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Research

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Sero-prevalence and correlates of Human Immunodeficiency Virus, Hepatitis B and C viruses, and syphilis infections among blood donors at the Butembo blood bank, North Kivu, Democratic Republic of Congo: a blood bank-based study

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Abstract

Introduction: *blood-borne infections are common during unsafe blood transmission. There is a paucity of information on their burden at blood banks of the Democratic Republic of Congo (DRC). This aimed to determine the prevalence and factors associated with Human Immunodeficiency Virus (HIV), hepatitis B and C viruses, and syphilis infections among blood donors at the Butembo blood bank, North Kivu, DRC.* ***Methods:*** *this study used the dataset of the Butembo blood bank using a step-wise approach. HIV, hepatitis B and C viruses, and syphilis infections were determined using serological testing. Logistic regression models were performed to explore factors associated with blood-borne infections.* ***Results:*** *in total, this study enrolled 12208 participants among which 5.8% (n=608) had blood-borne infections. Most of the participants with blood-borne infections were female (67.3%) with a mean age of 22.7 years and standard deviation of 5.3. The overall seroprevalence rates of hepatitis C and B viruses, syphilis and HIV among blood donors were 34.9% (n=212), 32.1% (195), 25.3% (n=154), and 7% (n=47) respectively. Factors associated with blood-borne infections among blood donors included being female (aOR: 3.53, 95% CI: 1.16-8.19; p = 0.030), attaining a low level of education (aOR: 5.12, 95% CI: 1.59-1.39; p = 0.016), living in rural areas (aOR: 4.33, 95% CI: 1.277.34; p = 0.028), having received prior treatment for STDs, being married (aOR: 3.87, 95% CI: 1.37-6.66; p = 0.010), being younger than 30 years old (aOR: 6.44, 95% CI: 2.51-13.4; p=0.007), and being employed (aOR: 1.95, 95% CI: 1.60-3.51; p=0.006). Attaining a university level of education showed a protective effect against hepatitis B virus (aOR: 0.26, 95% CI: 0.12-0.71; p = 0.018) and syphilis (aOR: 0.65, 95%CI: 0.09-0.85; p=0.013) among blood donors.* ***Conclusion:*** *the prevalence of HIV, hepatitis B and C viruses, and syphilis infections among blood donors is high. Our findings recommended a proper screening of blood-borne infections at blood banks for effective prevention and control of transfusion-transmitted diseases.*

Introduction

Blood transfusions are among the main causes of infection transmission when poor infection prevention and control measures are applied during blood transfusions [1,2]. In total, nearly 90 million blood units were collected annually across the world [3]. Transfusion-transmissible infections (TTIs), also named blood-borne infections, are common in settings where poorly screened blood products are given to patients with severe anemia [4]. Transfusion-transmissible infections secondary to blood transfusions constitute a significant public health problem [5], with half a billion cases worldwide [6]. Several studies suggested that in the aftermath of blood transfusions, blood-borne infections might be prevented if proper measures are performed in healthcare settings, especially in developing countries [1,2,7]. A study found that the seroprevalence rates of hepatitis B virus (HBV), syphilis, hepatitis C virus (HCV), and HIV were 10.1%, 5.7%, 4.8%, and 4.1%, respectively, including Cameroon [4].

Despite the guidelines established by the World Health Organization (WHO) to reduce the burden of transfusion-transmitted diseases, studies recommended the implementation of bank blood to reduce the burden of transfusion-transmitted disorders [5-9]. However, more studies are needed to explore the burden of blood-borne infections in blood bank of developing countries, including in the eastern Democratic Republic of Congo (DRC), where blood banks have been implemented for the last ten years. Similarly, studies found that six in ten HCV-infected Congolese patients are diagnosed at the terminal stage of the disease [10,11]. Although studies showed that factors associated with blood-

borne infections included the age at first sexual intercourse, inconsistent condom use, having multiple sexual partners, being female or being single [4,12], these factors have not yet been determined at the Butembo blood bank, located in Butembo city, North Kivu province in eastern DRC. The aim of this study was to determine the seroprevalence and factors associated with human immunodeficiency virus (HIV), hepatitis B and C viruses, and syphilis infections among blood donors at the Butembo blood bank, North Kivu, DRC

Methods

Study design and setting: we conducted a retrospective study of blood donor data recorded between January 2014 and December 2018 at the Butembo blood bank, located in Butembo city, in North Kivu province, in DRC. This blood bank has been implemented since 2014 in order to dispatch blood products whenever needed in health facilities in 17 health zones located in the northern part of North Kivu province in the DRC. At this blood bank, blood is usually collected from blood donors either referred from nearby health facilities or attended the blood bank willingly after being sensitized to donate blood.

Study population: in this study, we operationalized a "blood donor" as an individual who gave blood products to anemic patients [13]. We purposively included all adult blood donors, apparently subjects, aged between 18 and 50 years, with a hemoglobin level estimated to 12g/dl, who gave blood at Butembo Blood Bank, whose data were well recorded in the dataset. Exclusions were blood donors with missing data, those with serious illness.

Study procedures: two independent research assistants purposefully collected data based on retrieval of all data encoded in the database, according to a step-wise approach centered on the data review recommended by the WHO, to determine the completeness of reporting data as well as the internal and external consistency of recorded data [14]. An extraction sheet was used to collect information on the demographic profile including age, gender, year, and blood group. The outcomes variables were HIV, hepatitis B and C viruses, and syphilis infections, diagnosed using the serological testing for HBV anti-body, HCV anti-body, syphilis antibody, and HIV.

Laboratory analysis: HIV antibodies were detected using rapid tests detecting HIV-1 and HIV-2 infections. Hepatitis B virus (HBV) was detecting using an immunoassay-based DIASpot HBAntigene Kit. HCV was detecting using DIASpot HCV-Ab-test strips. Syphilis was detecting using the Venereal Disease Research Laboratory [5].

Statistical analysis: data were entered into Microsoft Excel before being exported to SPPS for further analysis. Descriptive statistics were summarized as frequencies and percentages for categorical variables, including the seroprevalence of human immunodeficiency virus, hepatitis B and C viruses, and syphilis, and mean and median for continuous variables. Inferential analyses were performed using hierarchical logistic regression modelling to explore factors associated with the blood-borne infections. These factors were included in the regression models based on their potential confounding or influencing effects reported in previous studies. Only factors with a value of less than 0.2 at univariate analysis were included in multivariable regressions. The chi-square test was used to compare categorical variables. The threshold of statistical significance was set at 0.05. Associations were assessed using odd ratios.

Ethical considerations: before data collection, all study protocols received approval from the Academic Board of the Faculty of Medicine at the Catholic University of Graben (DRC). Permissions for carrying out the study were obtained from the chairman of the health zone in Butembo and the executive director of the blood transfusion center in Butembo. The study was conducted according to the recommendations of the Declaration of Helsinki. Blood donors were informed that testing for TTIs would be done.

Results

General characteristics of the study population: in total, twenty thousand two hundreds and eights donors were to the Butembo Blood Bank between January 2014 and December 2018, among which 608 (5.8%) had blood-borne infections including human immunodeficiency virus, hepatitis B and C viruses, and syphilis infections. Most of the participants with human immunodeficiency virus, hepatitis B and C viruses, and syphilis infections were female (67.3%), single (69.6%), employed (35.4%), attained primary level of education (41.3%), lived in urban areas (72.5%), belonged to blood group O (59.5%), and were treated for Sexually Transmitted Diseases (STDs) five years before the time their donation of blood to the blood bank (84%) (Table 1).

Prevalence of blood-borne infections: the overall seroprevalence rates of hepatitis C and B viruses, syphilis and HIV among blood donors were 34.9% (n = 212), 32.1% (n = 195) 25.3% (n = 154), and 7% (n = 47) respectively (Table 2).

Factors associated with blood-borne infections: at univariate analysis, the factors associated with HIV, hepatitis B and C viruses, and syphilis infections included being female, having a low level of education, living in rural settings, having a history of treatment for STDs five years before the blood donation, being married, having a younger age than 30 years, and being employed (Table 3). At multivariate analyses, we found that hepatitis C was statistically associated with being female (AOR: 3.53, 95% CI: 1.16-8.19; p = 0.030), attaining a primary level of education (aOR: 5.12, 95% CI: 1.59-1.39; p = 0.016), living in rural areas (aOR: 4.33, 95% CI: 1.277.34; p = 0.028), and being treated for STDs five years before the donation of blood. While attaining a university level of education showed a negative association with hepatitis B among blood donors (aOR: 0.26, 95% CI: 0.12-0.71; p = 0.018); being married (aOR: 3.87, 95% CI: 1.37-6.66; p = 0.010) and being employed (aOR: 3.75, 95% CI: 1.21-12.65; p = 0.022) increase the risk of hepatitis B in our sample. Our results also demonstrated that being younger than 30 years old (aOR: 6.44, 95% CI: 2.51-13.4; p=0.007), being female (aOR: 6.96, 95% CI: 1.23-30.59; p=0.008), having been treated for STDs five years before the blood donations to blood bank (aOR: 2.48, 95% CI: 1.03-5.97; p=0.043), and having unprotected sexual intercourse increases the risk of syphilis blood donors. Whereas attaining a university level of education (aOR: 0.65, 95%CI: 0.09-0.85; p=0.013) showed statistical association with syphilis in a protective nature, our research also showed that being a younger (aOR: 3.24, 95% CI: 1.46-5.61; p=0.034), living in rural areas (aOR: 3.75, 95% CI: 1.21-11.05; p=0.024), and having a job (aOR: 1.95, 95% CI: 1.60-3.51; p=0.006) are statistically associated with HIV (Table 4).

Discussion

This study aimed to determine the prevalence and factors associated with blood-borne infections among blood donors at the Butembo blood bank, North Kivu, DRC. Its findings showed that 5.8% of blood donors had TTIs, among which HBV, HBC, syphilis, and HIV were common. The majority of blood donors were single, attained the primary level of education, were unemployed, lived in urban areas, and had unprotected sexual intercourse six months before the time they gave blood to the blood bank. The factors associated with blood-borne infections were being a female, attaining a low level of education, living in rural settings, having received prior treatment for STDs, being married, being younger than 30 years old, and being employed. Attaining a university level of education showed a protective effect against HBV and syphilis among blood donors. The findings indicating that 5.8% of blood donors had blood-borne infections was higher than the average of the WHO and lower than the findings of a study carried out in Ethiopia [1]. The prevalence of transfusion-transmitted diseases varies in different regions across the world, depending on behavioral and cultural factors communities. Our findings on blood-borne infections were higher than other research [1,5,15,16]. We argue that in developing

settings, blood-borne infections might be poorly detected during blood transfusion procedures, given the paucity or lack of trained health workers [17] and specific diagnostic tests for potential transfusion transmitted-diseases [18]. In such settings, HBV and HCV are frequently diagnosed at advanced stages of the liver disease´s course [12,19,20]. Our study emphasizes the significant risk of silently blood-borne transfusions. It highlights the need for strategies targeting the reduction of this risk and the need for a careful check-up of blood products during transfusion procedures to avoid post-transfusion infection.

Similar to our findings, numerous studies showed that factors associated with blood-borne infections included the female gender, low level of education, living in rural settings, being treated for STDs five years to blood donation, young age, being married, and being employed [1,10]. Blood-borne infections remain a significant public health concern among persons aged 15-49 years [6], especially those with multiple sexual partners [2], who highly increase the risk of transfusion-transmitted disorders [21]. Additionally, our findings on factors associated with syphilis align with previous studies [13,22]. We argue that most individuals of reproductive age live with undiagnosed syphilis in developing countries. Finally, our results showed that attaining a high level of education had a protective effect against both HBV and syphilis. These findings are in line with studies indicating that low levels of education are a significant risk factor for blood-borne infections [23], especially the HBV [24]. We argue that the choice of blood donors may be based on their education level.

Our findings cannot underestimate the power of the following limitations. First, a poor documentary record may affect the retrospective nature of its design. A prospective study centered on determining the incidence of blood-borne transfusions is recommended. Second, although this study involved all the blood products received at the Blood Transfusion Center of Butembo, a countrywide study is welcome to better understand the risk of blood-borne infections during blood transfusion in the DRC.

Conclusion

We found that the prevalence of blood-borne infections among blood donors is high. Factors associated with HIV, hepatitis B and C viruses, and syphilis infections included being female, having a low level of education, living in rural settings, having a history of treatment for STDs five years before the blood donation, being married, having a younger age than 30 years, and being employed. Attaining a university level of education had a protective effect against hepatitis B and syphilis. Our study highlights the importance of education in reducing the burden of blood-borne infections in general, especially among blood donors. Our findings recommended a proper screening of blood donors for blood-borne infections at blood bank for appropriate infection prevention and control measures for transfusion-transmitted diseases.

What is known about this topic

- *Blood transfusions are among the main causes of infection transmission when poor infection prevention and control measures are applied;*
- *The implementation of bank blood reduces the burden of transfusion-transmitted disorders.*

What this study adds

- *One in twenty voluntary blood donors has blood-borne infections;*
- *Blood products should be taken at educated individuals to reduce the transfusion-transmitted diseases.*

Competing interests

The authors declare no competing interests.

Authors' contributions

Rock Kasereka Masuka: study design and data collection. Bives Mutume Nzanzu Vivalya: data analysis and manuscript drafting. Ildephonse Kamwira Soly: revision of manuscript. All the authors have read and agreed to the final manuscript.

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Tables

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Table 2: distribution of participants according to blood-borne infections

Table 3: univariate analysis of factors associated with blood-borne infections among blood donors at blood transfusion center of Butembo

Table 4: multivariate analysis of factors associated with blood-borne infections among blood donors at blood transfusion center of Butembo

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Table 1: baseline information of study participants					
Variables	**Blood-borne infections**				
		Absent	**Present**	**P-value/Fisher**	**X^2**
Participants	12208	11600 (95%)	608 (5%)		
Age (mean ± SD)	22.7 ± 5.3	21.3 ± 6.5)	23.4 ± 5.7		
Sex					
Male	4317	4118 (35.5%)	199 (32.7%)	0.257	11
Female	7891	7482 (64.5%)	409 (67.3%)		
Marital status				0.760	0.89
Married/cohabiting	3115	2989 (25.8%)	126 (20.7%)		
Single	8990	8567 (73.9%)	423 (69.6%)		
Divorced/separated	103	44 (0.3%)	59 (9.7%)		
Educational level				0.398	3.28
Illiterate	1666	1582 (13.6%)	84 (13.8%)		
Primary	5723	5472 (47.2%)	251 (41.3%)		
Secondary	3563	3395 (29.3%)	168 (27.6%)		
Tertiary	1256	1151 (9.9%)	105 (17.3%)		
Residence				0.073	3.20
Urban	8245	7804 (67.3%)	441 (72.5%)		
Rural	3963	3796 (32.7%)	167 (27.5%)		
Occupation				0.841	1.18
Unemployed	3090	2875 (24.8%)	215 (35.4%)		
Employed	2179	2022 (17.4%)	157 (25.8%)		
Student	2274	2173 (18.7%)	101 (16.6%)		
Farmer	3004	2887 (24.9%)	117 (19.4%)		
Other	1661	1643 (14.2%)	18 (3%)		
Blood group				0.003	7.38
A	2974	2764 (23.8%)	210 (34.5%)		
B	448	437 (3.8%)	11 (1.8%)		
AB	397	372 (3.2%)	25 (4.1%)		
0	8389	8027 (69.2%)	362 (59.5%)		
Treated for STDs in the previous 5 years				<0.001	15.24
Yes	1336	825 (7.1%)	511 (84%)		
No	10872	10775 (92.3%)	97 (16%)		
Having unprotected sex intercourse 6 months to blood obtaining				0.041	5.37
Yes	3572	3427 (29.5%)	145 (23.8%)		
No	8636	8183 (70.5%)	454 (76.2%)		
Not having given blood within last two years				<0.001	3.52
Yes	1824	1687 (14.5%)	137 (22.5%)		
No	10384	9913 (85.5%)	471 (77.5%)		

Table 2: distribution of participants according to blood-borne infections		
Variable	**Frequency**	**Percentage**
Hepatitis C virus infection	212	34.9%
Hepatitis B virus infection	195	32.1 %
Syphilis	154	25.3 %
HIV	47	7.7%

Table 3: univariate analysis of factors associated with blood-borne infections among blood donors at blood transfusion center of Butembo

	Hepatitis C		**Hepatitis B**		**Syphilis**		**HIV**	
	cOR	**P**	**cOR**	**P**	**cOR**	**P**	**cOR**	**P**
Age in years								
≤30	4.97 (0.99-25.13)	0.162	2.99 (0.68-8.01)	0.175	6.58 (2.82-14.01)	0.017	3.42 (1.55-5.80)	0.19
>30	Reference		Reference		Reference		Reference	
Sex								
Male	Reference		Reference		Reference		Reference	
Female	3.55 (1.23-8.75)	0.06	1.24 (0.75-4.76	0.734	7.14 (2.08-43.26)	0.020	8.18 (4.24-35.22)	0.11
Marital status								
Married/cohabiting	2.68 (0.90-7.67)	0.067	3.87 (1.37-6.66)	0.010	1.85 (0.56-6.09)	0.313	2.68 (0.93-7.67)	0.067
Single	1.88 (0.19-10.02)	0.550	2.57 (0.74-6.53)	0.140	1.09 (0.28-6.16)	0.744	3.39 (0.59-7.51)	0.172
Divorced/separated	Reference		Reference		Reference		Reference	
Educational level								
Illiterate	Reference		Reference		Reference		Reference	
Primary	5.12 (1.59-6.39)	0.016	0.81 (0.19-3.89)	0.781	1.16 (0.83-3.42)	0.016	1.21 (0.97-1.25)	0.897
Secondary	2.04 (0.87-6.83)	0.326	3.01 (0.96-7.66)	0.100	2.12 (0.79-7.78)	0.248	0.98 (0.74-3.25)	0.185
Tertiary	1.75 (0.78-7.99)	0.871	0.36 (0.12-0.79)	0.009	1.63 (0.36-5.79)	0.862	1.01 (0.69-2.43)	0.15
Residence								
Urban	Reference		Reference		Reference		Reference	
Rural	4.33 (1.27-7.34)	0.028	1.28 (0.44-3.72)	0.651	1.48 (0.46-4.76)	0.509	3.75 (1.21-11.05)	0.024
Occupation								
Unemployed	Reference		Reference		Reference		Reference	
Employed	1.48 (0.46-4.76)	0.509	3.75 (1.21-12.65)	0.022	1.43 (0.27-7.56)	0.675	1.95 (1.60-3.51)	0.006
Student	3.07 (0.43-21.69)	0.261	0.48 (0.06-3.94)	0.494	0.82 (0.17-3.96)	0.804	1.23 (1.01-2.40)	0.133
Farmer	Reference		Reference		Reference		0.47 (0.26-0.79)	0.284
Other	1.71 (0.29-10.02)	0.550	1.27 (0.24-6.61)	0.778	2.13 (0.22-20.49)	0.514	0.68 (0.52-1.24)	0.712
Treated for STDs in the previous 5 years								
Yes	8.24 (2.21-17.50)	0.14	3.22 (0.93-6.49)	0.118	3.54 (1.32-8.04)	0.972	2.16 (0.67-4.18)	0.432
No	Reference		Reference		Reference		Reference	
Having unprotected sex intercourse 6 months								
Yes	3.87 (1.27-11.72)	0.037	1.96 (0.67-5.79)	0.221	3.26 (1.05-10.07)	0.040	2.40 (0.80-7.23)	0.119
No	Reference		Reference		Reference		Reference	
Not having given blood within last two years								
Yes	4.44 (1.06-6.14)	0.528	1.82 (0.95-8.34)	0.479	7.00 (1.75-10.4)	0.036	4.32 (1.57-64.70)	0.059
No	Reference		Reference		Reference		Reference	

Table 4: multivariate analysis of factors associated with blood-borne infections among blood donors at blood transfusion center of Butembo								
	Hepatitis C		Hepatitis B		Syphilis		HIV	
	aOR	P	aOR	P	aOR	P	aOR	P
Age in years								
≤30	4.04 (0.72-22.49)	0.111	2.98 (0.64-7.96)	0.166	6.44 (2.51-13.4)	0.007	3.24 (1.46-5.61)	0.034
>30	Reference		Reference		Reference		Reference	
Sex								
Male	Reference		Reference		Reference		Reference	
Female	3.53 (1.16-8.19)	0.030			6.96 (1.23-30.59)	0.008	8.05 (0.91-33.01)	0.060
Marital status								
Married/cohabiting	2.68 (0.90-7.67)	0.067	3.87 (1.37-6.66)	0.010	1.99 (0.66-7.19)	0.313	2.68 (0.93-7.67)	0.067
Single	1.88 (0.19-10.02)	0.550	2.57 (0.74-6.53)	0.140	1.09 (0.28-6.16)	0.744	3.39 (0.59-7.51)	0.172
Divorced/separated	Reference		Reference		Reference		Reference	
Educational level								
Illiterate	Reference		Reference		Reference		Reference	
Primary	1.16 (0.83-3.42)	0.016	1.21 (0.97-1.25)	0.8971	0.46 (0.11-1.71)	0.183	3.02 (0.34-27)	0.322
Secondary	1.92 (0.64-5.78)	0.248	0.89 (0.74-1.06)	0.105	4.59 (1.43-14.77)	0.11*	0.35 (0.08-0.61	0.012
Tertiary	1.45 (0.36-5.79)	0.599	0.76 (0.52-0.86)	0.015	0.65 (0.09-0.85)	0.013*	2.76 (0.52-14.48)	0.211
Residence								
Urban	Reference		Reference		Reference		Reference	
Rural	4.33 (1.27-7.34)	0.028	1.01 (0.75-3.24)	0.975	1.48 (0.46-4.76)	0.509	3.75 (1.21-11.05)	0.024
Occupation								
Unemployed	Reference		Reference		Reference		Reference	
Employed	1.48 (0.46-4.76)	0.509	3.75 (1.21-12.65)	0.022	1.43 (0.27-7.56)	0.675	1.95 (1.60-3.51)	0.006
Student	3.07 (0.43-21.69)	0.261	0.48 (0.06-3.94)	0.494	0.82 (0.17-3.96)	0.804	1.23 (1.01-2.40)	0.133
Farmer	Reference		Reference		Reference		0.47 (0.26-0.79)	0.284
Other	1.71 (0.29-10.02)	0.550	1.27 (0.24-6.61)	0.778	2.13 (0.22-20.49)	0.514	0.68 (0.52-1.24)	0.712
Treated for STDs in the previous 5 years								
Yes	7.75 (1.59-39.70)	0.014	2.15 (0.82-5.68)	0.121	2.48 (1.03-5.97)	0.043	1.96 (0.49-7.92)	0.340
No	Reference		Reference		Reference		Reference	
Having unprotected sex intercourse 6 months								
Yes	3.87 (1.27-11.72)	0.037	1.96 (0.67-5.79)	0.221	3.26 (1.05-10.07)	0.040	2.40 (0.80-7.23)	0.119
No	Reference		Reference		Reference		Reference	
Not having given blood within last two years								
Yes	3.73 (1.06-13.09)	0.401	1.82 (0.35-9.52)	0.479	6.96 (1.23-9.59)	0.028	8.05 (0.91-71.01)	0.060
No	Reference		Reference		Reference		Reference	