Risk factors associated with transfusion transmissible infections among blood donors at Karongi Regional Centre for Blood Transfusion-Western Province of Rwanda

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ABSTRACT

Introduction: Blood transfusion saves human lives, but also it can be a route for Transfusion-transmissible Infections (TTIs) such as Human Immuno-Deficiency Virus (HIV), Hepatitis B virus (HBV), Hepatitis C virus (HCV), and Syphilis. TTIs are still a threat to the safety of blood given also the growing magnitude of viral infections (HIV, HBV, and HCV) in the population especially in the Western province of Rwanda. This study aimed to explore the risk factors associated with TTIs among blood donors in the Regional Centre for Blood Transfusion (RCBT) of Karongi, Rwanda. **Methods:** A secondary data analysis was conducted on cross-sectionally collected data from blood donors collected from 2015 to 2019 in the Regional Centre for Blood Transfusion of Karongi. The key variables for the current analysis were age, gender, residence, blood group, occupation, marital status, and blood donor regularity status and TTIs results reported. We analysed data using Stata version 15 and proportions of TTIs by various characteristics were calculated. Logistic regression was used to identify the factors independently associated with each of the TTIs among blood donors. The significant risk factors were assessed using a P-value of 0.05 and 95% confidence intervals. **Results:** Among 36,708 donations, the proportion of HBV, HCV, HIV and Syphilis was 1.3%, 0.44%, 0.065% and 0.34% respectively and the overall prevalence of all TTIs was 2.1%. HBV was associated with male gender (AOR: 1.7, 95% CI: 1.4-2.1), age group of 26-35 years (AOR: 1.5, 95% CI: 1.2-1.9), being a new blood donors (AOR:13.2, 95% CI: 8.5-20.6), living in Rusizi District (AOR: 2.5, 95% CI: 1.9-3.3) and being married (AOR: 1.7, 95% CI: 1.2-2.4). HCV was associated with male gender (AOR:1.5, 95% CI: 1.1-2.1), age groups of 26- 35 years (AOR:1.6, 95% CI: 1.1-2.5), 36-45 years (AOR:2.0, 95% CI: 1.2-3.5), 46-55 years (AOR:2.4, 95% CI: 1.2-4.8), 56-65 years (AOR:5.8, 95% CI: 2.4-14.0), being a new blood donors (AOR:4.7, 95% CI: 2.8-7.8), Rusizi District (AOR:2.9, 95% CI: 1.6-5.3), Nyamasheke District (AOR:3.9, 95% CI: 2.1-7.0) and Karongi (AOR:2.6, 95% CI; 1.4-4.8). HIV was related to being new blood donors (AOR:12.1, 95% CI: 1.6-91.0) and living in urban areas (AOR:4.1, 95% CI: 1.2-13.5). Male gender (AOR:1.9, 95% CI: 1.2-2.9) and new blood donors (AOR: 2.3, 95% CI: 1.4-3.6) determined the risk of Syphilis. **Conclusion:** This study illuminates key risk factors for TTIs in blood donors, emphasizing the importance of improving donor screening and selection processes. Its findings necessitate enhanced health education and continuous monitoring with sensitive testing methods. The results also underscore the need for such measures in similar settings globally for safer blood supply.

Introduction

Blood transfusion is one of the modern medical interventions used to save patients' life. But, it is not risk-free because some blood-borne pathogens might be transmitted through blood to patients [1]. Human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), and Syphilis are the major infections that cause Transfusion-transmissible infections (TTIs) [2], which can threaten the life of patients and reduced the quality of blood.

The World Health Organization (WHO) suggested compulsory screening of all blood donors for HIV 1&2, HCV, HBV, and syphilis infections to prevent the risk associated with exposure to TTIs [3]. The combination of TTIs screening and the development of sensitive screening tests have contributed to the reduction of the incidence and prevalence of TTIs in different countries [1]. However, TTIs risk is still high in low-income countries compared with high-income countries [4]. According to WHO report, the prevalence of HBV, HCV, and HIV infections among blood donors in different parts of the world varies from 0.008% to 6.08%, 0.004% to 1.96%, and 0.0004% to 2.0%, respectively [5]. In Africa 5-10% of HIV transmission is a result of transfusing contaminated blood [6]. In sub-Saharan Africa, 12.5% of transfused patients are at risk of post-transfusion hepatitis [7].

Prevention of TTIs is more cost-effective than allowing the further spread of TTIs which causes additional avoidable pressures on the healthcare system including morbidity and mortality which have a high impact, not only on the recipients but also on their families, their communities, and the entire society. In addition, a lower prevalence of TTIs in the donor population also reduces the discard of donated blood and hence results in improved efficiency and use of resources [8,9].

Different studies indicated that TTIs might be significantly associated with age, sex, occupation, number, and place of donation, and marital status. A study conducted in Northwest Ethiopia indicated that the blood donors´ age, sex, occupation, number, and place of donation were significantly associated with HBV infection while blood donors employed by the government and unemployed were more likely to have HCV infection. However, HIV and syphilis infections among blood donors were found to be highly associated with the regularity of donations and occupations [9-11]. Another study conducted in Eritrea revealed that male blood donors were less likely to be seropositive to TTIs compared to female donors and a study conducted in Kenya also showed that being married and a male were high-risk factors associated with TTIs [10,12].

In Rwanda, to reduce TTI-associated risk, different strategies have been established including improvements in blood donor recruitment and selection and more effective TTIs detection techniques [13]. Also, continuous monitoring of TTIs and evaluation of trends in the prevalence of TTIs are crucial elements for the assessment of blood safety and the effectiveness of the blood safety strategies [12].

Despite the known importance of monitoring TTIs with their trend´s evaluation, published information on TTIs burden in Rwanda is limited and also there is no report in our knowledge on the relationship between the prevalence of TTIs and associated donor characteristics. The Western province has reported a high rate of major TTIs in the general population [14-16]. In a study conducted in 2019, the prevalence of Hepatitis B Virus in the general population of Western Province varied from 3% to 8% while in the whole country, its prevalence was at 3.9% [14]. Also, another study published in 2019 showed that the prevalence of Hepatitis C Virus in the Western province was 5.9% [15]. In 2019, the Rwanda Population-Based Impact Assessment indicated that HIV prevalence in Western Province and the whole country was 3% [17]. A study conducted in 2016 showed the prevalence of 1.5% for Syphilis among the general population in Western Province and 0.9% in the whole country [16]. However, to our knowledge, factors associated with this high prevalence of TTIs in the western province are less known. Knowing that contaminated blood can threaten life, therefore, this study aimed to determine the prevalence of TTIs (Hepatitis B&C, HIV and Syphilis) and to explore risk factors associated with TTIs among blood donors in Karongi Regional Centre for Blood Transfusion that serves the Western province between 2015 and 2019.

Methods

Study setting

The current study analyzed secondary data cross-sectionally collected by the Regional Center for Blood Transfusion (RCBT) Karongi among blood donors who donated blood from 2015 to 2019. RCBT Karongi is one of the five Regional Centers composing the Blood Transfusion Division (BTD). RCBT Karongi is based in Karongi district, Western province of Rwanda but serves 5 districts in the Western province including Karongi, Nyamasheke, Rusizi, Rutsiro, and Ngororero Districts.The five districts, as per the data provided by the National Institute of Statistics of Rwanda (NISR), have a combined population of 2,200,335 individuals [18].

Each blood donor received in RCBT Karongi is registered using a donor file and information from the file is later entered in the online system known as eProgesa used to manage blood donor´s database.

Study population

The study population consisted of blood donors who donated blood at RCBT Karongi from January 2015 to December 2019. Blood donors with valid positive or negative results for HBV, HCV, HIV, and Syphilis were included. Blood donors with indeterminate results: results that are inconclusive for being either positive or negative, for any of the four Transfusion Transmissible Infections (TTIs) were excluded from the study.

Data collection and extraction

In this study, data variables including age, gender, residence, blood group, and serological results of TTIs were extracted from the eProgesa software. Additionally, variables related to occupation, marital status, and blood donor regularity were obtained from the blood donor's files.

Serological testing was done by using serum or plasma samples collected from blood donors were screened for HBV, HIV, HCV using Enzyme Immuno-Assay (EIA)/Chemiluminescence Immunoassay which has a sensitivity of 100% and specificity of 99.7%, and for Syphilis with Rapid Reagin Plasma (RPR) which has a 100% sensitivity. Confirmation of HIV was done by using the Western blot technique while HBV and Syphilis were confirmed through HBsAg Neutralization Test and Treponema Pallidum Hemagglutination method (TPHA) respectively. All tests were performed according to the manufacturer´s instructions [19-21]

Study variables

In this study, the presence of HBV, HCV, HIV, or Syphilis served as the dependent variable. An individual was categorized as having a transfusion-transmissible infection (TTI) if they tested positive for any of these four diseases. The independent variables encompassed age, sex, residence area type, occupation, district of residence, marital status, blood group, and the donor's regularity status (one-time donor or repeat donor).

Data analysis

The data from this study were extracted, cleaned, and imported into Stata software version 15 for analysis. Descriptive statistics, including frequencies, median with range, and proportions with 95% confidence intervals (95% CI), were calculated and reported. The proportion of transfusion-transmissible infections (TTIs) per year was determined by dividing the number of blood donations with positive TTI serologic markers in a year by the total number of blood donations in that year. The overall prevalence of all TTIs was determined by summing up the total number of cases for each TTI (HIV, HBV, HCV, and syphilis) and dividing this number by the total number of blood donors screened during the study period. Logistic regression was employed to examine the significance of potential risk factors in relation to TTIs. Odds ratios with their respective 95% confidence intervals (CI) and P-values were computed. A significance level of 0.05 was utilized in the analysis.

Ethical considerations

The authorization to undertake this research was granted by RCBT Karongi, as substantiated by a reference letter (Ref: No. 025/RBC/BIOS/BTD/RCBT Karongi/2020). Given the nature of our study, which relied on secondary data, obtaining explicit consent forms from the participants was not required. However, we duly recognized and honored the initial consent given by participants at the time of primary data collection, which had included the potential for the

data's use in further research studies. We also ensured the confidentiality of all data involved in our research. To uphold anonymity, we refrained from using any identifiable personal information such as participants' names during the analysis. Additionally, to safeguard the data and further protect privacy, all data was securely stored in password-encrypted computer systems.

Results

Blood donors´ profile

Table 1 presents the characteristics of blood donors at RCBT Karongi from 2015 to 2019. A total of 36,708 individuals donated blood during this period, with 57.5% being males. The median age of blood donors was 24, ranging from 18 to 65 years, and the age group of 18-25 years accounted for 56.9% of donors. Approximately half (50.4%) of the blood donors had the "O" blood group, and new donors constituted 64.8% of the total. The majority of donors (53.8%) originated from schools, and 86.7% were singles. Notably, a significant proportion of donors came from the Nyamasheke district (28.6%), while the Ngororero district contributed the fewest donors (2%). Among the donor categories, students had the highest donation rate, accounting for 75.2% of the donors.

Prevalence of HIV, HBV, HCV, and Syphilis among blood donors

Between 2015 and 2019 at RCBT Karongi, the overall prevalence of transfusion-transmissible infections (TTIs) was 2.1%. However, the specific prevalence rates for HBV, HCV, HIV, and Syphilis were 1.3%, 0.4%, 0.06%, and 0.34%, respectively (Table 2). Notably, there was a significant decreasing trend in HBV prevalence (P-Value = 0.018) over the study period. In contrast, the prevalence of HIV and Syphilis remained relatively stable from 2015 to 2019. HCV exhibited a decline in 2016, followed by an increase in 2017, and then remained relatively constant from 2018 to 2019(Figure 1).

Table 3 demonstrates that the highest occurrence of Hepatitis B Virus (HBV) was found in males, exhibiting a rate of 1.6%, and in the age group of 26-35 years with an infection rate of 1.8%. Evaluating the frequency of donations, new blood donors were identified to have a significant prevalence of HBV infections at 1.9%. Urban blood donors were more frequently infected with HBV, having a 2.1% rate, as compared to their rural counterparts. Among all districts, Rusizi reported the highest HBV infection rate at 2.6%. The incidence of HBV was notably high among married blood donors and donors from military and police camp, with rates of 1.7% and 16.8% respectively.

The prevalence of HCV was found high among males with 0.5% and the age group of 56-65 years showed a high prevalence of 1.8% compared to other age groups. Based on donor regularity, a high proportion in HCV was found among new blood donors wit 5.9%, those who lived in urban areas with 0.85%, and those who came from the Karongi district with 3.8%.

The proportion of HIV was found high among females with 0.07%, the age group of 56-65 years with 0.25%, new blood donors with 0.096%, urban blood donors with 0.18%, those who came from the Ngororero district with 0.14%, married blood donors with 0.13% and among informal employed blood donors with 0.1%.

The current study found that a high proportion of Syphilis was among males with 0.45%, age group of 36-45 years with 0.69%, new blood donors with 0.40%, urban blood donors with 0.51% those who came from Rusizi district with 0.45%, married blood donors with 0.70%, and among police and army with 1.2%.

Risk factors of TTIs infections

The bivariate analysis revealed a significant correlation between Hepatitis B Virus (HBV) incidence in blood donors and several factors: gender, age, donation frequency, location of residence, district, marital status, and occupation. The findings suggested that male donors had higher exposure than females, with an Odds Ratio (OR) of 1.8 and a 95% Confidence Interval (CI) of 1.5-2.2. Age groups 26-35 years (OR: 1.8, 95% CI: 1.5-2.3) and 36-45 years (OR: 1.7, 95% CI: 1.3-2.3) also exhibited higher association with HBV compared to the 18-25 years age group. New donors (OR: 11.9, 95% CI: 7.6-18.4) were more susceptible to HBV than recurring donors. Blood donors from Rusizi

District showed a higher likelihood of HBV (OR: 2.9, 95% CI: 2.2-3.8) compared to donors from other districts. Donors residing in rural areas (OR: 1.3, 95% CI: 1.0-1.6), urban locations (OR: 2.1, 95% CI: 1.6-2.6), and military and police camps (OR: 1.6, 95% CI: 1.1-2.6) all demonstrated an elevated risk of HBV infections when compared to donors originating from schools. Additionally, donors who were married (OR: 1.4, 95% CI: 1.1-1.8), informally employed (OR: 1.4, 95% CI: 1.1-1.8), and self-employed (OR: 2.1, 95% CI: 1.2-3.7) were found to be more prone to HBV.In relation to Hepatitis C Virus (HCV), significant associations were found with gender, age, donation frequency, type of residence, district of residence, and marital status. Male donors (OR: 1.7, 95% CI: 1.2-2.4) and those within the age brackets of 26-35 years (OR: 1.7, 95% CI: 1.2-2.5), 36-45 years (OR: 2.2, 95% CI: 1.4-3.5), 46-55 years (OR: 2.6, 95% CI: 1.4-4.8), and 56-65 years (OR: 6.2, 95% CI: 2.8-13.6) demonstrated a higher risk of HCV. New donors (OR: 4.3, 95% CI: 2.6-7.0) and those living in the districts of Rusizi (OR: 3.5, 95% CI: 1.9-6.2), Nyamasheke (OR: 3.1, 95% CI: 1.7-5.3), and Karongi (OR: 2.1, 95% CI: 1.1-3.7) were also associated with an increased likelihood of HCV infections. Blood donors residing in urban areas had higher exposure to HCV (OR: 2.5, 95% CI: 1.7-3.8) when compared to donors from schools. Moreover, married blood donors (OR: 1.6, 95% CI: 1.1-2.3) were found to be more prone to HCV relative to their single counterparts.

Bivariate analysis indicated that HIV prevalence among blood donors was linked with age, donor frequency, and type of residence. Those in the age group of 36-45 years (OR: 3.0, 95% CI: 1.1-8.5), new donors (OR: 12.4, 95% CI: 1.6-92.5), and those residing in urban areas (OR: 6.1, 95% CI: 2.1-17.1) showed a higher propensity for HIV infections.As for Syphilis, bivariate analysis associated its prevalence among blood donors with gender, age, donation frequency, type of residence, district of residence, marital status, and occupation. Males (OR: 1.9, 95% CI: 1.2-2.9), age groups of 26-35 years (OR: 2.3, 95% CI: 1.5-3.5), 36-45 years (OR: 3.5, 95% CI: 2.2-5.6), and new blood donors (OR: 1.9, 95% CI: 1.2-2.9) had a higher risk. Moreover, donors living in the districts of Rusizi (OR: 2.0, 95% CI: 1.2-3.3) and Rutsiro (OR: 1.7, 95% CI: 1.0-2.9) showed increased susceptibility to Syphilis. Risk of Syphilis was also greater in donors living in rural (OR: 3.2, 95% CI: 1.9-5.5), urban (OR: 3.2, 95% CI: 1.9-5.5) areas and military & police camps (OR: 7.6, 95% CI: 4.1-14.1), and among married donors (OR: 2.5, 95% CI: 1.7-3.7). Those in informal employment (OR: 2.8, 95% CI: 1.8-4.3), the police or army (OR: 5.1, 95% CI: 2.8-8.9), and self-employed individuals (OR: 3.9, 95% CI: 1.5-9.9) were found to have an increased risk for Syphilis.In the multivariate analysis (Table 4), HBV showed a significant correlation with male gender (AOR: 1.7, 95% CI: 1.3-2.1), age group of 26-35 years (AOR: 1.2, 95% CI: 1.1-1.9), new donors (AOR: 13.2, 95% CI: 8.4-20.6), donors living in Rusizi District (AOR: 2.5, 95% CI: 1.9-3.3), and those who were married (OR: 1.7, 95% CI: 1.2-2.4).HCV had a significant correlation with being male (AOR: 1.5, 95% CI: 1.1-2.1), and various age groups such as 26-35 years (AOR: 1.6, 95% CI: 1.1-2.4), 36-45 years (AOR: 2.0, 95% CI: 1.1-3.5), 46-55 years (AOR: 2.4, 95% CI: 1.2-4.8), and 56-65 years (AOR: 5.8, 95% CI: 2.4-14.0). HCV was also notably correlated with new blood donors (AOR: 4.7, 95% CI: 2.8-7.8), and residents of the districts of Rusizi (AOR: 2.9, 95% CI: 1.6-5.3), Nyamasheke (AOR: 3.9, 95% CI: 2.1-7.0), and Karongi (AOR: 2.6, 95% CI: 1.4-4.8).There was a significant link between HIV infection and being a new blood donor (AOR: 12.1, 95% CI: 1.6-91.0), as well as being a blood donor who lives in urban areas (AOR: 4.1, 95% CI: 1.2-13.5).Syphilis had key associations with being male (AOR: 1.9, 95% CI: 1.2-2.9), being a first-time blood donor (AOR: 2.3, 95% CI: 1.4-3.6), and living in both rural (AOR: 2.2, 95% CI: 1.2-3.8) and urban areas (AOR: 2.2, 95% CI: 1.2-4.2).

Discussion

Blood transfusion services in Rwanda have strived to improve the quality of blood since 2011. However, the Western province has been reporting a high rate of the major TTIs in the general population. Therefore, the identification and trends evaluation of the proportion and the risk factors associated with TTIs in the Western province has been a valuable index on assessing the existing intervention strategies for fighting TTIs among blood donors. Hence, this study aimed to determine TTIs prevalence and explore associated risk factors among blood donors at Karongi Regional Centre for Blood Transfusion from 2015 to 2019.

Findings showed a significantly decreasing trend of HBV proportion and a slightly decrease in HCV proportion while the proportion of HIV and Syphilis among blood donors remained slightly constant from 2015 to 2019. This may be explained by vaccination campaigns among people at risk for HBV and HCV testing campaigns that targeted suspected individuals in Rwanda. These campaigns may have lowered the prevalence of HBV and HCV [14, 15]. However, low prevalence of syphilis might be associated with the lower prevalence of HIV proving success of the national HIV control program and surveillance systems [16, 17]. In addition, since 2014 blood service in Rwanda started the accreditation process which may be resulted in strengthening blood donors selection and qualification process, which has led to the decline of TTIs prevalence among blood donors [22].

In this study, the HBV, HCV, and Syphilis infections were was significantly associated with male blood donors. This was similar to the finding of a study conducted in Jijiga Blood Bank, Eastern Ethiopia [23]. The higher risk for males to counteract TTIs can be related to being more involved in sexual intercourse, fights, and conflicts that might lead to blood contacts [12, 14].

The current analysis revealed that the risk of HBV and HCV increases with age. This association is consistent with what was found in studies conducted in the National Blood Transfusion Service of Eritrea and Western China [12,24]. HBV and HCV infection were increasing by age among blood donors and this might be due to duration of exposure to the virus and also to the fact that people in these age groups are more sexual active than young people [25]. According to blood donor´s regularity, in RCBT Karongi, new blood donors were found to be significantly related with all TTIs (HBV, HCV, HIV, and Syphilis) . This association was similarly found in studies conducted in Shiyan-Central China [26], Eritrea [12], Bahir Dar district blood bank, northwest Ethiopia [9]. These findings of this study support the hypothesis that first-time blood donors represent a high-risk group for transfusion-transmissible infections (TTIs). This could be due to the fact that repeat donors undergo screening during their initial donation, resulting in individuals with TTIs or a higher risk of acquiring TTIs not returning for subsequent donations [27].

HIV and Syphilis were found to be significantly associated with urban areas among blood donors. This reflects the situation existing in Rwanda where urban areas present a high prevalence of HIV [17]. However, in a study conducted in Rwanda in 2016 in the general population, the prevalence of Syphilis was not significantly associated with urban areas [16]. But it was hypothesized that the prevalence of syphilis would be significantly higher in urban residences in different studies and surveys conducted [28,29].

The districts bordering neighbouring countries to Rwanda constituted a high risk for HBV and HCV. In line with this, Rusizi, Karongi, and Nyamasheke District bordered with Democratic Republic of Congo (DRC). Moreover, Rusizi districts bordered Burundi. Located at the borders, these districts are marked by high across borders migration and business movements, factors that might lead to having more vagabonding sexual intercourses.

Married blood donors were also found to be significantly risk factor for HBV among blood donors in RCBT Karongi. This was similar to the study conducted in five Chinese blood centres [30]. Though, this might be linked to sexual behaviour, possibly behaviour like traditional scarification or low vaccination rate among the married population [14].

The strength of the current study relies on the larger sample size, wider coverage of socio-demographic characteristics, and the long study duration (5 years). However, this was a retrospective cross-sectional study, we were not able to provide information regarding further behavioural and sexual risk factors and cause-effect relationship to TTIs among blood donors such as a history of traditional operations, history of invasive procedures, history of multiple sexual partners, history of having unprotected sex, etc. In addition, our study indeed focused on HIV, Hepatitis B and C, and Syphilis because these are the infections that the World Health Organization (WHO) mandates screening for in all blood donations. It is critical to note that these diseases are also the primary TTIs of significance in Rwanda, hence our focus on these in our study. We, however, limited our scope to the four aforementioned infections due to their significant public health impact and the current national screening recommendations in Rwanda [13]. We recognize

this as a limitation of our study and other potential TTIs could be explored further in future research.

Conclusion

The findings of this study hold significant implications for public health and blood safety. Our analysis demonstrated a notable overall TTIs prevalence in the blood donor population, with several key demographic and regional factors contributing to the risk. Particularly, new blood donors, certain age groups, and urban dwellers exhibited higher infection rates. Distinct trends in HIV, HBV, HCV, and Syphilis infections were also observed. These findings emphasize the need for refined donor screening and selection strategies, as well as targeted health education programs, to enhance the safety of blood supply. Moreover, continuous monitoring of TTIs trends using sensitive testing methods is critical for effective disease control. Our results underscore the urgency of these measures in the studied region and potentially serve as a reference for similar settings worldwide.

What is known about this topic

- Blood transfusion is not risk-free because some blood-borne pathogens might be transmitted through blood to patients
- The prevalence of Hepatitis B Virus in the general population of Western Province varied from 3% to 8%, Hepatitis C Virus in the Western province was 5.9%. In 2019, HIV prevalence in Western Province and the whole country was 3% and the prevalence of 1.5% for Syphilis among the general population in Western Province
- A lower prevalence of TTIs in the donor population reduces the discard of donated blood
- TTIs might be significantly associated with age, sex, occupation, number, and place of donation, and marital status.

What this study adds

- This study indicated the prevalence of TTIs in the western province.
- This study explored risk factors associated with TTIs in Karongi Regional Centre for Blood Transfusion in Western province.
- This study provided evidence-based recommendations that were used to set new strategies for blood donors screening criteria to decrease the rate of TTIs among blood donors

Competing interests

The authors declare no competing interests.

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Authors' contributions

ON analysed the data, drafted, and finalised the manuscript. EM advised on data analysis and structure of the manuscript and reviewed the manuscrpt. HDU, FN and TM contributed to drafting the manuscript, FB and JO assisted in the analysis. All authors have read and agreed to the publisheable version of the manuscript.

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Tables and figures

Table 1: Socio-demographic characteristics of blood donors

Table 2: Prevalence of HIV, HBV, HCV, and Syphilis among blood donors in RCBT Karongi from 2015 to 2019

Table 3: Proportion and risk factors associated with TTIs among blood donors in RCBT Karongi (2015-2019) (Bivariate analysis)

Table 4: Risk factors associated with TTIs among blood donors in RCBT Karongi (2015-2019) (Multivariate analysis)

Figure 1: Trends of HIV, HBV, HCV, and Syphilis among blood donors in RCBT Karongi from 2015 to 2019

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Table 1: Socio-demographic characteristics of blood donors	
Characteristics	**Number N (%) n=36,708**
Gender	
Male	21,091 (57.46)
Female	15,617 (42.54)
Age group (Years)	
18-25	20,883 (56.89)
26-35	9,205 (25.08)
36-45	4,598 (12.53)
46-55	1,637 (4.46)
56-65	385 (1.05)
ABO Blood Group	
O Type	18,521 (50.45)
A Type	9,512 (25.91)
B Type	7,172 (19.54)
AB Type	1,503 (4.09)
Donor Regularity	
New donor	23,794 (64.82)
Repeat donor	12,914 (35.18)
Residence type	
School	19,778 (53.88)
Rural	10,769 (29.34)
Urban	4,892 (13.33)
Military & Police camp	1,269 (3.46)
District	
Karongi	9,653 (26.30)
Nyamasheke	10,515 (28.64)
Rusizi	7,232 (19.70)
Rutsiro	8,616 (23.47)
Ngororero	692 (1.89)
Marital Status	
Single	31,849 (86.76)
Married	4,794 (13.06)
Religious	28 (0.08)
Divorced	5 (0.01)
Widowed	32 (0.09)
Occupation	
Student	27,606 (75.20)
Informal employment	4,749 (12.94)
Government employed civilian	1,890 (5.15)
Government employed uniformed	1,250 (3.41)
Self employed	529 (1.44)
Private institution staff	320 (0.87)
Unemployed	261 (0.71)
NGOs Staff	59 (0.16)
Religion	43 (0.12)

Table 2: Prevalence of HIV, HBV, HCV, and Syphilis among blood donors in RCBT Karongi from 2015 to 2019

Year	Total Tested Blood donors	HBV n (%)	HCV n (%)	HIV n (%)	Syphilis n (%)	Overall TTIs n (%)
2015	5,352	87 (1.6%)	7 (1.3%)	2 (0.04%)	14 (0.26%)	110 (2.1%)
2016	7,251	122 (1.7%)	24 (0.3%)	6 (0.08%)	38 (0.52%)	190 (2.5%)
2017	9,071	123 (1.4%)	78 (0.9%)	8 (0.09%)	29 (0.32%)	238 (2.6%)
2018	7,720	82 (1.1%)	26 (0.3%)	3 (0.04%)	21 (0.27%)	132 (1.7%)
2019	7,314	60 (0.8%)	25 (0.3%)	5 (0.07%)	21 (0.29%)	111 (1.5%)
TOTAL	36, 708	474 (1.3%)	160 (0.44%)	24 (0.065%)	123 (0.34%)	781 (2.1%)

Table 3: Proportion and risk factors associated with TTIs among blood donors in RCBT Karongi (2015-2019) (Bivariate analysis)

Characteristics	HBV			HCV			HIV			Syphilis		
	n (%)	OR (95% CI)	P-Values	n (%)	OR (95% CI)	P-Values	n (%)	OR (95% CI)	P-Values	n (%)	OR (95% CI)	P-Values
Gender												
Female	135 (0.86%)	1.0		48 (0.31%)	1.0		11 (0.07%)	1.0		27 (0.17%)	1.0	
Male	339 (1.6%)	1.8 (1.5-2.2)	0.000	112 (0.53%)	1.7 (1.2-2.4)	0.001	13 (0.06%)	0.8 (0.3-1.9)	0.745	96 (0.45%)	2.6 (1.7-4.0)	0.000
Age group (Years)												
18-25	201 (0.96%)	1.00		62 (0.29%)	1.0		9 (0.04%)	1.0		41 (0.19%)	1.0	
26-35	166 (1.8%)	1.8 (1.5-2.3)	0.000	47 (0.51%)	1.7 (1.1-2.5)	0.005	6 (0.07%)	1.5 (0.5-4.2)	0.432	42 (0.45%)	2.3 (1.5-3.5)	0.000
36-45	78 (1.7%)	1.7 (1.3-2.3)	0.000	31 (0.67%)	2.2 (1.4-3.5)	0.000	6 (0.13%)	3.0 (1.1-8.5)	0.035	32 (0.69%)	3.5 (2.2-5.6)	0.000
46-55	23 (1.4%)	1.4 (0.9-2.2)	0.084	13 (0.79%)	2.6 (1.4-4.8)	0.001	2 (0.12%)	2.8 (0.6-13.1)	0.182	6 (0.36%)	1.8 (0.7-4.4)	0.153
56-65	6 (1.6%)	1.6 (0.7-3.6)	0.243	7 (1.82%)	6.2 (2.8-13.6)	0.000	1 (0.26%)	6.0 (0.7-47.7)	0.088	2 (0.51%)	2.6 (0.6-11.0)	0.179
Donor Regularity												
Repeat donor	21 (0.16%)	1.0		18 (0.14%)	1.0		1 (0.008%)	1.0		27 (0.21%)	1.0	
New donor	453 (1.9%)	11.9 (7.6-18.4)	0.000	142 (0.59%)	4.3 (2.6-7.0)	0.000	23 (0.096%)	12.4 (1.6-92.5)	0.013	96 (0.40%)	1.9 (1.2-2.9)	0.003
Residence type												
School	204 (1.03%)	1.0		66 (0.33%)	1.0		6 (0.030%)	1.0		31 (0.15%)	1.0	
Rural	145 (1.3%)	1.3 (1.1-1.6)	0.014	47 (0.44%)	1.3 (0.8-1.9)	0.159	8 (0.074%)	2.4 (0.8-7.0)	0.097	52 (0.48%)	3.0 (1.9-4.8)	0.000
Urban	103 (2.1%)	2.1 (1.6-2.6)	0.000	42 (0.86%)	2.5 (1.7-3.8)	0.000	9 (0.18%)	6.0 (2.1-17.0)	0.001	25 (0.51%)	3.2 (1.9-5.5)	0.000
Military & Police camp	22 (1.7%)	1.6 (1.1-2.6)	0.020	5 (0.39%)	1.1 (0.4-2.9)	0.720	1 (0.078%)	2.4 (0.8-7.0)	0.377	15 (1.18%)	7.6 (4.1-14.1)	0.000
District												
Rutsiro	78 (0.90%)	1.0		16 (0.18%)	1.0		4 (0.0380)	1.0		24 (0.22%)	1.0	
Karongi	90 (0.93%)	1.1 (0.7-1.3)	0.848	37 (3.83%)	2.0 (1.1-3.7)	0.015	7 (0.072%)	1.9 (0.5-6.5)	0.303	30 (0.31%)	1.3 (0.7-2.3)	0.259
Nyamasheke	110 (1.05%)	1.1 (0.8-1.5)	0.326	60 (0.57%)	3.0 (1.7-5.3)	0.000	5 (0.069%)	1.8 (0.4-6.7)	0.373	33 (0.45%)	2.0 (1.1-3.3)	0.010
Rusizi	189 (2.6%)	2.9 (2.2-3.8)	0.000	47 (0.64%)	3.5 (1.9-6.2)	0.000	7 (0.081%)	2.1 (0.6-7.3)	0.226	34 (0.39%)	1.7 (1.0-2.9)	0.040
Ngororero	7 (1.01%)	1.1 (0.5-2.4)	0.777	0	1.0		1 (0.14%)	3.8 (0.4-34.0)	0.232	2 (0.28%)	1.2 (0.2-5.3)	0.748
Marital Status												
Single	389 (1.22%)	1.0		129 (0.41%)	1.0		18 (0.056%)	1.0		89 (0.27%)	1.0	
Married	83 (1.73%)	1.4 (1.1-1.8)	0.004	31 (0.65%)	1.6 (1.1-2.3)	0.019	6 (0.12%)	2.2 (0.8-5.5)	0.092	34 (0.71%)	2.5 (1.7-3.7)	0.000
Religious	1 (.35.7%)	2.9 (0.4-22.0)	0.282	0	1.0		0	1.0		0	1.0	
Divorced	0 (0.00%)	1.0		0	1.0		0	1.0		0	1.0	
Widowed	1 (3.13%)	2.6 (0.3-19.1)	0.346	0	1.0		0	1.0		0	1.0	
Occupation												
Student	321 (1.16%)	1.0		121 (0.44%)	1.0		17 (0.061%)	1.0		66 (0.24%)	1.0	
Informal employment	79 (1.66%)	1.4 (1.1-1.8)	0.004	24 (0.50%)	1.1 (07-1.7)	0.523	1 (0.053%)	0.8 (0.1-6.4)	0.883	32 (0.67%)	2.8 (1.8-4.3)	0.000
Government employed civilian	25 (1.32%)	1.1 (0.7-1.7)	0.532	6 (0.32%)	0.7 (0.3-1.6)	0.440	5 (0.11%)	1.7 (0.6-4.6)	0.292	5 (0.26%)	1.1 (0.4-2.7)	0.827
Government employed uniformed	21 (16.8%)	1.4 (0.9-2.2)	0.100	5 (0.40%)	0.9 (0.3-2.2)	0.841				15 (1.20%)	5.0 (2.8-8.9)	0.000
Self employed	13 (2.46%)	2.1 (1.2-3.7)	0.008	1 (0.19%)	0.4 (0.06-3.0)	0.401	1 (0.080%)	1.2 (0.1-9.7)	0.799	5 (0.94%)	3.9 (1.5-9.9)	0.003
Private institution staff	7 (2.19%)	1.9 (0.8-4.0)	0.096	0	1.0		0	1.0		0	1.0	
Unemployed	6 (2.29)	2.0 (0.8-4.5)	0.096	3 (1.15%)	2.6 (0.8-8.3)	0.098	0	1.0		0	1.0	
NGOs Staff	1 (1.69%)	1.4 (0.2-10.6)	0.705	0	1.0		0	1.0		0	1.0	
Religion	1 (2.32%)	2.023 (0.277-14.74)	0.487	0	1.0		0	1.0		27 (0.17%)	1.0	

Table 4: Risk factors associated with TTIs among blood donors in RCBT Karongi (2015-2019) (Multivariate analysis)								
Characteristics	**HBV**		**HCV**		**HIV**		**Syphilis**	
	AOR (95% CI)	***P*-values**	**AOR (95% CI)**	***P*-values**	**AOR (95% CI)**	***P*-values**	**AOR (95% CI)**	***P*-values**
Gender								
Female	1.0		1.0				1	
Male	1.7 (1.3-2.0)	0.000	1.5 (1.0-2.1)	0.015			1.9 (1.2-2.9)	0.005
Age group (Years)								
18-25	1.0		1.0		1.0		1.0	
26-35	1.5 (1.1-1.9)	0.001	1.6 (1.0-2.4)	0.025	0.9 (0.3-2.9)	0.945	1.2 (0.7-2.0)	0.406
36-45	1.2 (0.8-1.7)	0.180	2.0 (1.1-3.5)	0.011	1.8 (0.5-5.9)	0.324	1.3 (0.7-2.5)	0.311
46-55	0.9 (0.5-1.5)	0.868	2.4 (1.2-4.8)	0.012	1.6 (0.3-8.4)	0.553	0.6 (0.2-1.7)	0.442
56-65	1.1 (0.4-2.5)	0.858	5.8 (2.4-14.0)	0.000	3.7 (0.4-32.1)	0.226	0.9 (0.2-4.1)	0.939
Donor Regularity								
Repeat donor	1.0		1.0		1.0		1	
New donor	13.2 (8.4-20.6)	0.000	4.7 (2.8-7.8)	0.000	12.1 (1.6-91.0)	0.015	2.3 (1.4-3.6)	0.000
Residence type								
School	1.0		1.0		1.0		1	
Rural	0.8 (0.6-1.1)	0.366	1.1 (0.6-1.6)	0.796	2.1 (0.6-7.0)	0.200	2.2 (1.2-3.8)	0.006
Urban	0.9 (0.5-1.5)	0.868	1.2 (0.7-2.0)	0.336	4.1 (1.2-13.5)	0.020	2.2 (1.2-4.2)	0.011
Military & Police camp	1.9 (0.2-15.1)	0.532	0.4 (0.1-1.1)	0.096	1.6 (0.1-15.6)	0.668	0.0001 (0.0-14.0)	0.981
District								
Rutsiro	1.0		1.0					
Karongi	1.2 (0.8-1.6)	0.252	2.6 (1.4-4.8)	0.002				
Nyamasheke	1.2 (0.9-1.7)	0.097	3.9 (2.1-7.0)	0.000				
Rusizi	2.5 (1.9-3.3)	0.000	2.9 (1.6-5.3)	0.000				
Ngororero	1.1 (0.4-2.3)	0.867	1.0					
Marital Status								
Single	1.0		1.0					
Married	1.7 (1.2-2.4)	0.001	1.526 (0.939-2.481)	0.088				
Religious	1.9 (0.1-2.1)	0.986	1.0					
Divorced	1.0		1.0					
Widowed	5.4 (0.6-43.9)	0.113	1.0					

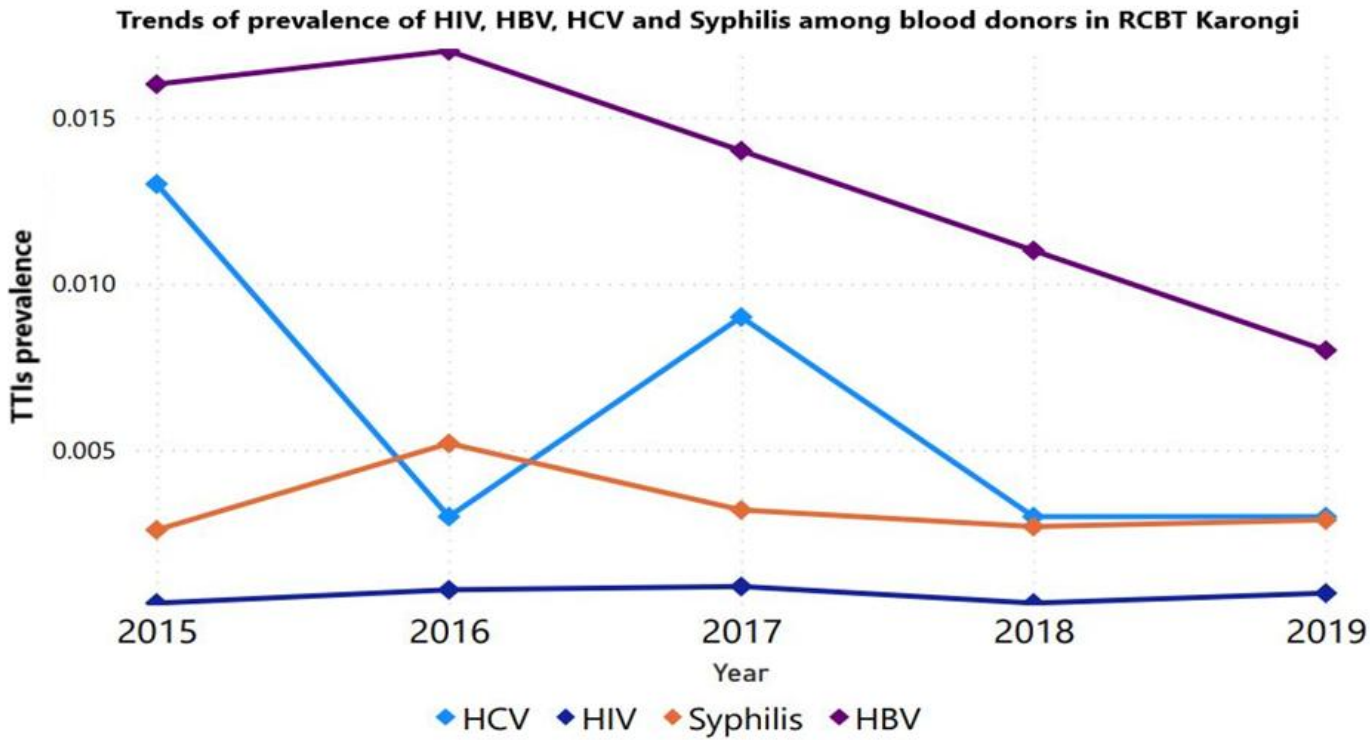

Figure 1: Trends of HIV, HBV, HCV, and Syphilis among blood donors in RCBT Karongi from 2015 to 2019