%) [21] Hawassa (3.4%) [35], Dire Dawa (3.73%) [36], Wolaita Sodo (9.5%) [22]. Similarly, the findings of this study are lower than those reported from other countries like Ghana (9.6%) [37], Sierra Leone (10.2%) [38], and Yemen (5.1%) [39]. However, the prevalence was higher than the study conducted in Yemen (0.6%) [8], Nepal (0.47%) [40], India (0.68%) [41], and Pakistan (1.4%) [42]. The differences observed across studies may be attributed to variations in sociodemographic factors, cultural and societal behaviors, socioeconomic conditions, and levels of awareness within the populations studied. Furthermore, discrepancies in the performance and sensitivity of screening methods used at different times could also contribute to these variations.

The current study also revealed that donors with body tattoos were significantly more likely to be infected with HBV [AOR = 19.1, 95% CI: (4.0–89.8, $p \le 0.01$)]. This association may be explained using shared, non-sterile materials from traditional tattooing sources, which can facilitate HBV transmission. Additionally, the site of donation from Debre Berhan showed a statistically significant association with HBV prevalence [AOR = 24.18, 95% CI: (1.98–295.14, $p = 0.01$)], potentially reflecting local variations in risk factors or public health practices.

In the present study, the overall prevalence of HCV was ($n = 7$, 1.3%). This finding is in line with the study conducted in Bahir Dar (1.33%) [21] and Yemen (1.3%) [8]. However, it is slightly lower than the study conducted in South Gondar (4.2%) [12], Gondar (1.6%) [43], Kenya (3.2%) [11], Sierra Leone (1.2%) [38]. But higher than the study conducted in Nekemte (0.64%) [33] Dessie, (0.0%) [14], Iraq (0.3%) [44], and India (0.074%) [41]. The discrepancy in HCV infection rates across different regions in Ethiopia and other countries may be attributed to variations in risk behaviors, geographical factors, study populations, and differences in diagnostic techniques.

In the current study, the seroprevalence of HCV was almost similar among male ($n = 4$, 1.2%) and female ($n = 3$, 1.4%) participants. All HCV cases ($n = 7$, 1.6%) were observed among individuals aged 18–25 years. This finding is similar to the study conducted in Gondar [45]. A higher prevalence of HCV infection was also noted among students ($n = 6$, 1.7%) and urban residents ($n = 6$, 1.2%). This age group is often associated with behaviors that increase the risk of HCV

TABLE 5 | Factors associated with syphilis infection among voluntary blood donors in North Shoa, Ethiopia (April 2022–July 2022).

Variables	Characteristics	Positive for Syphilis	COR (95%CI)	*p*-value	AOR (95% CI)	*p*-values
Sex	Male	11 (3.4)	3.34 (1.15–9.77)	0.027	3.78 (1.23-11.61)	0.03
	Female	5 (2.4)	1	1	1	
Age group	15–25	12 (2.8)	3.2 (0.68–15.2)	0.14	3.56 (0.62–20.51)	0.4
	26–35	2 (2.5)	3.5 (0.46–26.2)	0.22	4.28 (0.54–33.58)	0.2
	> 35	2 (8.3)	1	1	1	
Education status	No formal education	0 (0.0)	7.9 (0.01–3.2)		0.12 (0.01–1.01)	0.99
	Complete primary and secondary	7 (2.1)	2.3 (0.85–6.3)	0.12	2.4 (0.77–7.45)	0.94
	Complete college and above	9 (4.7)	1		1	1
History of chronic disease	Yes	1 (12.5)	4.9 (0.56–42.4)	0.15	0.17 (0.018–1.67)	0.09
	No	7 (1.3)	1	1	1	

Abbreviations: 1, Reference; AOR, adjusted odds ratio; CI, confidence interval; COR, crude odds ratio.

transmission, such as unprotected sexual activity, injection drug use, or unsafe tattooing practices. Additionally, younger individuals may lack awareness of preventive measures or have limited access to healthcare services, increasing their vulnerability to infection. Socioeconomic factors and peer influence, common in this age range, could also contribute to the higher prevalence.

The prevalence of HIV in this study was ($n = 6$, 1.1%). This is comparable with the study conducted in Cameroon (1%) [17] but higher than the study conducted in Dessie (0.26%) [14], Jijiga (0.1%) [9], Pakistan (0.7%) [42], and China (0.31%) [5]. Moreover, the finding is also lower than the study reported from south Gondar (2.6%) [12] and Gondar (3.8%) [45]. The findings indicate a high burden of HIV among volunteer blood donors, which may also reflect the prevalence within the general population. HIV was more prevalent in the 18–25 age group ($n = 5$, 1.1%), and urban residents ($n = 6$, 1.2%). Additionally, a subset of HIV-positive donors ($n = 3$, 1.5%) reported a history of blood donation, and most ($n = 5$, 1.5%) lacked knowledge about HIV transmission. This underscores the need for ongoing awareness campaigns on HIV transmission in the study area to help reduce the burden.

Our study demonstrated the prevalence of syphilis was ($n = 16$, 3.0%), which was higher than the study conducted in Dessie (1.82%) [14], Gondar (1.3%) [45], Bahir Dar (1.2%) [21], Debre Tabor (0.74%) [27], Hawassa (0.5%) [35], Eritrea (0.6%) [28], Kenya (1.56%) [26] and India (1.45%) [46]. However, it is lower than the study conducted in Wolaita Sodo (7.9%) [22] and Cameroon (8.1%) [25]. This variation could be attributed to differences in study settings, sample sizes, and the sensitivity and specificity of diagnostic kits used. The data revealed that male donors were significantly more likely to test positive for syphilis compared to female donors [AOR = 3.78, 95% CI: (1.23–11.61, $p = 0.03$)]. This could be due to higher engagement in risky behaviors, such as unprotected sexual activity, and potentially greater exposure to high-risk networks or environments.

This study highlighted the high prevalence of TTIs in the study area ($n = 40$, 7.4%). The highest proportion of TTI cases was observed among individuals aged 18–25 years ($n = 31$, 7.1%) and those who were single ($n = 23$, 5.3%). Another similar study also reported similar findings [47–49]. This might be due to engagement in risky behaviors, such as unprotected sexual activity. In terms of occupation, students ($n = 21$, 6.0%) and government employees ($n = 11$, 10.5%) exhibited the highest prevalence of TTIs. Similar findings were also reported in different countries [11, 21, 48–51]. This could reflect distinct risk dynamics, such as unsafe practices or social behaviors. Majority of TTI-positive donors were urban residents ($n = 38$, 7.7%). Similar findings were also reported in different countries [19–24]. This might be due to greater exposure to high-risk networks and increased access to blood donation services, leading to higher detection rates. Furthermore, most TTIs-positive donors reported a history of blood donation ($n = 23$, 11.6%), often with multiple previous donations ($n = 23$, 14.1%), emphasizing the need for targeted education, behavioral interventions, and strict screening in these groups.

5 | Conclusion

This study highlights a significant burden of TTIs among voluntary blood donors in North Shoa, Ethiopia, with an overall prevalence of ($n = 40$, 7.4%). Syphilis was the most prevalent infection, followed by hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV). Male donors, individuals aged 18–25 years old, and urban residents were disproportionately affected, reflecting underlying behavioral, demographic, and environmental risk factors. The findings underscore the urgent need for enhanced public awareness, strict donor screening, and improved diagnostic techniques to mitigate TTI transmission risks. Strengthening public health interventions and fostering community engagement will be vital for improving blood safety and reducing the broader burden of TTIs in the region.

Author Contributions

Demissew Shenkute Gebreyes: conceptualization, methodology, investigation, formal analysis, data curation, writing – review and editing, and writing – original draft. **Kifle Kifetew:** funding acquisition, supervision, and project administration. **Aragaw Gizaw:** funding acquisition, visualization, resources, and data curation. **Tsegahun Asfaw Abebe:** investigation, writing – original draft, writing – review and editing, formal analysis, methodology, and data curation. **Tassew Tefera Shenkutie:** investigation, writing – original draft, writing – review and editing, formal analysis, and data curation. **Deribew Genetu:** investigation, writing – original draft, writing – review and editing, formal analysis, and data curation. **Berhanu Yitayew:** funding acquisition, writing – original draft, writing – review and editing, and supervision. **Awraris Hailu:** conceptualization, methodology, software, supervision, writing – original draft, writing – review and editing.

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Ethics Statement

Ethical approval for the study was obtained from the Debre Berhan University, Health Science College Institutional Research Review Board (protocol number: IRB:004). Written informed consent was obtained from all study participants before data collection. Confidentiality of the study participants was also strictly maintained by giving a code. Donors who were positive for any transfusion-transmissible infections during the study period were counseled and linked to healthcare facilities. The study was conducted according to the Declaration of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors confirm that the data supporting the findings of this study are available within the article.

Transparency Statement

The lead authors Demissew Shenkute Gebreyes and Tsegahun Asfaw Abebe affirm that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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