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Trends in hepatitis B and hepatitis C seroprevalence among blood donors – Haiti, 2005–2014

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Abstract

Background and Objectives—Data on the seroprevalence of viral hepatitis are limited in Haiti; consequently, the epidemiology is poorly described. This study aims to provide a descriptive analysis of hepatitis B virus (HBV) and hepatitis C virus (HCV) seroprevalence of blood donations in Haiti.

Materials and Methods—Using Haiti's National Blood Safety Program and Haitian Red Cross reports from 2005 to 2014, we analysed the results of screening tests of donor serum samples to assess HBV and HCV seroprevalence among adults aged 17 to 65 years.

Results—A total of 198 758 donor samples were screened from 2005 to 2014, of which 0·56% were positive for antibody to hepatitis C virus (anti-HCV) and 3·80% were positive for hepatitis B surface antigen. Over the 10-year study period, anti-HCV seroprevalence among blood donors increased by 31% from 0.66% to 0.86% (95% CI: 1·01–1·70); however, this trend was not uniform over time, with a significant decrease from 0·66% in 2005 to 0·39% in 2009 (95% CI: 0·43– 0·82) and 0·43% in 2012 (95% CI: 0·50–0·90). Conversely, HBV decreased significantly by 13% from 3·95% in 2005 to 3·42% in 2014 (95% CI: 0·77–0·97), a trend that was also observed in 2012 and 2013.

Conclusion—The significant, uniform decrease in HBV seroprevalence in more recent years may represent the positive impact of public health interventions in preventing the transmission of blood-borne infections. More research is needed to understand why the trends in HCV transmission are non-uniform and to investigate the significant increase in more recent years.

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Authors contribution

AEJB and WRA conceived of the study idea. AEJB, WRA, EH and MC contributed to study design, literature search, data analysis and interpretation, preparation of figures and tables and writing. AEJB, EN and EP contributed to data collection.

Conflict of interests

The authors declare no conflict of interests.

Keywords

donors; epidemiology; Haiti; transfusion–transmissible infections

Introduction

Transfusion-transmissible infections (TTI), including human immunodeficiency virus (HIV-1 and HIV-2), hepatitis B virus (HBV), and hepatitis C virus (HCV), occur when a bacterium, parasite, virus, or other potential pathogens are transmitted to the transfusion recipient through donated blood products [1]. Transmission of HIV, HBV, and HCV through blood transfusion may approach 100%, consequently, this mode poses the greatest risk to the recipient as compared to other more common routes of exposure such as sexual contact (0·1–10%) and mother-child transmission (11–32%) [2]. In addition, the financial burden of collecting blood products found to be infected with a TTI to national blood services is also substantial. In 2005, it was estimated that around 240 000 units of blood with evidence of infectious disease markers (i.e. HIV, hepatitis B and C viruses and syphilis) were discarded in Latin America and the Caribbean, which represented a total loss of $13 4 million USD to the region [2].

Since 2004, Haiti's National Blood Safety Program (NBSP) has received technical and financial support from the U.S. Centers for Disease Control and Prevention (CDC) under the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) to increase the safety and adequacy of blood collections. Under this collaboration, NBSP and its main partner, the Haitian Red Cross (HRC), routinely perform screening tests for HIV-1/HIV-2, HBV, HCV, syphilis, and human T-lymphotropic viruses (HTLV-1, and HTLV-2) on blood donations to prevent transfusion-transmission.

Data on the seroprevalence of HBV and HCV virus in the general population of Haiti are very limited, and, where available, quite dated. A survey by Allain *et al.* found a low prevalence (0·40–1·50%) of HCV antibodies among a sample of three categories of patients seeking care – 500 pregnant women, 228 consecutive surgical patients and 1727 patients presenting with symptoms suggesting HIV disease in rural Haiti [3]. Alternatively, a 2015 systematic review and meta-analysis that utilised Hepatitis B surface antigen (HBsAg) as a serological marker for chronic HBV infection found that the pooled prevalence – the prevalence aggregated from multiple studies using statistical techniques- of HBV in Haiti ranged between 9·00 and 19·89% for the two papers included in the systematic review with dates between 1989 and 1992. This pooled seroprevalence was considerably higher than the global prevalence rate of HBV at 3·61% and the highest documented prevalence of HBV in the Caribbean regions and the Americas [4]. A high prevalence of TTIs, such as HBV and HCV, among the general population may impact the blood donors' base (i.e. potential blood donors and blood donors' population) and increase blood units wasted due to TTI reactivity.

Because of the significant clinical impact of HBV and HCV in patients, understanding the epidemiologic characteristics of these viruses in blood donors would provide the NBSP and Haiti's Ministry of Health (MSPP) with important trend information on both viruses and would help to assess the need for interventions (e.g. nosocomial risk prevention, health

education among population, vaccination). The objective of this evaluation is to assess and descriptively analyse NBSP and HRC data on the seroprevalence of HBV and HCV among blood donors over a period of 10-years (2005–2014), as a means of determining geographic differences and trends in viral transmission and prevalence, and guiding subsequent research.

Materials and Methods

Blood Donor Serum Sample

The number of active blood collection and distribution sites ranged from four in 2005 to 35 in 2014 (15 blood transfusion posts, 20 blood depots). A careful look at Fig. 1 shows the geographic distribution of different blood centres all over the country and reveals that there are some areas with more condensed facilities, mainly around Port-au-Prince, and others with less dense distribution of facilities, which is reflective of population density. The 10 administrative departments were aggregated into four regional groupings based on the number of collection and distribution sites and were assigned as follows: northern (Nord-Ouest, Nord, and Nord-Est departments), central (Artibonite and Centre departments), Port-au-Prince (Ouest and Nippes departments) and southern (Grand'Anse, Sud, and Sud-Est departments).

The National Blood Transfusion Center (NBTC) is responsible for screening blood donations from all regions of the country. Once collected, the blood samples were regularly delivered from the blood collection sites or blood posts to NBTC either by plane or ground transportation in order to maintain a safe and adequate national blood supply. All donor (volunteer and replacement donors) serum samples were screened according to minimal international standards (i.e. initial screening test, repeat reactive tests, confirmatory testing) [5] at the NBTC in Port-au-Prince for HBV and HCV during the study period. HBsAg is used as a serological marker for acute and chronic HBV infection and was screened using a semi-automated enzyme-linked-immunosorbent serologic assay technique (ELISA – *Tecan Sunrise*) with reported sensitivity and specificity of 100% each [5]. HCV was screened using the same method from 2005 to 2014. For quality control, 100% of positive samples and 20% of negative samples were sent to a reference laboratory in Haiti in order to get a more precise diagnosis and reduce risk associated with blood transfusion. Murex EIA (Enzyme Immunoassay) is the assay used for screening. In 2014, implementation of an automated chemiluminescent micro particle immunoassay (*Architect* PLCs) offered the opportunity to go on by confirming all specimens with a positive marker. Discordant cases were reconciled and were generally found to be related to transcription errors of assay data (e.g. data entry errors) or improper sample handling. All HBV – and/or HCV – reactive blood donors were permanently excluded from the national blood supply.

Data Source

Data for this study were reported to the NBSP via surveillance records from the Haitian Red Cross. These data represent all blood units (blood donations) screened from blood donors aged 17 to 65 between 1 January 2005 and 31 December 2014. Data were provided as aggregate counts of donations screening positive for HBV and HCV between 2010 and 2014

and total blood donations; for 2005–2009, the only available data were annual HBV and HCV seroprevalence percentages; we, therefore, estimated the annual donations based on the seroprevalence of HBV and HCV and the total blood donations.

Statistical analyses

Data were analysed using Cox proportional hazards models using SAS software version 9·3 (SAS Institute Inc., Cary, NC, USA). Overall seroprevalence of HBsAg and HCV from 2005 to 2014 were computed as total number of blood donations positive for HBsAg and HCV, respectively, divided by the total number blood donations (blood donation serum samples assessed) during the same period; individual-level data were not available and did not allow for controlling for repeat donors. Annual seroprevalence of HBsAg and HCV were also calculated for each year between 2010 and 2014 and were stratified by administrative department and region. Changes in annual seroprevalence of HBsAg and HCV from 2005 to 2014, using 2005 as a reference group, were assessed via prevalence ratios (PR), calculated via Cox proportional hazards models with equal time to follow-up (time=1) for all observations. Since data were provided as aggregate counts, line list data were simulated in SAS in order to obtain prevalence ratios and corresponding confidence intervals. Cox proportional hazards models were chosen based on previous literature suggesting alternatives to logistic regression in order to ease interpretation of results via prevalence ratios versus convoluted odds ratios and to address overestimation of odds ratios in less-rare outcomes. Both logistic regression models and generalised additive Poisson regression models were considered for analysis and all provided concurrent estimates when compared to those obtained via Cox proportional hazards modelling [6, 8]. Region-specific changes were assessed using Cox proportional hazards models between the years of 2010 and 2014; donation information by region was not available prior to 2010.

This activity was reviewed in accordance with CDC human subjects review procedures and was determined by CGH Office of the Associate Director for Science as non-research.

Results

A total of 198 758 blood donations were screened at the NBTC during the 10-year study period, of which 3·80% were positive for HBV and 0·56% for HCV. The number of units of blood collected increased from 10 823 units in 2005 to 28 867 units in 2014. HBV infections accounted for approximately one-third to one-half (range: 37–46%) of all TTI infections annually over the study period and remained more prevalent than HCV (Fig. 2).

Cox proportional hazards models demonstrated a significant 31% increase in seroprevalence of HCV between 2005 and 2014 (95% CI: 1·01–1·70) and similarly, a 57% increase between 2005 and 2013 (95% CI: 1·21–2·04). However, this trend was not uniform over time: there was a significant 40% decrease in seroprevalence of HCV between 2005 and 2009 (95% CI: 0·43–0·82) and similarly a 33% decrease in seroprevalence between 2005 and 2012 (95% CI: 0·50–0·90) (Table 1). In contrast, there was a significant decrease in HBV seroprevalence between 2005 and 2014 (PR: 0·87, 95% CI: 0·77–0·97). This trend was more uniform than that seen for HCV: there was also a significant decrease in HBV between 2005 and 2013

(PR: 0·89, 95% CI: 0·80–1·00*) and between 2005 and 2012 (PR: 0·89, 95% CI: 0·79–0·99), suggesting a consistently downward trend in more current years.

Figure 3 shows the geographic distribution of HBV and HCV median seroprevalence rates over the 10 years by administrative departments (n = 10). Regional data presented in Table 2 demonstrate that the seroprevalence of HBV remained variable across the regions and the years, most notably in the southern region where HBV seroprevalence ranged from 2·58% in 2010 to 5·07% in 2011, a nearly twofold increase in seroprevalence (PR: 1·97, 95% CI: 1·50–2·59). HBV seroprevalence was more consistent across the Port-au-Prince region (range: 2·92– 3·49%) with no significant differences from 2010, the reference year. In the central region and northern region, HBV seroprevalence was generally more consistent, though both years experienced significant decreases in seroprevalence from 2010: there was a significant 21% decrease in seroprevalence in 2011 in the northern region (2011 PR 0·79; 95% CI: 0·64–0·99) and a significant 28% decrease in seroprevalence in 2012 in the central region (2012 PR: 0·72; 95% CI: 0·59–0·89). HCV seroprevalence, although much lower than HBV seroprevalence, was similarly variable, with seroprevalence in the Port-au-Prince region being the most variable (range: 0·45% to 1·18%). Cox proportional hazards models demonstrated significant increases in HCV among blood donors between 2010 and 2013 for the Port-au-Prince, northern and central regions (PRs: 2·27, 1·77, and 1·82, respectively) and between 2010 and 2014 for the Port-au-Prince region and the northern region (PRs: 1·75 and 1·69, respectively). There was no statistically significant difference in HCV observed in the southern region when using 2010 as a reference.

Discussion

This assessment provides descriptive epidemiology of HBV and HCV seroprevalence among blood donors in Haiti from 2005 to 2014. The analysis included the 2010 earthquake period that had an immediate and severe impact on Haiti's health system. Both HBV and HCV seroprevalence decreased significantly since the years following the earthquake; however, for HCV this downward trend was contrasted with a significant increase in seroprevalence starting in 2013. Although these trends were generally observed in the four regions, there were variations in seroprevalence across all four regions over the five-year period, suggesting that seroprevalence of TTIs may vary.

According to the HRC, the seroprevalence of HBV among blood donors prior to PEPFAR/CDC support and implementation of the NBSP was 4·36% in 2003 and 4·12% in 2004; similarly, HCV seroprevalence was 0·42% in 2003 and 0·62% in 2004. At the implementation of the NBSP in 2005, among blood donors, HBsAg seroprevalence was 3·95% and HCV seroprevalence was 0·66%. Based on a 2014 seroprevalence of HBV of 3·42%, Haiti is considered a country with an intermediate endemicity according to WHO classification of Hepatitis B virus endemicity [9]. A similar conclusion was drawn in a recent HBV serosurvey conducted among pregnant women in Haiti which reported a 2·5% seroprevalence [10].

Routes of transmission for HBV and HCV, similar to those for HIV, are either vertical (from infected pregnant mother to her baby), sexual, or parenteral [11]. Further-more, several

studies have assessed donor compliance with relevant risk factors [12, 13]. Although the seroprevalence of HBV among blood donors continued to be the highest among all TTIs, HBV seroprevalence experienced a significant 13 4% decrease over the 10-year study period. Although not measured in this study, one possible explanation for the decrease in HBV seroprevalence may be the positive impact of public health interventions in preventing the transmission of blood-borne infections in Haiti. Specifically, in the period covered by this study, multiple programmes and interventions focusing on improving knowledge of HIV risk factors, safe sexual practices and access to condoms were conducted in order to reduce HIV/ AIDS seroprevalence in Haiti [14–16].

Despite Haiti's low endemicity for chronic HCV, this study demonstrates that the seroprevalence of HCV infection has increased significantly among blood donors in the past ten years. Studies have shown that injection drug use is the most common risk factor for acute hepatitis C [11]. Consequently, several countries require persons who report risky behaviours related to injection drug use to defer from blood donation. Persons who have had a tattoo or body piercing within the past 6 months are also deferred from blood donation. Although Haiti has such regulations, if the blood donor does not disclose such risky behaviours, there is no way to confirm when or if the tattoo or body piercing occurred. Furthermore, donors may not necessarily report risky behaviours related to injection drug use.

This significant increase in HCV seroprevalence may also indicate possible health care-associated infections or unsafe injection practices. Historically, medical care has played an important role in the transmission of HCV infection in addition to the transfusion of blood and blood products, which remained the most likely route of health care-associated transmission globally [17]. It is also known that HCV transmission per exposure to a contaminated syringe is 5- to 20-fold higher than HIV transmission, and that hepatitis C Virus in the presence of serum can survive for 5-days at room temperature, and detected up to 63-days in syringes [8]. The CDC recently investigated a case of acute HCV infection in a repeat blood donor in California, USA that had no traditional risk factors for HCV; the investigation revealed that the donor had likely been exposed to HCV through an injection received at a clinic in which syringes were being re-used. Four other persons who underwent procedures at the clinic on the same day were also subsequently identified to have HCV infection. Multiple other health care-associated outbreaks of HCV infection resulting from unsafe injection practices have been documented by CDC during 2008–2015 [18]. On the other hand, the largest increase in HCV observed in this study, a 127% increase from 0·52% to 1·18%, was in the Port-au-Prince region between 2010 and 2013, in the years following Haiti's devastating 2010 earthquake. This earthquake resulted in more than 220 000 deaths, over 300 000 injured and left well over a million displaced making it one of the deadliest natural disasters on record [12]. In the aftermath of a natural disaster, persons who were involved in close contact with the dead may have been exposed to chronic infectious hazards and blood-borne viruses, including HIV, HBC and HCV [19]. While it is possible that such cases occurred, disruptions in health care delivery in 2010 and increase in blood donations (and/or first-time donors) might also account for the significant increase in the overall prevalence rates for HCV among all donations collected after the earthquake.

This study is subject to some limitations. First, there were some data missing at the initial stage of the implementation of NBSP, in 2005, and data were unable to be broken down by region. CDC supported Haiti's Ministry of Health for strengthening the NBSP data collection and management system to allow more efficient tracking and reporting of data on the blood donor population. Secondly, all data were provided as aggregate case counts (or overall prevalence for 2005–2009) and thus there was no way to determine whether the donations were all from individual donors or whether a single donor provided multiple units in the same calendar year. This has the potential to bias the results, particularly towards lower seroprevalences if healthy donors are more likely donate frequently, as has been observed in previous research where incidence of TTIs was three times higher among first-time donors than among repeat donors and was lower among repeat donors than among the general population of donors [7]. Similarly, the aggregated data did not include information on the demographic (e.g. race/ ethnicity, gender, and age) of the blood donors. Fourth, a number of blood bags from international donors, prescreened for HBV, HCV and other markers, were received by the HRC during the first months (January – March) of 2010 in response to the earthquake, and therefore some of the donations, and resulting seroprevalence, may be influenced by these external donations. Fifth, the aggregate nature of the data does not allow for tracking over time, and thus there is an inability to assess cause of the observed trends. Our final limitation is that results cannot be generalised to the general Haitian population as our sample was limited to blood donors between the ages of 17 and 65 years, a population whose disease seroprevalence profile differs from that of the general population.

Viral hepatitis (VH) exists throughout the world and is a major global health problem affecting 400 million people worldwide (over ten times the number of people affected with HIV). The World Health Organization (WHO) has called for the global elimination of VH by 2030; essentially underlining the necessity for the provision of safe blood to protect against the transmission of hepatitis B and C [20]. While a related analysis has already been implemented in 38 sub-Saharan Africa countries [21], this is the first study to evaluate the seroprevalence of HBV an HCV among Haitian blood donors over a ten-year period.

Despite the fact that the blood donor population is not a representative sample of the Haitian population, in order to assess the magnitude of this disease (not only in the blood donor population but also in the general population), the findings of this investigation offer additional information on the burden of HBV and HCV infection in the country. Additional epidemiological information on the seroprevalence of VH infection in Haiti is needed to assess the cause of the trends observed during this study in order to develop targeted interventions to prevent and control VH infection.

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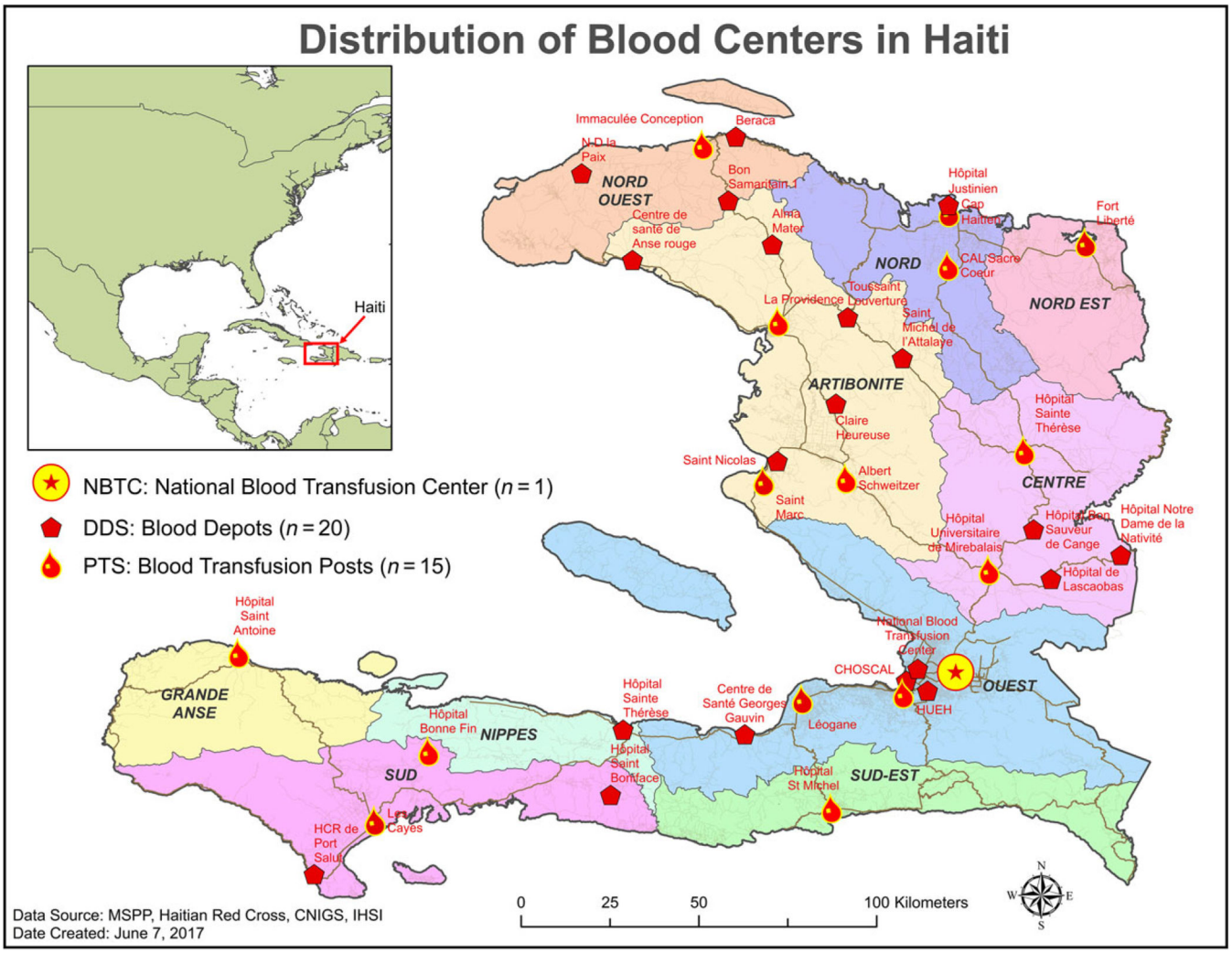

Fig. 1.

Haiti's National Blood Service Network per type, 2014. Haiti's blood network consists of three levels of facilities. The Blood Transfusion Posts – PTS are intermediate structures, extra or intra-hospital structure, performing blood collections. They prepare, store and distribute blood bags that are qualified by the National Blood Transfusion Centre – NBTC. The Blood Depots-DDS are hosted by hospital laboratories and are responsible for the storage and distribution of blood. The country has a wide distribution of blood centres and is based on the actual needs for blood, logistics and infrastructure.

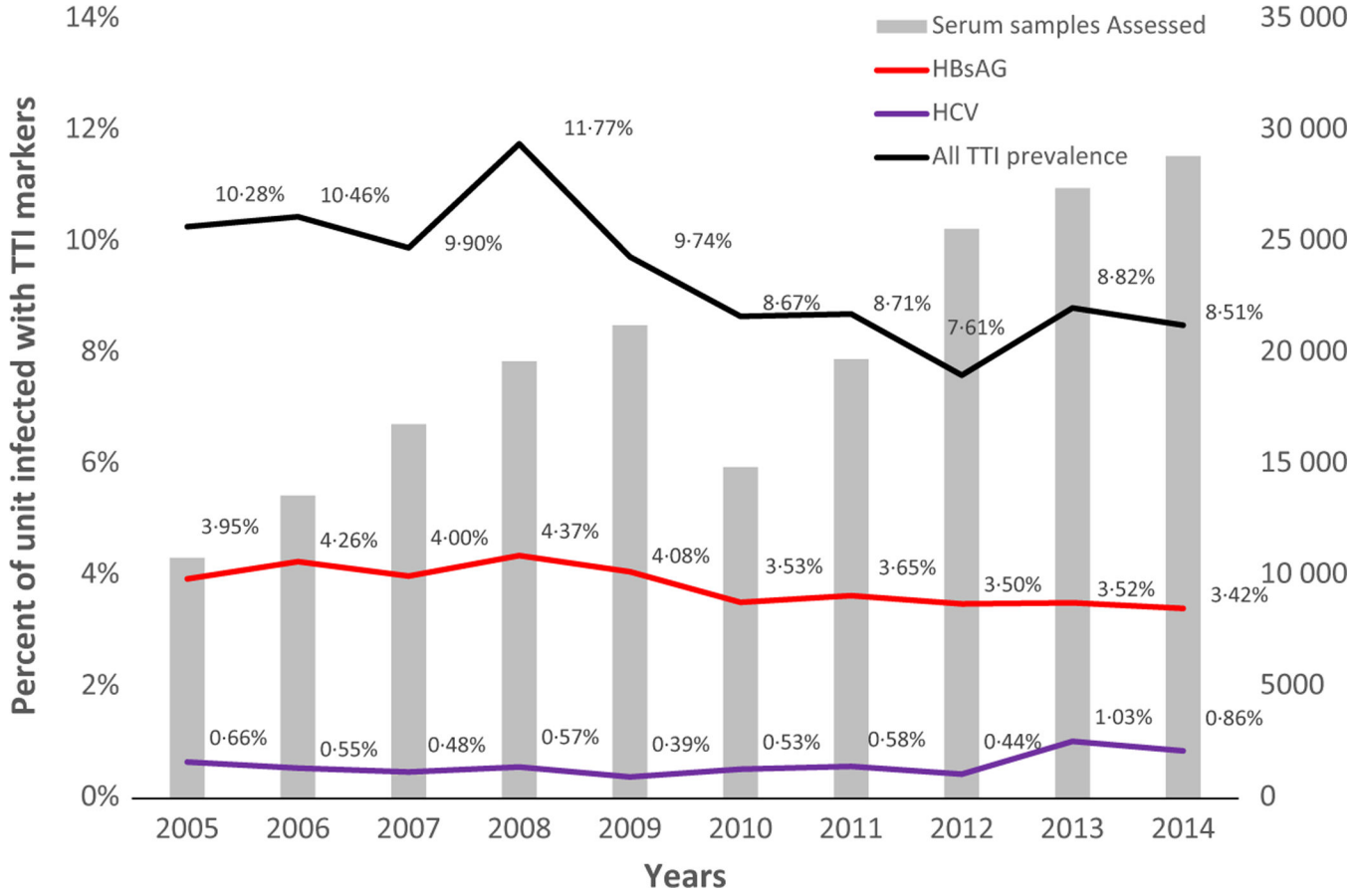

Fig. 2.

Transfusion-transmissible infection seroprevalence rate over time – Haiti, 2005–2014. Seroprevalence trends are represented for HBsAg, HCV and for the total transfusion-transmissible infection (TTI). The seroprevalence of each TTI was calculated as the total number of marker-reactive donations for a period divided by the total number of blood units collected in the same period. HBsAg, Hepatitis B surface antigen; HCV, Hepatitis C virus; TTI, Transfusion-transmitted infection including HCV, HBsAg, HIV, Syphilis, and HTLV.

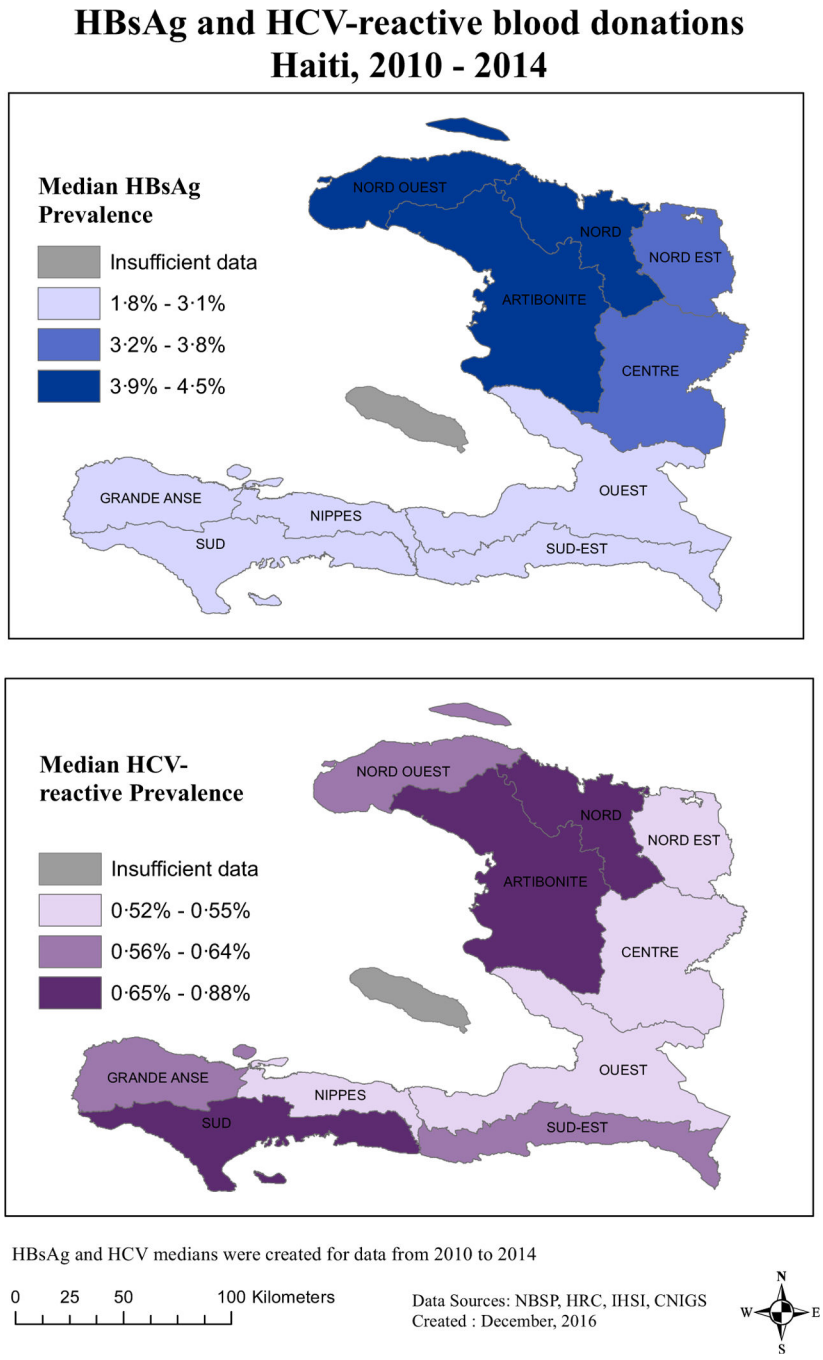

Fig. 3.

Geographic distribution of median reported seroprevalence of HBsAg and HCV-reactive on blood donations – Haiti, between 2010 and 2014. Administrative department and region seroprevalence of HBsAg and HCV from 2010 to 2014 were computed as total number of blood donations positive for HBsAg and HCV for each region, respectively, divided by the total number blood donations for the region. The highest median reported seroprevalence of HBsAg from 2010 to 2014 was in the North regions (North and North-West department), followed by the Artibonite region. The North and Artibonite regions had also the greater

seroprevalence of HCV from 2010 to 2014 study period. HCV, Hepatitis C virus; HBsAg, Hepatitis B surface antigen.

Table 1

HBV and HCV seroprevalence among blood donors using Cox proportional hazards modelling – Haiti, 2005 through 2014

	HBsAg		HCV	
Year	**PR**	**95% CI**	**PR**	**95% CI**
2005	-	-	-	-
2006	1·08	0·95–1·22	0·84	0·61–1·16
2007	1·01	0·90–1·14	0·73	0·53–1·01
2008	1·11	0·99–1·24	0·87	0·65–1·17
2009	1·03	0·92–1·16	0·60	0·43–0·82
2010	0·89	0·79–1·01	0·81	0·59–1·11
2011	0·92	0·82–1·04	0·89	0·66–1·19
2012	0·89	0·79–0·99	0·67	0·50–0·90
2013	0·89	0·80–1·00 *	1·57	1·21–2·04
2014	0·87	0·77–0·97	1·31	1·01–1·70

HBsAg, hepatitis B surface antigen; HCV, hepatitis C virus; PR, prevalence ratio; 95% CI, 95% confidence interval.

Bold values indicate statistical significance at the 0·05 level.

Sources: National Blood Safety Program; Haitian Red Cross.

* Indicates a value below 1·00 but rounded to two decimal places.

Table 2

Annual and regional seroprevalence of HBsAg and HCV among blood donors – Haiti, 2010–2014

	Port-au-Prince		Northern		Central		Southern	
Year	**SP**	**PR (95% CI)**	**SP**	**PR (95% CI)**	**SP**	**PR (95% CI)**	**SP**	**PR (95% CI)**
HBsAg								
2010	3·05%	-	4·01%	-	4·27%	-	2·58%	-
2011	3·05%	1·00 (0·81–1·23)	3·18%	**0·79 (0·64–0·99)**	4·31%	1·01(0·81–1·25)	5·07%	**1·97 (1·50–2·59)**
2012	3·49%	1·14 (0·94–1·39)	4·50%	1·12 (0·93–1·36)	3·09%	**0·72 (0·59–0·89)**	2·69%	1·05 (0·77–1·41)
2013	3·00%	0·96 (0·78–1·17)	4·20%	1·17 (0·97–1·41)	4·16%	1·07 (0·88–1·30)	2·88%	0·81 (0·60–1·10)
2014	3·00%	0·86 (0·71–1·05)	4·20%	1·07 (0·88–1·30)	4·16%	1·10 (0·91–1·32)	2·88%	1·05 (0·78–1·41)
HCV								
2010	0·52%	-	0·57%	-	0·46%	–	0·56%	-
2011	0·52%	0·99 (0·59–1·66)	0·52%	0·90 (0·51–1·60)	0·62%	1·34 (0·72–2·49)	0·80%	1·42 (0·76–2·66)
2012	0·45%	0·86 (0·51–1·42)	0·44%	0·74 (0·42–1·29)	0·50%	1·05 (0·58–1·90)	0·31%	0·54 (0·25–1·16)
2013	1·18%	**2·27 (1·45–3·45)**	1·01%	**1·77 (1·11–2·83)**	0·84%	**1·82 (1·05–3·17)**	0·88%	1·55 (0·87–2·78)
2014	0·91%	**1·75 (1·11–2·76)**	0·97%	**1·69 (1·04–2·73)**	0·71%	1·53 (0·88–2·67)	0·76%	1·34 (0·73–2·47)

HBsAg, hepatitis B surface antigen; HCV, hepatitis C virus; PR, prevalence ratio; 95% CI, 95% confidence interval; SP, seroprevalence.

Sources: National Blood Safety Program; Haitian Red Cross.

Bold values indicate statistical significance at alpha= 0·05 level.