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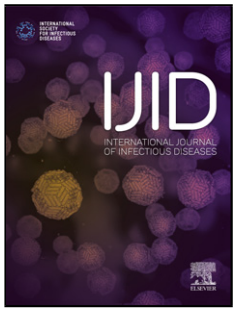

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Seroprevalence of hepatitis B and hepatitis C among blood donors in Sierra Leone: a multi-year retrospective study

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Highlights

- National prevalence of viral hepatitis in Sierra Leone is still unknown
- Among almost 30,000 blood donors from five blood banks across the country, HBV and HCV prevalence was overall 10.8% and 1.2% respectively
- Over 80% of donations were family replacement
- Infection was strongly associated with being a first-time donor
- Blood donations continued uninterrupted throughout the Ebola outbreak

Abstract

Objectives

In Sierra Leone, very little data are available on hepatitis B virus (HBV) and hepatitis C virus (HCV) prevalence. Blood donor screening permits estimation of the prevalence of transfusion transmissible infections in a general open population. We analyzed blood donor data in Sierra Leone to estimate national viral hepatitis prevalence and identify risk factors for hepatitis infection among the donor population.

Methods

We conducted a retrospective data analysis in five government hospitals. We collected HBV and HCV screening results, donor demographics, and donation type (family replacement or voluntary donor; first-time or repeat). Univariate and multivariate analyses were performed to determine associations between infections and socio-demographic factors.

Results

The number of donors screened was 29,713. The overall prevalence was: 10.8% (3200) for HBV and 1.2% (357) for HCV. HBV infection was strongest associated with male sex (p: <0.0001) and younger age (p: <0.0004 for the 22-27 age group). Both HBV and HCV infection were higher in certain locations.

Conclusion

Our findings stress the presence of viral hepatitis infection throughout the country and the need to invest in safe blood services, vaccination and treatment of viral hepatitis at national level.

Keywords

Viral hepatitis; Sierra Leone; epidemiology; blood donors; seroprevalence

Introduction

Hepatitis B (HBV) and Hepatitis C (HCV) virus infections are major health burdens. Globally, 257 million people are infected with HBV and 71 million are infected with HCV (World Health Organization 2017). Viral hepatitis caused an estimated 1.3 million deaths in 2015 and both HBV and HCV can lead to chronic infection with complications including liver fibrosis, cirrhosis, hepatocellular carcinoma (HCC) and ultimately liver failure (World Health Organization 2017). In the African region, HBV is highly endemic with a 6.1% prevalence estimate, and HCC is currently the leading cause of cancer among men (Stanaway et al. 2016; Ott et al. 2017; World Health Organization 2017). Information about HCV in West Africa is scarce.

Sierra Leone is a small country in West Africa where under-resourced health systems and poor social and economic determinants of health have been attributed to a series of viral outbreaks in recent years including cholera, yellow fever, Lassa fever and Ebola virus disease (EVD) (World Health Organization 2015). In particular, the 2013-2016 Ebola epidemic put the country's health

system under considerable strain as many clinical staff lost their lives (Evans et al. 2015). Disruption of clinical services, fear of nosocomial transmission of the disease, misinformation and mistrust among authorities contributed to reduced access to health care services (Parpia et al. 2016; Ribacke et al. 2016).

There are no national estimates for the prevalence of viral hepatitis for Sierra Leone, but several small studies on HBV reported concerning rates. In these studies, the prevalence of HBV surface antigen (HBsAg) was found to be 18.2% in primary school children (Hodges et al. 1998), 6.2% in antenatal women (Wurie et al. 2005), 13.7% in a group of febrile patients in a small, private hospital (Ansumana et al. 2018), 39.5% in adults presenting to a private clinic (Adesida et al. 2010), 8.7% among health care workers (Massaquoi et al. 2018), and 14% in a group of 326 blood donors (García-Tardón et al. 2017). Recently, Yambasu et al found an overall HBV prevalence of 9.7% among blood donors in 2016 (Yambasu et al. 2018). HCV infection was reported in two of these studies and varied widely. In the studies by Garcia-Tardon and Yambasu, HCV antibodies were detected in 7.5% and 1% of blood donors (García-Tardón et al. 2017; Yambasu et al. 2018).

In the absence of country-prevalence reports, blood donor screening data can provide important information regarding risk associated with blood transfusion and some insight into the magnitude of the problem of transfusion transmissible infections (Buseri et al. 2009; Tessema et al. 2010; Hope et al. 2014; Agyeman et al. 2016; Ofori-Asenso and Agyeman 2016).

Blood donors in Sierra Leone are screened for HBV, HCV, HIV and syphilis. In this study, we conducted a retrospective analysis of HBV and HCV rapid test screening results in the district National Safe Blood Services (NSBS) registers of five blood banks between 2013 and 2017, to determine HBV and HCV seroprevalence as well as examine if the Ebola outbreak affected blood supply.

Methods

Study setting

The study includes blood bank data from public hospitals across East, North, Southern regions and Western area of the country, located in five out of the fourteen national districts (Figure 1). These blood banks provide blood transfusions for the entire population in the districts; from 300,000 in Pujehun to 1,000,000 in Freetown. With the exception of Connaught in Freetown, these blood banks mainly serve rural populations (Figure 1). The data collection period spanned the 2013-2016 Ebola outbreak, which affected all districts. Most EVD cases occurred in Bombali and Western Urban districts (Figure 1).

Blood donor screening

Per national guidelines, blood was obtained from relatives of the transfusion recipient (family replacement) or from voluntary blood donors. Transfusion recipients in Sierra Leone are obliged to replace blood supply, except when their life is in danger. Family replacement donors donated at the blood bank on the hospital grounds, whereas voluntary donors either visited the hospital or were screened elsewhere during community blood drives. Prior to blood collection, donors received a hemoglobin and blood grouping test, and subsequently were screened with rapid test

strips to detect HBsAg (this test does not discriminate between acute or chronic infection), HCV antibody, HIV 1/2 antibody and syphilis (anti-*treponema pallidum*). In case of a positive test or hemoglobin level <12 g/dl, the person was excluded from donating.

Data collection

Trained staff extracted data from written NSBS registers to develop an electronic database with de-identified information (name, residential address). Data on blood donor's sex, age and occupation were collected. We categorized age into four groups according to the median and interquartile range in the total dataset. To develop the following occupational categories we considered existing literature (Bower et al. 2016; Richardson et al. 2016; Jofre-Bonet and Kamara 2018) and classifications from the International Labour Organization, adjusting to the Sierra Leone context as needed: 'Farming, fishing, mining'; 'Formal occupation', which included terms like government, office, business, often requiring secondary or higher education; 'Informal occupation', jobs generally associated with short contracts, not requiring education, such as petty trading, driving, or any type of laborer, non-paid persons; and 'students'. We separately developed a category for all health care workers, because of the occupational hazard associated with HBV and HCV infection. Because of the small number of health care workers in our dataset, we included them in the 'Formal occupation' group in the regression analyses. In addition, information about the type of donation (family replacement or voluntary donor) and the frequency (first-time or repeat donor) were registered.

Statistical analysis

Data were analyzed SAS (Version 9.4. SAS Institute Inc., Cary, NC, USA) and Graphpad Prism (Version 7 Graphpad software Inc., La Jolla, CA, USA). We conducted univariate and multivariate regression to estimate odds ratios (OR) with 95% confidence intervals (CI) for potential predictors for HBV and HCV infection. We included demographic variables, location, sex, age, and occupation as well as donation type. The multivariate model adjusted for all variables. We performed both complete case and missing indicator analyses with missing data indicators for the variables with >2% missing entries. We calculated p-values but did not define findings as "statistically significant" based on a p-value threshold (Amrhein et al. 2019).

Results

Demographic characteristics of blood donors

We included 29,713 of 30,467 donor entries for which hepatitis screening results were registered. The timeframe for data collection in the various districts did not completely overlap due to limited availability of registers and/or staff to extract the data (Table 1). The median age of donors was 27 years old and 76.5% of donors were male. The majority of screened donors were family replacement donors (80.2%); in Makeni and Kono these proportions were highest (Table 1). A total of 15.2% of donors was excluded from donating (deferred) following the rapid test screening process (95% of excluded donors had a single positive screening test; 5% had multiple positive tests) and this occurred most often in Bo (19.2%) and Makeni (22.6%).

Donor screening during the Ebola outbreak

Donor screening volumes generally fluctuated over time. Whilst blood banks remained open to provide blood throughout 2013-2016; during the peak of the EVD outbreak (June 2014 – Jan 2015)

we recorded the lowest number of screenings across the districts (Figure 2). The reduction was most pronounced in Bombali (Makeni Govt Hospital) and Kono (Koidu Govt Hospital), where a high number of Ebola cases was registered (Figure 1).

Seroprevalence of HBV and HCV

Based on all screening data, seroprevalence of HBV and HCV was 10.8% (3200/29713), and 1.2% (357/29713) respectively (Table 2). The percentage of HBV positive tests ranged from 6.9% in Connaught to 15% in Makeni, whereas HCV prevalence was much lower, ranging from 0.3% in Pujehun to 1.9% in Makeni. A small percentage (0.2%) of donors screened positive for both viruses. Overall HBV and HCV seroprevalence was 11.3% and 1.3% respectively after limiting the dataset to first-time donors (Table 2). To obtain more insight into HBV and HCV prevalence, we plotted the HBV and HCV seroprevalence rates of all screened donors by month for all districts (Figure 3). Despite some month-to-month variation, HBV seroprevalence remained relatively stable (Figure 3a), which is in line with an endemic distribution pattern. In contrast, HCV seroprevalence (Figure 3b) was low with a noticeable peak in detection in Kono and Makeni in early 2016 (cause unknown).

Factors associated with HBV and HCV infection

We next investigated whether demographic or donation-associated factors were predictors for HBV or HCV infection. In univariate analyses, being a first-time (OR:31.5 (95%CI: 17.9-55.7; $p<0.0001$ and OR:9.6 (95%CI: 3.6-25.8; $p<0.0001$ for HBV and HCV respectively) and family replacement (OR:1.7 (95%CI: 1.4-2.0; $p<0.0001$; OR:1.6 (95%CI: 1.0-2.7; $p=0.028$) donor were strongest associated with HBV and HCV infection (Table 3). The location of the blood bank was

associated with HBV and HCV infection as well (Table 3). For occupation, being a farmer, fisherman or miner, was associated with HBV and HCV infection (OR:1.2 (95%CI: 1.0-1.4; p=0.0058; OR:1.6 (95%CI: 1.1-2.2; p=0.013 for HBV and HCV, respectively; Table 3). For HBV, other occupations, men and individuals below 34 years of age had higher odds for HBV infection (Table 4). HCV infection was not associated with age or sex.

The HBV seroprevalence among health care workers was 7.8% (31/398), which is lower than the overall prevalence (10.8%) we found. Similarly, HCV among health care staff (4/398; 1.0%) was lower than the overall prevalence (1.2%).

In the adjusted models, being a first-time donor was strongly associated with HBV and HCV infection HCV (OR: 38.4 [95% CI: 20.5-71.8], p<0.0001; OR: 13.3 [95% CI: 4.9-36.3], p<0.0001 respectively). Younger people (< 34 years) had a higher odds of HBV infection. Blood bank location was also important: donors in Bo, Kono and Makeni had higher odds of HBV and HCV infection. Family replacement donations were weakly negatively associated with HBV infection (OR 0.8 [95% CI: 0.7-1.0], p=0.063). Occupation was not a predictor for a positive HBV or HCV test. Results remained similar in a missing indicator analysis (Supplementary Table 1).

Discussion

In our study, we observed a seroprevalence of 10.8% for HBV and 1.2% for HCV among blood donors across five Sierra Leonean districts. While we acknowledge that blood donors do not exactly reflect the general population, donor seroprevalence data are a useful first tool to

estimate a country-level prevalence and the volume and duration of our data collection contribute to the generalizability of our results. To the best of our knowledge, this is the largest HBV and HCV prevalence study in Sierra Leone.

Our hepatitis seroprevalence estimates are comparable with outcomes of similar studies conducted in Sierra Leone (Yambasu et al. 2018) and other Sub-Sharan West-African countries (Allain et al. 2010; Nagalo et al. 2012; Xie et al. 2015). HBV infection was the main reason potential blood donors were ineligible to donate and was associated with male sex and younger age. None of the occupational groups were at higher risk for viral hepatitis, including health care workers, among whom we observed a lower HBV prevalence of 7.8%. This is slightly lower but comparable to the reported HBV prevalence of 8.7% and 10% among healthcare workers in Freetown (Massaquoi et al. 2018; Qin et al. 2018).

HCV infection was only associated with location of the blood bank and was highest among donors in Kono and Makeni. The blood banks in these two districts are located on busy trade routes – and HCV transmission here is potentially linked to sex work (UNAIDS 2017).

Being a first-time donor was strongly associated with HBV and HCV infection. This is likely because following a positive test result, donors are advised that they cannot donate again. Similar findings were reported in Ghana and Burkina Faso, countries with comparable donation systems that showed equally high HBV prevalence among first time volunteer and replacements donors (Allain et al. 2010; Nagalo et al. 2012). In a country where viral hepatitis is endemic with a blood donation system that largely relies on first-time donors, this finding stresses a high

transmission risk and thus a need to for safe transfusions. Blood services in Sierra Leone largely depend on family replacement donations, which made up 52%-91% of donations in the districts. To increase safe donations, WHO recommends phasing out the 'family replacement' system and work with voluntary blood donations (World Health Organization 2012). It will require policy changes and support throughout the public health system to build a sustainable pool of voluntary donors. Voluntary blood donations in Sierra Leone now often rely on ad hoc community mobile drive and students donating blood in exchange for a meal and transport fee and our study shows that these first-time voluntary donors do not have lower risk for HBV infection.

Due to the high HBV prevalence in a setting of a weak health system, transfusion itself is a risk for viral hepatitis (Nagalo et al. 2012; World Health Organization 2017). An accurate and robust screening process is therefore crucial to ensure safe blood services. HBV and HCV screening is currently performed with rapid tests (RDTs) per minimum WHO standards (World Health Organization 2012). HCV antibody RDTs generally have high sensitivity and specificity (Khuroo et al. 2015; Tang et al. 2017), but the sensitivity of HBsAg RDT varies strongly among brands. A systematic review estimated a pooled 90% sensitivity and 99.5% specificity (Amini et al. 2017). Therefore, introduction of HBV tests with higher sensitivity, such as enzyme immune assays or molecular tests would contribute to reliable HBV diagnosis and safer transfusions.

Blood donations continued uninterrupted throughout the Ebola outbreak-for which the blood bank technicians should be commended. However, particularly in Makeni and Kono, we observed a reduction in screenings during the peak of the outbreak, suggesting reduced access to blood donations. Other districts were not deeply affected by the outbreak. In Pujehun with the lowest

number of confirmed Ebola cases, a referral system at the hospital was reinforced at the time, which caused an increase in admissions (Quaglio et al. 2019), and consequently an increasing trend in blood donor screening. An accurate analysis of the impact on blood services, however, would require pre and post epidemic numbers over a longer time period, which were not available. Moreover, decline in maternal (Brolin Ribacke et al. 2016) and child health services (Sun et al. 2017) caused by Ebola may also have impacted blood donations, of which women and children are the main recipients.

Our study has several limitations. First of all, all data were derived from handwritten registers in which certain information, including the number of times a person donated, may not be accurate or complete. Additionally, we only included entries with registered hepatitis test results; it is unclear if missing test results were due to data entry omissions or an interrupted supply of test kits. Secondly, blood banks used HBsAg and HCV tests from different manufacturers with variation in sensitivity and specificity, possibly resulting in heterogenous underestimation of infections. HBsAg and HCV tests were supplied by NSBS on central level or provided by non-governmental organizations. None of the blood banks documented test manufacturer information.

Overall, our findings indicate the presence of viral hepatitis infection throughout the country and provide some insight in predictors for infection. Our study stresses the need to develop policies to invest in safe blood services, as well as expanding access to vaccination, including HBV birth-dose vaccines (Spearman et al. 2017), and antiviral treatment.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval

All aspects of the study were approved by the Sierra Leone Ethics and Scientific Review Committee and Partners in Health Sierra Leone Research Committee.

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Table 1. Study period and demographic characteristics of blood donors.

		Bo Govt Hospital	Connaught Govt Hospital	Koidu Govt Hospital	Makeni Govt Hospital	Pujehun Govt Hospital	Total
Timeframe collected donor data	start date	06/01/2012	07/03/2013	6/13/2013	3/16/2014	10/17/2013	06/01/2012
	end date	8/26/2014	10/17/2016	3/13/2017	9/30/2016	5/31/2017	5/31/2017
Screening data (n)		**4189**	**5205**	**10015**	**7122**	**3182**	**29713**
Sex	Male	3772 (90.0)	4525 (86.9)	7224 (72.1)	4904 (68.9)	2311 (72.6)	22736 (76.5)
	Female	393 (9.4)	613 (11.8)	2781 (27.8)	2213 (31.1)	851 (26.8)	6851 (23.1)
	Missing	24 (0.6)	67 (1.3)	10 (0.1)	5 (0.1)	20 (0.6)	126 (0.4)
Age	<22	832 (19.9)	778 (14.9)	2551 (25.5)	1171 (16.4)	686 (21.6)	6018 (20.3)
	22-26	1327 (31.7)	1375 (26.4)	2330 (23.3)	2056 (28.9)	809 (25.4)	7897 (26.6)
	27-34	1126 (26.9)	1580 (30.4)	2565 (25.6)	1937 (27.2)	818 (25.7)	8026 (27.0)
	>34	842 (20.1)	1100 (21.1)	2569 (25.6)	1715 (24.1)	869 (27.3)	7095 (23.9)
	Missing	62 (1.5)	372 (7.1)	0	243 (3.4)	0	677 (2.3)
	median	26	27	27	27	28	27
	[min;max]	15;70	14;89	15;82	14;93	17;65	14;93
Occupation	Farming, fishing, mining	202 (4.8)	58 (1.1)	2449 (24.4)	1372 (19.3)	1229 (38.6)	5310 (17.9)
	Informal	842 (20.1)	1769 (34.0)	2365 (23.6)	2932 (41.2)	849 (26.7)	8757 (29.5)
	Formal - Medical	27 (0.6)	61 (1.2)	161 (1.6)	72 (1.0)	77 (2.4)	398 (1.3)
	Formal - Other	251 (6.0)	765 (14.7)	1798 (18.0)	564 (7.9)	247 (7.8)	3625 (12.2)
	Student	819 (19.6)	1249 (24.0)	2823 (28.2)	1493 (21.0)	698 (21.9)	7082 (23.8)
	Missing	2048 (48.9)	1303 (25.0)	419 (4.2)	689 (9.7)	82 (2.6)	4541 (15.3)
Type of Donation	Family Replacement	2197 (52.4)	4174 (80.2)	8889 (88.8)	6464 (90.8)	2120 (66.6)	23844 (80.2)
	Voluntary	78 (1.9)	555 (10.7)	1085 (10.8)	119 (1.7)	1025 (32.2)	2862 (9.6)
	Missing	1914 (45.7)	476 (9.1)	41 (0.4)	539 (7.6)	37 (1.2)	3007 (10.1)
Number of donations	>1 (repeat)	122 (2.9)	138 (2.7)	2349 (23.5)	60 (0.8)	301 (9.5)	2970 (10.0)
	1 (first-time)	2158 (51.5)	4609 (88.5)	7600 (75.9)	6531 (91.7)	2589 (81.4)	23487 (79.0)
	Missing	1909 (45.6)	458 (8.8)	66 (0.7)	531 (7.5)	292 (9.2)	3256 (11.0)
Donors deferred		805 (19.2)	432 (8.3)	1353 (13.5)	1610 (22.6)	302 (9.5)	4502 (15.2)

Table 2. HBV and HCV seroprevalence among blood donors

	Variable (N)	**HBV n (%)**	**HCV n (%)**	**HBV+HCV n (%)**
Site	Bo (4189**)**	597 (14.3)	39 (0.9)	4 (0.1)
	Connaught (Freetown; 5205**)**	359 (6.9)	19 (0.4)	6 (0.1)
	Kono (10015**)**	947 (9.5)	153 (1.5)	18 (0.2)
	Makeni (7122**)**	1070 (15.0)	137 (1.9)	15 (0.2)
	Pujehun (3182**)**	227 (7.1)	9 (0.3)	4 (0.1)
Sex	Male (22736)	2544 (11.2)	272 (1.2)	36 (0.2)
	Female (6851)	649 (9.5)	85 (1.2)	11 (0.2)
Age	<22 (6018)	684 (11.4)	64 (1.1)	10 (0.2)
	22-26 (7897)	926 (11.7)	83 (1.1)	9 (0.1)
	27-34 (8026)	857 (10.7)	106 (1.3)	13 (0.2)
	>34 (7095)	672 (9.5)	96 (1.4)	14 (0.2)
Occupation	Farming, fishing mining (5310)	564 (10.6)	93 (1.8)	14 (0.3)
	Informal (8757)	963 (11.0)	106 (1.2)	12 (0.1)
	Formal (4023)	358 (8.9)	45 (1.1)	5 (0.1)
	Student (7082)	758 (10.7)	61 (0.9)	10 (0.1)
Type of Donation	Family Replacement (23844)	2487 (10.4)	287 (1.2)	39 (0.2)
	Voluntary (2862)	185 (6.5)	21 (0.7)	3 (0.1)
Number of donations	First-time (23487)	2665 (11.3)	301 (1.3)	41 (0.2)
	Repeat (>1) (2970)	12 (0.004)	4 (0.001)	0 (0)
	TOTAL	**3200 (10.8)**	**357 (1.2)**	**47 (0.2)**

Table 3. Univariate and multivariate (adjusting for all variables) regression for positive HBV and HCV test. Estimates are reported as odds ratios with 95% confidence intervals (OR, 95% CI).

		HBV (univariate)		HBV (multivariate)		HCV (univariate)		HCV (multivariate)	
		OR (95%CI)	**p-value**	**OR (95%CI)**	**p-value**	**OR (95%CI)**	**p-value**	**OR (95%CI)**	**p-value**
Site	Bo	2.2 (1.8-2.5)	<.0001	1.9 (1.6-2.3)	<.0001	3.6 (1.7-7.4)	0.0005	3.1 (1.3-7.4)	0.01
	Connaught (Freetown)	1.0 (0.8-1.1)	0.68	0.7 (0.6-0.9)	0.0014	1.3 (0.6-2.9)	0.52	1.2 (0.5-3.1)	0.69
	Kono	1.3 (1.2-1.6)	<.0001	1.6 (1.4-1.9)	<.0001	5.5 (2.8-10.7)	<.0001	7.2 (3.5-14.8)	<.0001
	Makeni	2.3 (2.0-2.7)	<.0001	2.0 (1.7-2.3)	<.0001	6.9 (3.5-13.6)	<.0001	5.9 (2.8-12.2)	<.0001
	Pujehun	ref		ref		ref		ref	
Sex	Male	1.2 (1.1-1.3)	<.0001	1.4 (1.2-1.5)	<.0001	1.0 (0.8-1.2)	0.8	1.3 (1.0-1.7)	0.1
	Female	ref		ref		ref		ref	
Age-groups	<22	1.2 (1.1-1.4)	0.0004	1.3 (1.1-1.5)	0.0023	0.8 (0.5-1.0)	0.10	1.0 (0.6-1.5)	0.84
	22-27	1.3 (1.1-1.4)	<.0001	1.3 (1.1-1.4)	0.0004	0.8 (0.6-1.0)	0.079	0.8 (0.6-1.2)	0.29
	27-34	1.1 (1.0-1.3)	0.015	1.2 (1.0-1.3)	0.012	0.9 (0.7-1.3)	0.75	1.0 (0.7-1.4)	0.87
	>34	ref		ref		ref		ref	
Occupation	Farming, fishing mining	1.2 (1.0-1.4)	0.0058	1.0 (0.8-1.1)	0.65	1.6 (1.1-2.2)	0.013	1.2 (0.9-1.8)	0.24
	Informal	1.3 (1.1-1.4)	0.0003	1.0 (0.9-1.2)	0.92	1.1 (0.8-1.5)	0.65	1.0 (0.7-1.5)	0.95
	Formal	ref		ref		ref		ref	
	Student	1.2 (1.1-1.4)	0.0024	1.0 (0.8-1.1)	0.57	0.8 (0.5-1.1)	0.18	0.7 (0.5-1.1)	0.18
Type of Donation	Family Replacement	1.7 (1.4-2.0)	<.0001	0.8 (0.7-1.0)	0.063	1.6 (1.0-2.7)	0.028	0.7 (0.4-1.1)	0.12
	Voluntary	ref		ref		ref		ref	
Number of donations	First-time	31.5 (17.9-55.7)	<.0001	38.4 (20.5-71.8)	<.0001	9.6 (3.6-25.8)	<.0001	13.3 (4.9-36.3)	<.0001
	>1 (repeat)	ref				ref		ref	

Figure legends

Fig 1A. Map of Sierra Leone, indicating the locations of the five blood banks included in our study: Freetown (Connaught), Makeni, Bo, Koidu and Pujehun. **B**. Characteristics of the study setting

Fig 2. Absolute number of blood donors screened per district blood bank between July 2013 and May 2017. Bars indicate the total number of screenings performed per month across the five blood banks. Black lines above the graph show the time of the Ebola outbreak.

Fig 3. HBV (a) and HCV (b) seroprevalence over time across the five district blood banks. The gray bars indicate the overall percentage of all screened donations per month.

Figure 1

A

B

Blood bank	District	Region	Population (n)[a]	Population living in urban area (%)[a]	Estimated EVD cases (n)[b]
Bo Govt hospital	Bo	Southern	575,478	18.9	101-500
Connaught Govt hospital (Freetown)	Western-Urban	Western	1,055,964	100	501-4000
Koidu Govt hospital	Kono	Eastern	506,100	24.6	101-500
Makeni Govt hospital	Bombali	Northern	606,544	28.5	501-4000
Pujehun Govt hospital	Pujehun	Southern	346,461	8.1	21-100
Sierra Leone			7,092,113	41	14,124

EVD = Ebola virus disease
[a] 2015 Population and Housing Census (Statistics Sierra Leone 2016)
[b] Centers for Disease Control and Prevention (Centers for Disease Control and Prevention (CDC) 2017)

Figure 2

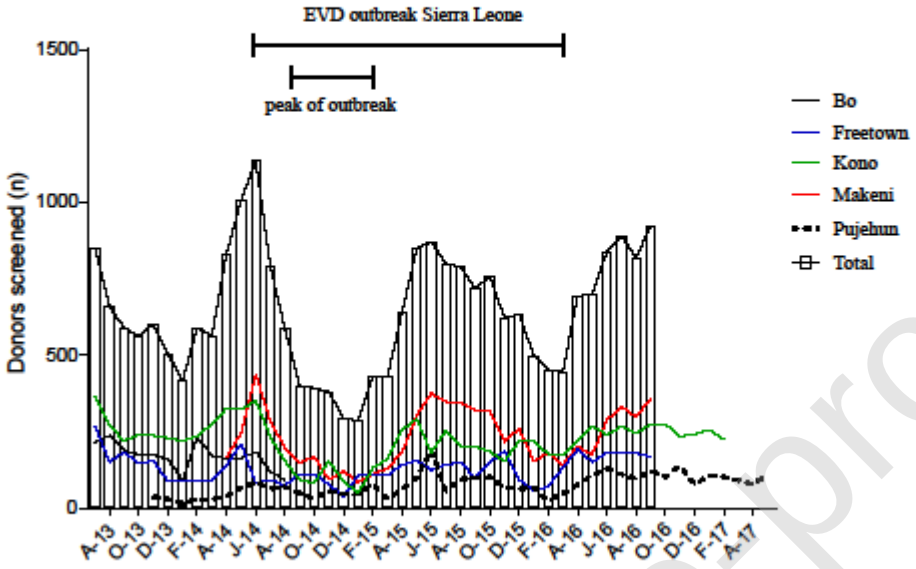

Figure 3