Estimating the Transmission Risks of Viral Hepatitis and HIV Among Blood Donors in Hossana, Southern Ethiopia

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Purpose: Screening of viral transfusion-transmissible infections (TTIs) among blood donors is of public health concern. It is a cost-effective method to monitor the occurrence, distribution, and trends of TTIs in healthy people. This study aimed to estimate the magnitude of the three common viral TTIs among blood donors in Hossana, Ethiopia.

Methods: A cross-sectional study was conducted among 417 blood donors from April to May 2020 in Southern Ethiopia. Data were collected using a structured questionnaire and laboratory blood screening for hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) using Wantai AiDTM HBsAg, anti-HCV, and HIV 1 + 2 Ag/Ab ELISA. Data were entered into Epi-Data version 3.1 and analyzed using SPSS version 21.0. A binary logistic regression model was fitted to identify factors associated with each viral infection. The odds ratio with a 95% confidence interval was calculated. A p-value <0.05 was considered statistically significant.

Results: A total of 417 blood donors participated in this study producing an overall prevalence of viral TTI was 14.38%. HBV, HCV, and HIV prevalence were 9.83%, 2.39%, and 4.31%, respectively. HBV-HIV was a common co-infection, which had 1.2%. In multivariate logistic regression analysis, family history of hepatitis (AOR=5.2, 95% CI (2.92, 7.41)) and multiple sexual contacts (AOR=4.2, 95% CI (2.32–7.41)) were significantly associated with HBV; low educational level (AOR=3.1, 95% CI (2.58–15.25)) and multiple sexual contacts (AOR=4.9, 95% CI (3.51–7.96)) were significantly associated with HIV, but the only variable alcohol consumption (AOR=2.7, 95% CI (6.72–23.76)) was also associated with HCV infection.

Conclusion: In this study, the magnitude of viral TTIs among blood donors is high. This indicates that there are high risks of transmission for these infectious pathogens. Therefore, effective stringent donor selection and screening protocols should be developed.

Keywords: HBV, HCV, HIV, seroprevalence, blood transfusion

Introduction

Blood transfusion is an effective treatment that saves millions of lives every year all over the world. It is a crucial component of the health-care service; however, it is associated with major TTIs risks.1 TTIs are a major problem associated with blood transfusion, particularly in developing countries.2,3 Usually, it leads to the transmission of infectious agents from asymptomatic donor to recipient. HBV, HCV, and HIV are common viral infections that can be transmitted from person to person through parenteral administration of blood or blood products.4,5 About 350 million people worldwide are chronically infected with HBV, more than 71 million with HCV, and 38 million with HIV.6,7
The prevalence of TTIs among blood donors is widely used as an indicator of the problem. In several settings, HBV, HCV, and HIV are the major TTIs. TTIs can exist asymptotically in donors and each blood transfusion carries a risk of transmitting blood-borne pathogens. For instance, in sub-Saharan Africa, 12.5% of patients who received blood transfusions are at risk of post-transfusion hepatitis infection, and 5–10% of HIV transmission is as a result of contaminated blood transfusions.

In Ethiopia, studies are showing the prevalence of transfusion transmitted infection burden varies in different places. In most of the transfusion centers, the testing of the blood for the presence of such pathogens was not universal. This difference in screening practices for TTIs in transfusion centers affects the prevalence estimation of TTIs. Studies showed that the total seroprevalence of TTIs among blood donors is 9.5% and 6.55% from Northern Ethiopia. A study conducted in Wolayta Sodo showed 8.5% seroprevalence of these infections and in Dire Dawa showed 3.7% prevalence of TTIs in blood donors.

Infection by such major viral transfusion-transmissible infections causes mortality, morbidity, and financial burden and thus is a major global health problem. Therefore, the prevention and control of TTIs is the concern and priority of the World Health Organization and blood transfusion programs in Sub-Saharan African countries, including Ethiopia. Laboratory testing of the blood is very crucial to prevent the transmission of these infections to safe healthcare delivery through blood transfusions. The screening for HBV, HCV, and HIV among blood donors can be a cost-effective approach to monitor the prevalence, distribution, and trends of these infections within the populations.

Since TTIs may occur in donors without symptoms, they must be screened for these high-risk behavior-related diseases. In Ethiopia, testing of the blood for the presence of major infectious pathogens such as HBV, HCV, and HIV is important for monitoring the magnitude of these infections, determining the risks, and optimizing donors’ recruitment strategies to minimize these disease transmissions. Therefore, this study aimed to estimate the magnitude of transmission risks of the three common viral TTIs among blood donors in Southern Ethiopia.

Materials and Methods

Study Setting

The study was conducted in the Southern Nation Nationalities of People Region, Hossana district blood bank. The blood bank was established in 2014 in Hossana town, Hadiya zone, which is located 232 km southwest of the capital city, Addis Ababa. It provides services for a population of approximately seven million people in the district and neighboring district. The blood bank mainly provides services for hospitals and referral units around the district by sustaining all the blood needs of patients. On average, the blood bank collects greater than 8000 units of blood from voluntary blood donors annually.

Study Design and Subjects

A facility-based cross-sectional study design was conducted among 417 blood donors to estimate the transmission risks of viral hepatitis and HIV. This study design considered appropriate for the objective, as its main intention was to estimate the prevalence of TTIs and to identify associated factors simultaneously at single-point data collection period of April to May 2020 in Hossana district blood bank. The source population was all potential donors who visited Hossana blood bank centre; while all blood donors who attended the blood bank during the study period and who were eligible to donate blood were the study population. Participants were included in the study if they met the national and regional donation requirements, which included being between the ages of 18 and 65, having a bodyweight greater than 45 kg, and having a hemoglobin level greater than 12.5 g/dL. All blood donors’ medical histories, physical examinations, and screenings were completed and registered, and eligibility to donate blood was checked. The donors who were not willing to consent to participate in the study were excluded. Every prospective blood donor who visited the blood bank and satisfied the inclusion criteria was selected once the person consented to be part of the study.

Sample Size Determination and Sampling Techniques

The sample size to estimate the transmission risks of viral TTIs among blood donors was determined by using single population proportion formula considering the seroprevalence of major blood-borne infections among blood donors based on the study conducted in Eastern Ethiopia with 95% confidence interval, 3% margin of error. Finally, it increased by 10% sample size to account for contingencies such as non-response rate and recording errors. Accordingly, the sample size was calculated to be 417.
Data Collection Process and Tools
Blood donors were interviewed by trained professional health-care workers using closed-ended structured questionnaires. The collected data were socio-demographic, behavioral, and clinical factors. The laboratory screening outcomes of the various infections were recorded for each interviewed blood donor.

Specimen Collection and Processing
About 5 mL of blood sample was collected from each collected blood bag using a sterile syringe. The serum was separated by centrifuging the blood at 2000 r/min for 5 minutes. Serums were collected in Eppendorf tubes and stored in a refrigerator at a temperature of below –20°C until the tests were done.

Serological Analysis
Blood samples were tested for HBV, HCV, and HIV using Wantai AiDTM HBsAg Enzyme-Linked Immuno-Sorbent Assay (ELISA), Wantai AiDTM anti-HCV ELISA, and WANTAI HIV 1 + 2 Ag/Ab ELISA test kits (Beijing Wantai Biological Pharmacy Enterprise Co., Ltd. China Laboratory Diagnosis), respectively. All of the positive-tested blood samples were repeated once before being reported positive by the same tests.

Data Entry and Analysis
Data was entered using Epi-Data version 3.1 and analyzed using SPSS version 21.0. Descriptive statistics; mean and standard deviation for continuous variables and frequency for categorical variables were used. A binary logistic regression model was fitted to identify factors associated with seroprevalence for HBV, HCV, and HIV infections. The variables in bivariate analysis with a p-value of <0.25 were taken as candidates for multivariate analysis. Those independent variables which showed association in the binary logistic regression analysis were considered as final predictors of the dependent variable. The variables that showed significant associations were reported by using p-value, odds ratios, and 95% CI. A p-value <0.05 was considered statistically significant.

Results
Socio-Demographic Characteristics
A total of 417 (58.3% males, age 20–65 years, mean age ± SD = 25.62 ± 4.31 years) blood donors participated in this study. Of the total, 277 (66.4%) donors were urban residents, 413 (99.0%) were voluntary donors, and 360 (86.3%) were those who donated blood for the first time (Table 1).

Magnitude of HIV, HBV and HCV
The overall prevalence of viral TTI was 60 (14.38%). The magnitude of HBV, HCV and HIV was 41 (9.83%), 10 (2.39%), 18 (4.31%), respectively. Nine out of 417 (2.16%) had multiple infections. The combinations were HBV-HIV 6 (1.44%) and HCV-HIV 3 (0.72%) (Table 2).

In this study, high rate of HBV and HIV was observed in relation to some risk factors characteristics of the study participants. Among participants with family history of hepatitis infection (n=32), individuals having multiple sexual contact (n=82), participants who had history of contact with hepatitis/jaundiced patients (n=41), alcohol consumption (n=89), and chat chewing (n=74) the magnitude of checked the collected data daily to maintain its accuracy and completeness. The Manufacturer’s instructions and standard operating procedures were strictly followed during laboratory tests. Positive and negative controls were used to check the quality of reagents.

Ethical Approval and Consent to Participate
The study was conducted in accordance with the Declaration of Helsinki, after receiving ethical approval from the Institutional Review Board of Aklilu Lemma Institute of Pathobiology, Addis Ababa University (Reference Number ALIPB IRB/002/2011/2018). An official letter was submitted to the concerned administrative office in the district to get permission for the study, and written informed consent was obtained from each participant who participated in the study following an explanation of the purpose, the possible risks, and the importance of the study in their local languages. The participants were assured that they had the full right to participate or not to participate in the study. Individuals who tested positives were advised and linked to health facilities to obtain treatment and care. All information obtained in the study was maintained confidentially.

Quality Assurance
The training was given to data collectors on the objective of the study, the benefit, individual rights, informed consent and techniques of the interview, laboratory personals, and supervisors to ensure the quality of data. Supervisors
HBV was 18.8%, 17.1%, 17.1%, 15.7% and 14.9%, respectively. Whereas the magnitude of HIV was 8.5%, 8.1% and 7.9% among participants with risk characteristics multiple sexual contact, Khat chewing and alcohol consumption respectively (Table 3).

Factors Associated with Viral TTIs

Potential factors associated with three viral TTI statuses among blood donors in the study district were analyzed. Multivariable analysis was conducted to control the potential confounders. In this regard, those individuals who had family history of hepatitis patients were 5.2 times more likely to be infected with HBV (AOR = 5.2; 95% CI: 2.92, 7.41) compared to their counterparts. Individuals who had the exposure of having multiple sex partners were 4.2 times more likely associated with HBV compared to their counterparts (AOR = 4.2; 95% CI: 2.32, 7.43) and 4.91 times more likely associated with HIV compared to their counterparts (AOR = 4.9; 95% CI: 3.51, 9.65). Those who had no formal education were 3.1 times more likely to be at risk of infection with HBV than secondary and above level (AOR = 3.1; 95% CI: 2.58, 15.25). The odds of HIV were 2.7 times higher for individuals who had alcohol compared to those who had no alcohol (AOR = 2.7; 95% CI: 6.72, 23.76) (Tables 4 and 5).

Discussion

Blood transfusion is considered to be a potential risk factor for the transmission of blood-borne viral infections such as HBV, HCV, and HIV, which are the greatest threats to blood safety for the recipients. A safe blood supply is an essential component in improving health care. Every blood transfusion therefore carries a potential risk for transmissible diseases. Countries with scarce resources, such as sub Saharan, are constantly faced with a shortage of healthy blood for transfusion. This study revealed the overall magnitude of three common viral TTIs in the donor population was 14.4%. This finding is somewhat similar to that of studies conducted in Easter region, Jigjiga 11.5%, and Northwest region, Felege Hiwot 13.3% in Ethiopia and other developing countries; 12.0% in Kenya, 17.3% in Eritrea, 13.0% in Nigeria but lower studies reported in other locations of south Ethiopia; 29.5% in Sodo Wolaita, and 43.2% in Equatorial Guinea. This is probably because of the actual differences in study, population, duration, variation in occupation, and geographical differences of the study populations; moreover, the prescreening procedure may also play a role in the observed variations. In addition, this study focused on volunteer donors that might decrease the prevalence rates of TTIs from other studies. The World Health Organization encourages blood donation from voluntary donors because this kind of donation is believed to have a lesser chance of harboring and transmitting TTIs. Furthermore, the lower magnitude of TTIs in this study may be attributed to the fact that it only looked at three viral infections while other studies looked at including the magnitude of syphilis and malaria as well.

Table 1 Socio-Demographic Characteristics of Blood Donors in Hossana District Blood Bank, Southern Ethiopia, 2020 (n = 417)

| Characteristics | Frequency | Percentage |
|-----------------|-----------|------------|
| Gender          |           |            |
| Male            | 243       | 58.3       |
| Female          | 174       | 41.7       |
| Age category (years) |           |            |
| 18–30           | 146       | 35.0       |
| 31–45           | 194       | 46.5       |
| 46–65           | 77        | 18.5       |
| Residence:      |           |            |
| Rural           | 140       | 33.6       |
| Urban           | 277       | 66.4       |
| Marital status  |           |            |
| Married         | 235       | 56.4       |
| Single          | 178       | 42.7       |
| Widowed         | 2         | 0.5        |
| Divorced        | 2         | 0.5        |
| Educational status |         |            |
| No formal education | 55     | 13.2       |
| Primary level   | 193       | 46.3       |
| Secondary level and above | 169 | 40.5 |
| Occupation      |           |            |
| Employed        | 147       | 35.3       |
| Daily laborer   | 40        | 9.6        |
| Student         | 107       | 25.7       |
| House wife      | 44        | 10.6       |
| Other*          | 79        | 18.9       |
| Religion        |           |            |
| Orthodox        | 52        | 12.5       |
| Muslim          | 89        | 21.3       |
| Protestant      | 174       | 41.7       |
| Catholic        | 92        | 22.1       |
| Other**         | 10        | 2.4        |
| Donation type   |           |            |
| Voluntary       | 413       | 99.0       |
| Replacement     | 4         | 1.0        |
| Frequency of donation |       |            |
| First time      | 360       | 86.3       |
| Repeated        | 57        | 13.7       |

Notes: *Private work like driving, shopping; **seventh day apostolic, Jehovah witness and without any religion.
On the other hand, the current study finding is much higher than previous studies conducted in Ethiopia and other developing countries, like from Gondar 2.6%, and 6.55%, 7.0% in Hawassa in different parts of Ethiopia and other developing countries like Eretria, 3.8% in Ethiopia and other developing countries like 3.9% in Democratic Republic of Congo, 5.7% in Uganda, 0.98% in Iraq, 3.7% in Yemen, 7.29% in Saudi Arabia and 1.9% in India. Hence, compared with other resource-constrained settings, the burden of viral TTIs is quite high in this study. The widest difference in our country and the others could be due to the use of different generations of ELISA test kits having different sensitivities, and specificities in addition to differences in study design, population, duration, variation in occupation, and geographical factors.

HBV is endemic in most African countries, including Ethiopia. In this study, the magnitude of HBV is 9.8% which was somewhat similar to other studies conducted in Jigjiga (10.9%), and in Felege Hiwot (11.7%) of Ethiopia and other African countries like Nigeria (10.9%), Mozambique (10.6%) and Equatorial Guinea (10.1%), but higher compared with previous reports from Gondar (3.6%), Bahir Dar (4.11%) and Dire Dawa (3.7%) of Ethiopia and in Sudan 4.2%.

| Table 2 | Magnitude of Viral TTIs in Different Socio-Demographic Variables Among Blood Donors, in Hossana Blood Bank District, Southern Ethiopia |
|---------|----------------------------------------------------------------------------------------------------------------------------------|
| Variables | Characteristics | Total No of Participants | HBV+ | HCV+ | HIV+ |
|          |                  |                         | N (%) | N (%) | N (%) |
| Gender   | Male             | 243 (58.3)              | 26 (10.7) | 4 (1.7) | 14 (8.1) |
|          | Female           | 174 (41.3)              | 15 (3.7) | 6 (3.4) | 4 (2.3) |
| Age category (years) | 18–30          | 146 (35.0)              | 13 (8.9) | 3 (2.1) | 5 (3.4) |
|          | 31–45            | 194 (46.5)              | 24 (12.4) | 6 (3.1) | 10 (5.2) |
|          | 46–65            | 77 (18.5)               | 4 (5.2) | 1 (1.3) | 3 (3.9) |
| Residence | Rural           | 140 (33.6)             | 12 (8.6) | 3 (2.1) | 4 (2.6) |
|          | Urban            | 277 (66.4)             | 29 (10.5) | 7 (2.5) | 14 (5.1) |
| Marital status | Married       | 235 (56.4)              | 32 (13.6) | 8 (3.4) | 12 (5.1) |
|          | Single           | 178 (42.7)             | 9 (5.1) | 2 (1.1) | 6 (3.4) |
|          | Widowed          | 2 (0.5)                | –     | –     | –     |
|          | Divorced         | 2 (0.5)                | –     | –     | –     |
| Educational status | No formal education | 55 (13.2)                  | 7 (12.7) | 1 (1.8) | 3 (5.5) |
|          | Primary level    | 193 (46.3)             | 23 (11.9) | 4 (2.1) | 10 (5.2) |
|          | Secondary and above | 169 (40.5)              | 10 (5.9) | 5 (3.0) | 5 (3.0) |
| Occupation | Employed        | 147 (35.3)             | 19 (12.9) | 3 (2.1) | 9 (6.1) |
|          | Daily laborer    | 40 (9.6)               | 5 (12.5) | 1 (2.5) | 1 (2.5) |
|          | Student          | 107 (25.7)             | 10 (9.4) | 3 (2.8) | 6 (5.6) |
|          | House wife       | 44 (10.6)              | 2 (4.6) | 1 (2.3) | 2 (4.6) |
|          | Other            | 79 (18.9)              | 5 (6.3) | 2 (2.6) | 2 (2.5) |
| Religion | Orthodox         | 52 (12.5)              | 3 (5.8) | 1 (1.9) | 2 (3.9) |
|          | Muslim           | 89 (21.3)              | 9 (10.1) | 2 (2.2) | 3 (3.4) |
|          | Protestant       | 174 (41.7)             | 21 (12.1) | 5 (2.9) | 10 (5.8) |
|          | Catholic         | 92 (22.1)              | 7 (7.6) | 2 (2.2) | 3 (3.3) |
|          | Other            | 10 (2.4)               | 1 (10.0) | –     | –     |
| Donation type | Voluntary      | 413 (99.0)            | 41 (9.9) | 10 (2.4) | 18 (4.4) |
|          | Replacement      | 4 (1.0)                | –     | –     | –     |
| Frequency of donation | First time   | 360 (86.3)             | 39 (10.8) | 9 (2.9) | 16 (4.4) |
|          | Repeated         | 57 (13.7)              | 2 (3.51) | 1 (1.8) | 2 (3.5) |

**Abbreviations:** TTIs, transfusion transmissible viral infections; HBV+, hepatitis B virus positive; HCV+, hepatitis C virus positive; HIV+, Human Immunodeficiency Virus positive.
2.58%\textsuperscript{20} in other African countries. Socio-demographic and cultural differences might be a possible factor for these differences though there is a similarity between risk factors and route of transmission between viral TTIs. The reported prevalence of HBV was higher as compared to HCV and HIV. Several studies have shown similar findings compared with the present study.\textsuperscript{9,17,41} The probable reason for this high prevalence may be due to higher infectivity of HBV compared to HCV and HIV as well as poor awareness of the community towards hepatitis transmission and infection.

In this study, the magnitude of HCV infection was 2.4%, which is slightly comparable with previous studies (2.2%) in Ethiopia\textsuperscript{38} and elsewhere in Africa; like 2.8% in Nigeria\textsuperscript{5} and 3.21% in Kenya.\textsuperscript{34} It also significantly lower than previous studies reported 8.5% from Wolayta Sodo, Ethiopia\textsuperscript{11} and 6.0% in Nigeria,\textsuperscript{13} but it was also higher compared to different reports from Gondar 0.8%,\textsuperscript{10} Hawasa 0.6%,\textsuperscript{12} Jigjiga 0.7%\textsuperscript{1} in Ethiopia and elsewhere in the world; 0.51% in China,\textsuperscript{40} 0.21 and 0.03% in India,\textsuperscript{16,37} 0.8% in Yemen,\textsuperscript{6} and 1.3% in Cameroon.\textsuperscript{28} These variations could be a result of

| Variables                                      | Participants | HBV+ | HCV+ | HIV+ |
|-----------------------------------------------|--------------|------|------|------|
|                                               | N (%)        | N (%)| N (%)| N (%)|
| Hospital admission                            |              |      |      |      |
| Yes                                           | 47 (11.3)    | 5 (10.6) | 2 (4.3) | 3 (6.4) |
| No                                            | 370 (87.7)   | 36 (9.3)  | 8 (2.2)  | 15 (4.1) |
| Surgical procedure                            |              |      |      |      |
| Yes                                           | 28 (6.7)     | 3 (10.7)  | 1 (3.6)  | 1 (3.6)  |
| No                                            | 389 (93.3)   | 38 (9.8)  | 9 (2.3)  | 17 (4.4) |
| Multiple sexual contact                        |              |      |      |      |
| Yes                                           | 82 (19.7)    | 14 (17.1) | 3 (3.7)  | 7 (8.5)  |
| No                                            | 335 (80.3)   | 27 (8.1)  | 7 (2.1)  | 11 (3.3) |
| Alcohol consumption                           |              |      |      |      |
| Yes                                           | 89 (21.3)    | 14 (15.7) | 4 (4.5)  | 7 (7.9)  |
| No                                            | 328 (78.7)   | 27 (8.2)  | 6 (1.9)  | 11 (3.4) |
| Intravenous drug use                          |              |      |      |      |
| Yes                                           | 106 (25.4)   | 12 (11.3) | 3 (2.8)  | 5 (4.7)  |
| No                                            | 311 (74.5)   | 29 (9.3)  | 7 (2.3)  | 13 (4.2) |
| Tooth extraction                              |              |      |      |      |
| Yes                                           | 61 (14.6)    | 8 (13.1)  | 2 (3.3)  | 3 (4.9)  |
| No                                            | 356 (85.4)   | 33 (9.3)  | 8 (2.3)  | 15 (4.2) |
| Contact with hepatitis/jaundiced patients     |              |      |      |      |
| Yes                                           | 41 (9.8)     | 7 (17.1)  | 2 (4.9)  | 2 (4.9)  |
| No                                            | 376 (90.2)   | 34 (9.0)  | 8 (2.1)  | 16 (4.3) |
| History of tattooing/piercing                 |              |      |      |      |
| Yes                                           | 72 (17.3)    | 9 (12.5)  | 3 (4.2)  | 4 (5.6)  |
| No                                            | 345 (82.7)   | 32 (9.3)  | 7 (2.1)  | 14 (4.1) |
| Family history of hepatitis                   |              |      |      |      |
| Yes                                           | 32 (7.7)     | 6 (18.8)  | 1 (3.1)  | 1 (3.1)  |
| No                                            | 390 (92.3)   | 35 (9.0)  | 9 (2.3)  | 17 (4.4) |
| Chat chewing                                  |              |      |      |      |
| Yes                                           | 74 (17.4)    | 11 (14.9) | 3 (4.1)  | 6 (8.1)  |
| No                                            | 343 (82.6)   | 30 (8.4)  | 7 (2.1)  | 12 (3.5) |

Abbreviations: HBV+, hepatitis B virus positive; HCV+, hepatitis C virus positive; HIV+, Human Immunodeficiency Virus positive.
a combination of several factors, including the absence of immunization, low safety measures in public health services, the effectiveness of donor selection programs, and the quality of blood screening tests. Besides, donors donate blood without being screened for HCV, and the strain may be circulating in the community without noticing.

The overall magnitude of HIV in this study is 4.3%, which is nearly similar to that of studies conducted in Ethiopia like Felege Hiwot 3.8%, 17 in Gondar 5.9%, 47 and in other developing countries like Cameroon (4.1%). 32 However, it is much higher than the findings from studies conducted in Jigjiga (0.1%), 1 Hawassa (1.6%) 39 and Yirgalem (1.6%) 12 in Ethiopia and another world; from Eritrea (0.18%), 20 Yemen (0.14%), 41 and India (0.09%). The higher report from our study is probably due to the rise in seropositivity of HIV among the general population recently. It also explains the highest geographic distributions of HIV infection in the study area, which is in some way greater than Ethiopian national data. 21 Variations in the disease’s burden in society, population differences in social behavior, lifestyle, socioeconomic status, level of understanding, and variation in the study environment, as well as a strict nonstop establishment of HIV awareness in the previously listed study, may all contribute to the observed variations. In this study, most of the study participants have practiced multiple sexual contacts, body tattooing, dental extraction procedures, having alcohol, and chewing Khat. Ethiopian studies show a relationship between Khat use and unsafe sex more likely to have multiple sexual partners, which may predispose to HIV infection and viral hepatitis. 3,43

The overall magnitude of HBV, HCV, and HIV co-infection in our study was 2.16%. Different studies conducted in Ethiopia also report that the co-infection rate of these TTIs ranges from 0.19% to 4.8%. 21,42,47 The most common co-infection was HBV-HCV 9(2.16%). Comparable results were observed in Ethiopia 17,50 and

Table 4 The Magnitude of HBV in Relation to Risk Factors Characteristics of the Study Participants

| Characteristics                              | HBV Test Result |                  |                  |                  |                  |
|-----------------------------------------------|-----------------|------------------|------------------|------------------|------------------|
|                                               | Positive        | Negative         | COR (95% CI)     | AOR (95% CI)     |
| Multiple sexual contact                       |                 |                  |                  |                  |
| Yes                                           | 14              | 68               | 2.3 (1.9, 18.3)* | 4.2 (2.33, 7.43)** |
| No                                            | 27              | 308              | 1.00             | 1.00             |
| Alcohol consumption                           |                 |                  |                  |                  |
| Yes                                           | 14              | 75               | 2.1 (3.1, 20.2)* | 2.7 (6.7, 43.8)** |
| No                                            | 27              | 301              | 1.00             | 1.00             |
| Tooth extraction                              |                 |                  |                  |                  |
| Yes                                           | 8               | 53               | 1.5 (1.62, 32.2)*| 2.3 (0.41, 22.26)|
| No                                            | 33              | 323              | 1.00             | 1.00             |
| Contact with jaundiced hepatitis patients      |                 |                  |                  |                  |
| Yes                                           | 7               | 34               | 2.1 (7.8, 14.1)* | 3.4 (0.67, 14.13)|
| No                                            | 34              | 342              | 1.00             | 1.00             |
| Family history of hepatitis                   |                 |                  |                  |                  |
| Yes                                           | 6               | 26               | 2.4 (1.5, 8.9)*  | 5.2 (2.92, 7.41)** |
| No                                            | 35              | 350              | 1.00             | 1.00             |
| Chat chewing                                  |                 |                  |                  |                  |
| Yes                                           | 11              | 63               | 1.8 (1.2, 9.2)*  | 2.2 (0.86, 45.7) |
| No                                            | 30              | 313              | 1.00             | 1.00             |
| Educational level                             |                 |                  |                  |                  |
| No formal education                           | 7               | 48               | 1.1 (4.23, 11.14)*| 1.3 (0.91, 12.23)|
| Primary level                                 | 23              | 170              | 3.2 (3.17, 8.46)*| 3.1 (2.58, 15.25)** |
| Secondary and above                           | 10              | 159              | 1.00             | 1.00             |

Notes: *Candidate variable for multivariate analysis at P < 0.25. **Variable significant, ***variable highly significant by the multivariate analysis at P < 0.05.

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; 1, reference.
The occurrence of co-infections could be because these infections share similar modes of transmission.\(^5\),\(^6\),\(^7\),\(^8\) The occurrence of co-infections could be elsewhere in the world.\(^5\),\(^6\),\(^7\),\(^8\) The occurrence of co-infections could be because these infections share similar modes of transmission.\(^5\),\(^6\),\(^7\),\(^8\)

In this study, multiple sexual contacts, family with hepatitis or HIV and caring for hepatitis or HIV patients, non-formal or primary education status, and alcohol intake were significantly associated with viral TTIs. This finding is consistent with studies conducted in Ethiopia and other countries.\(^11\),\(^31\),\(^46\) Participants who had a family history of hepatitis infection were 5.2 times more likely to be infected with HBV (\(p < 0.05\)) and it was found to be an independent risk factor and supported by other studies conducted in Ethiopia,\(^8\),\(^11\),\(^46\) and other African countries.\(^14\),\(^19\),\(^25\) This indicates that the main root for transmission of HBV is cross-contamination of body fluids; hence, this could explain the presence of close contact with hepatitis patients or sexual contact increases the change of HBV transmission. Regarding this study, blood donors who were educated at the primary level and below were 3.3 times more likely to have HBV infection compared to literate donors. The relatively higher HBV seropositivity among the less educated might be attributed to poor awareness regarding mode of transmission due to their low educational status in which these individuals might have sexual contact and share sharp materials with a person infected with these types of HBV.

Multiple sexual activities were statistically associated with positivity of HIV (\(P\)-value < 0.05). Being a sexually transmitted disease, it is not surprising that increased exposure to sexual activity is associated with increased HIV prevalence. The key mode of acquiring HIV in Africa is sexual activity, multiple partners being one of the main risk factors.\(^14\),\(^15\) Non-formal or primary education status was identified to be independently associated with positive HIV status. The magnitude of HIV in this study was found to decrease with increasing levels of education among blood donors. This might be attributed to the fact that as the level of education increases, there is a high probability of being aware of preventive measures against HIV infection. Additionally, those with high education likely understand the criteria for self-deferral better. Some studies suggest that better educational attainment may correlate with a lower risk of infection among blood donors, as they are most likely to understand risky sexual relationships that may expose them to TTIs.\(^36\),\(^45\)

| Characteristics                      | HIV Test Result | COR (95% CI) | AOR (95% CI) |
|--------------------------------------|----------------|--------------|--------------|
|                                      | Positive       | Negative     |              |
| Multiple sexual contact              |                |              |              |
| Yes                                  | 7              | 75           | 2.7 (1.91, 13.37)* | 4.9 (3.51, 9.65)** |
| No                                   | 11             | 324          | 1.00         | 1.00          |
| Alcohol consumption                  |                |              |              |
| Yes                                  | 7              | 82           | 2.5 (3.1, 20.2)* | 2.7 (6.7, 43.8)** |
| No                                   | 11             | 317          | 1.00         | 1.00          |
| Tooth extraction                     |                |              |              |
| Yes                                  | 3              | 58           | 1.2 (0.62, 32.2) | 1.8 (0.27, 21.23) |
| No                                   | 15             | 341          | 1.00         | 1.00          |
| Intravenous drug use                 |                |              |              |
| Yes                                  | 5              | 101          | 1.1 (7.8, 54.1)* | 1.3 (0.86, 4.33) |
| No                                   | 13             | 298          | 1.00         | 1.00          |
| Surgical procedure                   |                |              |              |
| Yes                                  | 1              | 27           | 0.8 (1.5, 8.9) | 1.2 (0.62, 11.2) |
| No                                   | 17             | 372          | 1.00         | 1.00          |
| Chat chewing                         |                |              |              |
| Yes                                  | 6              | 68           | 2.3 (1.2, 9.2)* | 3.2 (8.6, 45.7)** |
| No                                   | 12             | 331          | 1.00         | 1.00          |

Notes: *Candidate variable for multivariate analysis at \(P < 0.25\). **Variable significant, ***Variable highly significant by the multivariate analysis at \(P < 0.05\).

Abbreviations: COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; 1, reference.
Conclusion
The magnitude and transmission risk level of common viral TTIs among blood donors in this study is high. This indicates there are high risks of transmission for these infectious pathogens among volunteer donors despite the current public health preventive measures. The most dominant viral TTI was HBV (9.8%), followed by HIV (4.3%). Family history of hepatitis or HIV (giving care to hepatitis or HIV patients), education level, multiple sex partners, and alcohol consumption were all linked to viral TTIs.

In the study district, special attention should be paid to HBV and HIV infections. Almost all donors were volunteers, proper screening of donated blood for HBV, HCV, and HIV with test methods that have improved diagnostic performance should be used, lowering the rate of hidden transmission (due to window time or poor test detection). Stringent donor selection and screening protocols, creating awareness among the general public regarding viral TTIs transmission and prevention should be strengthened. In addition, further assessment should be conducted at the community level to take measures on the potential risk factors of major TTIs in the district.

As a limitation, in this study, blood donors come from different places and included non-randomly; therefore it may not represent the population around the study area. Behavioral and lifestyle factors of STIs were self-reported, and it could be subjective. Another weakness may be related to the inherent weakness of the diagnostic test used which employs serological rather than molecular techniques. Therefore, the results reported in this study may underestimate (presence of a window period) or overestimate (high rate of false positivity) the prevalence of viral TTIs among donors in this population.

Data Sharing Statement
The data analyzed during the current study are available from the corresponding author on a reasonable request.

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Author Contributions
All authors made substantial contributions to conceptualization and design, acquisition of data, or analysis and interpretation of data; contributed in drafting the article or revising it critically for significant intellectual content; read and approved the final version of the manuscript to submit to the current journal; and agreed to be accountable for all aspects of the work.

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Disclosure
The authors declare that they have no conflicts of interests in this work.

References
1. Abate M, Wolde T. Seroprevalence of human immunodeficiency virus, hepatitis B virus, hepatitis C virus, and syphilis among blood donors at Jigjiga Blood Bank, Eastern Ethiopia. Ethiop J Health Sci. 2016;26:155–162. doi:10.4314/ejhs.v26i2.9
2. Abdo AE, Mohammed DA, Satti M. Prevalence of hepatitis B virus among blood donors and assessment of blood donor’s knowledge about HbV in Sudan. HIV/AIDS Res Treat Open J. 2015;2:76–80. doi:10.17140/HARTOJ-2-112
3. Abebe D, Debella A, Dejene A, et al. Khat chewing habit as a possible risk behaviour for Hiv infection: a case-control study. Ethiop J Health Dev. 2005;19:174–181.
4. Afrase A, Arif S, Akram M, Nasreen T, Ahmad SS. Association of sociodemographic factors with sero-prevalance of Hiv, Hcv and HbV infections among blood donors. Int J Curr Microbiol Appl Sci. 2015;223–229.
5. Ajugwo A, Erhabor T, Eledo B, Eze RI, Digban KA. Prevalence of transfusion transmissible infections in a Nigerian Tertiary Hospital. J Transmis Dis Immun. 2017;1:32–34.
6. Al-Hatheq A, Abakar AD, Al-Ofairi B. Seroprevalence of hepatitis C virus infection among blood donors and clinical visitors in Amran Governorate, Yemen. Int J Mol Microbiol. 2019;2:25–33.
7. Aluora PO, Muturi MW, Gachara G. Seroprevalence and genotypic characterization of HbV among low risk voluntary blood donors in Nairobi, Kenya. Virol J. 2020;17:1–9. doi:10.1186/s12985-020-01447-2
8. Assefa A, Mathewos B, Alemu A, Addis Z, Alem M, Gizachew M. Hepatitis B and C viral infections among blood donors at Bahir Dar, Ethiopia. Int J Med Res Health Sci. 2013;2:624–630. doi:10.5958/ j.2319-5886.2.3.110
9. Balew M, Moges F, Yismaw G, Unakal C. Assessment of hepatitis B virus and hepatitis C virus infections and associated risk factors in Hepatitis infected patients at Debretabor Hospital, South Gondar, Northwest Ethiopia. Asian Pacific J Trop Dis. 2014;4:1–7. doi:10.1016/S2222-1880(14)60304-2
10. Biadgo B, Shiferaw E, Woldu B, Alene KA, Melku M, Blackard J. Transfusion-transmissible viral infections among blood donors at the North Gondar District Blood Bank, Northwest Ethiopia: a three year retrospective study. *PLoS One*. 2017;12:e0180416. doi:10.1371/journal.pone.0180416

11. Bisetegen FS, Bekele FB, Ageru TA, Wada FW. Transfusion-Transmissible Infections among Voluntary Blood Donors at Wolaita Sodo University Teaching Referral Hospital, South Ethiopia. *Can J Infect Dis Med Microbiol*. 2016;2016.

12. Bonja F, Hussein M, Alenu J, Gemecha D, Birhaneselasie M. The prevalence of transfusion transmitted infections: a focus on hepatitis B virus among blood donors at Hawassa Blood Bank Center, Southern Ethiopia. *Int J Blood Transfus Immunohematol*. 2017;7:7-14. doi:10.5348/ijbti-2017-29-0A-2

13. Buseri FI, Muhibi MA, Jeremiah ZA. Sero-epidemiology of transfusion-transmissible infections in South-Western Kenya. *Int J Med Sci Educ*. 2015;29:93-96.

14. Chama D, Ahmed Y, Baboo KS, Halwindi H, Mulenga J. Transfusion transmissible infections among voluntary blood donors at the University Teaching Hospital, Lusaka, Zambia. *Med J Zambia*. 2015;42:90-95.

15. Chen L, Jha P, Stirling B, et al.; International Studies of HIV/AIDS Investigators. Sexual risk factors for hiv infection in early and advanced Hiv epidemics in Sub-Saharan Africa: systematic overview of 68 epidemiological studies. *PLoS One*. 2007;2:e1001. doi:10.1371/journal.pone.0001001

16. Chetna I, Richa S, Narendra M. Prevalence of hepatitis B, hepatitis C and Vdrl in blood donors in Tertiary Care Hospital in Western India. *Int J Med Sci Educ*. 2015;2.

17. Dessie A, Abera B, Wale F. Seroprevalence of major blood-borne infections among blood donors at Felege Hiwot Referral Hospital, Northwest Ethiopia. *Ethiop J Health Dev*. 2007;21:68-69. doi:10.4314/ehj.v21i1.10034

18. Farshadpour F, Taherkhani R, Taherkhani R, Tajbakhsh S, et al. Prevalence and trends of transfusion-transmissible viral infections among blood donors in South of Iran: an eleven-year retrospective study. *PLoS One*. 2016;11:e0157615. doi:10.1371/journal.pone.0157615

19. Atinuke Fasola F, Adeyokun Fatimah P, Akpan VO. A seven year review of the seroprevalence of transfusion transmitted infections in a hospital based blood bank in Ibadan, Nigeria. *Clin Med Res*. 2017;6:1-8. doi:10.11688/cmr.2017060111

20. Jineyay N, Sule D, Fessehay T. Transfusion transmitted infections—a retrospective analysis from the national blood transfusion service in Eritrea. *Pan African Med J*. 2011;9. doi:10.4314/pamj.v9i1.71219

21. Gebremichael SG. Determinants of survival time among Hiv-infected patients receiving care at antiretroviral therapy (art) clinic of a public hospital, Ethiopia. *MOJ Public Health*. 2020;9:201–207.

22. Habte Y, Seyoum B, Alemayehu T. Hepatitis B virus infection and associated factors among blood donors at Dire Dawa, Eastern Ethiopia. *J Antivir Antiretrovir*. 2016;8:103–106. doi:10.4172/ jaa.1000144

23. Heyredin I, Mengistie B, Weldegebir F. Seroprevalence of transfusion-transmittable infections and associated factors among blood donors in Eastern Ethiopia: an institutional-based cross-sectional study. *SAGE Open Med*. 2019;7:205031219834468. doi:10.1177/205031219834468

24. Jindal N, Arora U, Singh K. Prevalence of human immunodeficiency virus (Hiv), hepatitis B virus, and hepatitis C virus in three groups of populations at high risk of Hiv infection in Amritsar (Punjab), Northern India. *Jpn J Infect Dis*. 2008;61:79.

25. Loua A, Diallo MB, Magassouba FB, Camara M, Bah MA, Cisse A. Seroprevalence of hepatitis B in blood donors in Guinea. *Med Trop*. 2005;65:396-397.

26. Michel KN. Seroprevalence hepatitis B in blood donors at Lubumbashi, Dr Congo (Case of Provincial Hospital Sendwe Reference). *Open Access Library J*. 2016;3:1.

27. Mohammed Y, Bekele A. Seroprevalence of transfusion transmitted infection among blood donors at Jigjiga Blood Bank, Eastern Ethiopia: retrospective 4 years study. *BMC Res Notes*. 2016;9:1-6. doi:10.1186/s13104-016-1925-6

28. Ebombou Moukoko CE, Sack FN, Essangui Same EG, Mbangu M, Lehman LG. Hiv, Hbv, Hcv and T. Pallidum infections among blood donors and transfusion-related complications among recipients at the Laquintine Hospital in Douala, Cameroon. *BMC Hematol*. 2014;14:1-9. doi:10.1186/2052-1839-14-5

29. Nada HA, Atwa M. Seroprevalence of Hbv, Hcv and syphilis markers among blood donors at Suez Canal University Hospital Blood Bank. *J Blood Disord Transfus*. 2013;5:177.

30. Nagalo BM, Bisseye C, Sanou M, et al. Seroprevalence and incidence of transfusion-transmitted infectious diseases among blood donors from regional blood transfusion centres in Burkina Faso, West Africa. *Trop Med Int Health*. 2012;17:247–253. doi:10.1111/j.1365-3156.2011.02902.x

31. Nkansah C, Serwaa D, Osei-Boakye F, Owusu-Ampomah R. Seroprevalence and trend of hepatitis B among blood donors in a district hospital in Ghana: a nine-year retrospective, descriptive cross-sectional study, *J Immunooassay Immunochrom.* 2020;41:71-83. doi:10.1007/s12114-019-1682601

32. Noubiap JIN, Joko WYA, Nansse JRN, Tene UG, Siaka C. Sero-epidemiology of human immunodeficiency virus, hepatitis B and C viruses, and syphilis infections among first-time blood donors in Edea, Cameroon. *Int J Infect Dis*. 2013;17:e832–e837. doi:10.1016/j. ijid.2012.12.007

33. Nwankwo E, Momodu I, Umar I, Musa B, Adeleke S. Seroprevalence of major blood-borne infections among blood donors in Kano, Nigeria. *Turk J Med Sci*. 2012;42:337-341.

34. Onyango CG, Ogonda L, Guyah B, et al. Seroprevalence and determinants of transfusion transmissible infectious diseases among voluntary blood donors in Homabay, Kisumu and Siaya Counties in Western Kenya. *BMC Res Notes*. 2018;11:1-6.

35. World Health Organization. *Global Health Sector Strategy on Viral Hepatitis 2016–2021. Towards Ending Viral Hepatitis*. World Health Organization; 2016.

36. World Health Organization. Screening Donated Blood for Transfusion-Transmissible Infections: Recommendations. World Health Organization; 2010.

37. Raina S, Raina S, Kaul R, Sharma V. Seroprevalence of hepatitis B, hepatitis C, human immunodeficiency virus surface, and syphilis among blood donors: a 6-year report from a sentinel site in Western Himalayas, India. *Indian J Sexual Transdit Dis AIDS*. 2015;36:220. doi:10.4103/0253-7184.167194

38. Hussein NR, Haj SM, Almizori LA, Taha AA. The prevalence of hepatitis B and C viruses among blood donors attending blood bank in Duhok, Kurdistan Region, Iraq. *Int J Infect*. 2017;4.

39. Redwan NA, Ahmed MM, Barnawi MB. Prevalence study of hepatitis B virus (Hbv) infection by serological techniques in Jeddah, Saudi Arabia. *Life Sci*. 2012;9:542–548.

40. RuiLing DO, XiaoChun QI, WangQian JI, et al. Hiv, Hcv, and Hbv co-infections in a rural area of Shanxi Province with a history of commercial blood donation. *Biomed Environ Sci*. 2011;24:207–213.

41. Mohammed Saghir SA, Al-Hassan FM, Ali Abasalihi OS, Alharyin AEA, Baqir HS. Frequencies of Hbv, Hiv, Hcv, and syphilis markers among blood donors: a hospital-based study in Hodeidah, Yemen. *Trop J Pharm Res*. 2012;11:132–136.

42. Sharaw B, Mulu A, Teku B, Tesfaye T. Hiv-sero-prevalence trend among blood donors in North East Ethiopia. *Afr Health Sci*. 2017;17:712–718. doi:10.4314/ahs.v17i3.13

43. Soboka M, Tesfaye M, Feyissa GT, Hanlon C. Khat use in people living with Hiv: a facility-based cross-sectional survey from South West Ethiopia. *BMC Psychiatr*. 2015;15:1–7. doi:10.1186/s12888-015-0446-5
44. Stokx J, Gillet P, De Weghheleire A, et al. Seroprevalence of transfusion-transmissible infections and evaluation of the pre-donation screening performance at the Provinicial Hospital of Tete, Mozambique. *BMC Infect Dis*. 2011;11:1–8.

45. Tayou Tagny C, Owusu-Ofori S, Mbanya D, Deneyes V. The blood donor in Sub-Saharan Africa: a review. *Transfus Med*. 2010;20:1–10. doi:10.1111/j.1365-3148.2009.00958.x

46. Tegene D, Desta K, Tegbaru B, Tilahun T. Seroprevalence and transmission of hepatitis B virus among delivering women and their new born in selected health facilities, Addis Ababa, Ethiopia: a cross sectional study. *BMC Res Notes*. 2014;7:1–7. doi:10.1186/1756-0500-7-239

47. Tessema B, Yismaw G, Kassu A, et al. Seroprevalence of Hiv, Hbv, Hcv and syphilis infections among blood donors at Gondar University Teaching Hospital, Northwest Ethiopia: declining trends over a period of five years. *BMC Infect Dis*. 2010;10:1–7. doi:10.1186/1471-2334-10-111

48. Umare A, Seyoum B, Gobena T, Mariyam TH, Chemin IA. Hepatitis B virus infections and associated factors among pregnant women attending antenatal care clinic at Deder Hospital, Eastern Ethiopia. *PLoS One*. 2016;11:e0166936. doi:10.1371/journal.pone.0166936

49. Xie DD, Li J, Chen JT, et al. Seroprevalence of human immunodeficiency virus, hepatitis B virus, hepatitis C virus, and treponema pallidum infections among blood donors on Bioko Island, Equatorial Guinea. *PLoS One*. 2015;10:e0139947. doi:10.1371/journal.pone.0139947

50. Yusuf M, Bekele A. Seroprevalence of transfusion transmitted infection among blood donors at Jijiga Blood Bank, Eastern Ethiopia: retrospective 4 years study. *BMC Res Notes*. 2016;9:1–6.