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A case-control study of risk factors for incident hepatitis B virus infection in South African blood donors

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Abstract

Objectives: Hepatitis B virus (HBV) infection remains a global health problem. Risk factors for HBV infection are usually assessed in prevalent rather than incident infections. To identify demographic and behavioral risks associated with incident HBV among South African blood donors.

Methods: A case-control study was performed between November 2014 and January 2018. Cases were blood donors testing positive for HBV DNA with or without hepatitis B surface antigen but negative for antibody to hepatitis B core antigen. Participants completed an audio computer-assisted structured interview on exposures during the previous 6 months. Sex-specific multivariable logistic regression yielded independent associations between risks and HBV infection.

Results: 56 females and 37 males with incident HBV were compared to 438 female and 439 male controls, respectively. For females, risk factors were accepting money or goods for sex, using agents to prepare one's anus prior to anal sex, penetrating injury, non-Black race, and lower educational status. Men reporting homosexual or bisexual orientation or sex with other men, previous injury, referral for HBV testing, or lack of medical insurance were at increased risk. For both sexes, having more than two male sexual partners increased risk.

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Declaration of competing interest

The authors have no competing interests to declare.

Research ethics

Ethical committee review approval was provided by the South African National Blood Service (SANBS: approval 2013/013) institutional review board (IRB), the University of California San Francisco Committee on Human Research (approval 14-13943), and from the Research Triangle International (RTI) IRB. The study was also overseen by an Observational Study Monitoring Board constituted by the US National Heart, Lung, and Blood Institute, National Institutes of Health.

Conclusions: Sexual behaviors predominated over parenteral exposures as risks for incident HBV in both female and male blood donors.

Keywords

Hepatitis B virus; Transfusion; Blood donors; Risk factors

Introduction

Hepatitis B virus (HBV) infection remains a serious health problem globally, with 3.5% (296 million) of the adult population estimated to have chronic infection. Of 1.5 million new infections in 2019, most have been acquired in Africa [1]. Furthermore, HBV continues to be endemic in Africa and the Western Pacific countries, which carry the highest global burden with a hepatitis B surface antigen (HBsAg) prevalence of 6% each [2–4].

Worldwide, the Expanded Programme on Immunization (EPI) for HBV has been the single most important strategy, leading to a significant reduction of incident HBV infections in children under 5 years of age to less than 1% in 2019. Thereby, the global goal of the “Sustainable Development Goals” has been reached, but major gaps remain in the same regions that carry the highest burden of HBV [1]. In addition, HIV and HBV co-infections account for 2.7 millions of all global cases, highlighting that efforts directed against both epidemics remain essential [2].

Prevalent infection is the proportion of the population with mostly chronic HBV, while incidence counts persons with recently acquired HBV in a defined unit of time. Within the South African blood donor population, the prevalence of HBV among first-time blood donors decreased from 0.84–0.66% between 2011 and 2019, and there was a significantly lower HBV prevalence in the post- vs pre-HBV EPI birth cohorts (0.14% vs 1.29%) [5]. Similarly, HBV incidence in first-time donors has also decreased from 3.35 to 1.80 (1.33–2.45) per 1000 person-years for the same time periods [5]. Blood donor prevalence and incidence are significantly lower than reported for other populations in South Africa, most likely due to donor selection criteria and the healthy donor effect [6,7].

Factors associated with the prevalence and incidence of HBV infection may not be the same because of differences in the types of behavioral exposures during childhood and adulthood and changes in individual behaviors over time. Previously reported risk factors for prevalent HBV infections in the blood donor setting in Africa include being male, rural residence, younger age, lower education status, ethnic tattooing, being a first-time or family replacement donor as well as co-infection with HIV and hepatitis C virus (HCV) [8–14]. Reliable data on risk factors for incident HBV infections in both male and female adults are sparse but may provide better measures of contemporary behavioral risks in adults.

Current laboratory screening of blood donations in South Africa can differentiate between prevalent and incident HBV infections, allowing the study of demographic and behavioral risk factors associated with incident infection. We hypothesized that greater number of recent sexual partners, recent scarification/tattoo/body markings, and a history of personal

contact with an HBV-infected person would be associated with incident HBV infection in both sexes.

Methods

Setting

The South African National Blood Service (SANBS) collects over 900,000 units of whole blood each year from a pool of approximately 350,000 donors. These donations are collected in eight of the nine provinces of the country, covering both urban and rural settings. Several strategies have been successfully implemented by SANBS to reduce the risk of transfusion-transmitted infections caused by HIV, HBV, HCV, and syphilis. SANBS performs health and infectious risk factor screening of all prospective donors by questionnaire and face-to-face interview, including questions on sexual behaviors and parenteral exposures linked to viral infection. In those deemed eligible for donation, a sample from each donation is tested for these viral infections by serology and individual donation (ID) nucleic acid testing (NAT) performed in parallel (Syphilis testing is by serology only).

Study design and population

We conducted a case-control study of incident HBV (cases) compared to infectious marker negative (controls) South African blood donors between November 2014 and January 2018. Study participants were identified from SANBS blood collection sites except for those in the Free State and Northern Cape area, where it was not possible to conduct study procedures for logistical reasons.

Cases were allogeneic whole blood donors who tested positive for incident HBV infection during the study period. Incident HBV-positive donors were defined as those who were HBV-NAT positive, HBsAg positive or negative, and total antibody to hepatitis B core antigen (anti-HBc) negative. Our definition requiring negative anti-HBc total (without testing for anti-HBc immunoglobulin M) was a more stringent approach to ensure that we identified and included cases who had been infected in the previous 6 months. Co-infection with HIV and/or HCV, whether incident or prevalent, was not an exclusion criterion. Controls were allogeneic blood donors negative for HIV, HBV, HCV, and syphilis, who were matched to HIV cases as part of a parallel study of risk factors for incident HIV infection cases (results of a parallel case-control study of incident HIV infection will be reported in a separate manuscript). For the risk factors in incident HIV infection, controls were frequency matched at a 3:1 ratio to incident HIV cases by race, age, and geographic location using information in the blood center database and then recruited either by recall or on the same day of their index blood donation to participate as a comparison group. The same controls were used for the analysis of risk factors for incident HBV. All controls were included, leading to a ratio of ~9:1 controls per HBV case given lower rates of incident HBV infection in the study population.

Research nurses coordinated participant recruitment, information sharing about the study, consent, and enrollment. HBV cases were identified from their screening test results associated with their donation. Additional confirmation of HBV infection was conducted

on a follow up sample post donation, when available. Potential cases were recalled and counseled about their donation results and then invited to participate. Controls were enrolled immediately after donation if all their markers were negative. All participants had to be able and willing to provide informed consent and complete the audio computer-assisted structured interview (ACASI) in English.

Donors were ineligible if they provided autologous or directed blood donations; if they were deferred from donation for health or infectious risk factors, were less than age 18, otherwise unable to provide informed consent, or had insufficient volume of blood collected to complete their screening tests.

Risk questionnaire

Eligible cases and controls completed a confidential ACASI on motivations for blood donation and behavioral factors. This risk factor interview was developed using content from previous studies of infection risks in blood donors conducted in Brazil using the same ACASI technique [15]. The interview content was modified to include reported and putative risk factors in Sub-Saharan Africa for both HIV and HBV infection. The instrument included questions on previous blood donations, perceived risk behaviors, sexual orientation and behavior, alcohol and drug usage, and questions on invasive interventions (medical procedures, scarifications). Risk exposures were assessed over two intervals, lifetime and within the 6 months preceding the donation.

Laboratory testing methods

All donations are routinely screened in parallel by ID-NAT using the Procleix Ultrio Plus (Elite) assay on Tigris (Panther), (Grifols, Sant Cugat del Vallès, Barcelona, Spain), and HBsAg on the PRISM-nEXT (Abbott, Wiesbaden, Germany). Donations that tested positive by NAT or NAT and HBsAg were further tested for anti-HBc total on the Roche Cobas e411 analyzer (Roche Diagnostics, Basel, Switzerland) to identify incident infections.

Data analysis

Questionnaire responses were linked with the participant's laboratory and demographic data from the blood center's operational databases and then extracted for analysis. Donation status was classified as either first time, lapsed (previous donation but none in the past year), or repeat (previous donation within the last year). The risk factor analysis by sex focused on behaviors reported in the 6 months before donation. Characteristics of the participants, by case vs control status, were stratified by sex and were reported using descriptive statistics. Frequencies and measures of statistical association for risk behaviors were compared for female and male cases and controls separately and are reported with a $P < 0.05$ level of significance.

We used the Fisher's exact test to test associations between categorical variables because of sparse observations in some strata.

Sex-specific data was further analyzed using multivariable logistic regression models for women and men separately. There were 17 variables for the female model. These variables

were identified through the bivariate analysis and subject area knowledge to have potentially important relationships to HBV status. We used statistical learning to screen all possible models using these 17 variables. The algorithm created all possible 1-variable models, all possible 2-variable models, all possible 3-variable models, etcetera, and up to the single 17-variable model, for a total of 131,071 potential models for females. Following the same process used for the females, there were 18 variables and 262,143 potential models for males. For this study, we restricted the male models to have nine variables or less, for a total of 155,381 potential models. Misclassification rates for each model were calculated using five-fold cross-validation. For males and females separately, we investigated a small subset of all the potential models by focusing on models with the lowest misclassification rates. From this small subset of potential models, we selected a final model for each sex based on consensus among the researchers.

Results

During the study period, 2,707,385 blood donations were made of which 2429 (0.09%) donors tested HBV positive, including 217 (8.9%) incident HBV infections. Of these, 93 cases (46%) were successfully enrolled. Various factors contributed to potential cases not enrolling, including being untraceable, refusal to participate, change of mind after initial agreement, and not attending the research study appointment. Compared to those enrolled, those not enrolled were more likely to be male, of older age, of white/Asian race, and less likely to have donated in the Eastern Cape zone.

The 93 incident HBV cases were compared to 877 enrolled controls (Table 1), thus the ratio of controls to incident HBV cases for this analysis was approximately 9:1. For both females and males, cases and controls had similar demographic characteristics. Enrolled cases were predominantly of Black race (88%), and most were female (60%). Sixty-eight percent of enrolled cases were repeat donors, and 57% were in the age group 21–30 years. Two HBV incident cases had longstanding HIV co-infection.

The bivariate risk behavior analyses for females are reported in Table 2a. For females, significant (P <0.05) risk factors were as follows: becoming sexually involved with partners who provide some material benefit such as food, shelter, transport, school fees, or other goods (accepting material goods for sex), having more than one male sexual partner, using anything to prepare one’s anus before or after having sex in the 6 months before donation, a percutaneous injury such as a knife or stab wound or being in an accident with loss of blood in the 6 months before donation, not being HBV vaccinated, and having an education level less than attaining a college or university qualification. Personal contact with an HBV-infected person yielded a borderline risk (P = 0.05).

The multivariable analysis for females (Table 3a) found that accepting money or goods for sex with some partners (adjusted odds ratio [aOR] = 6.0 95% confidence interval [CI] 1.7–20.6), the use of agents to prepare the anus prior to anal intercourse occasionally (aOR = 4.0 95% CI 1.2–12.7) or always (aOR = 3.0 95% CI 1.0–9.0), percutaneous injury (aOR = 4.0 95% CI 1.3–12.5), and the number of male sexual partners (aOR = 10.23 95% CI 3.1–34.2 for 2+ vs no partners) conferred the highest odds of incident HBV infection. Being

of another race (compared to Black race) was also associated with incident HBV infection (aOR = 2.9 95% CI 1.1–8.1). A higher level of education was borderline protective. Note, personal contact with an HBV-infected person was not retained in the final model.

For males, potential risk factors from the bivariable analysis were reporting homo- or bisexual orientation, not having medical insurance, and having been told by a healthcare worker to be tested for HBV. No significant association was identified for having had contact with an HBV-infected person (Table 2b). The multivariable analysis for males (Table 3b) found that reporting homosexual or bisexual orientation (aOR = 8.0 95% CI 2.2–28.3), having more than two male sexual partners (aOR = 3.6 95% CI 0.9–13.8), having been told by a healthcare worker to be tested for HBV (aOR = 5.3 95% CI 1.7–16.2), not having medical insurance (aOR = 3.1 95% CI 1.3–7.6), and previous percutaneous injury (aOR = 6.1 95% CI 1.0–36.8) increased the odds of incident HBV. Being of another race (compared to Black race) was borderline associated with incident HBV infection (aOR = 2.8 95% CI 0.8–9.1).

Self-reported HBV vaccination status was not significantly associated with infection in either sex, although the odds ratio trended toward protection in women.

In our analyses, we also assessed other potential risk factors such as tattooing, traditional scarification, circumcision, iatrogenic/medical exposures, and intravenous drug use. We only had small numbers for these categories and found that none of these exposures were associated with incident HBV in either sex.

Discussion

This study assessed risk exposures associated with incident HBV infections in South African blood donors and identified primarily sexual risks for both males and females, similar to those reported for prevalent HBV infections in high-income countries. Of note, men who reported homo- or bisexual orientation or having sex with men (MSM) had increased risk of incident HBV. Women who reported accepting money or goods for sex and use of agents to prepare the anus before anal sex were at increased risk of incident HBV. For both sexes, percutaneous injuries were found to be significantly associated with incident HBV. We did not identify other parenteral or iatrogenic exposures as potential risk factors and had insufficient statistical power to detect rare potential risk factors such as scarifications.

The epidemiology of prevalent HBV infections in South Africa has changed in the last 30 years from a highly prevalent infection in rural children, associated with horizontal transmission, and in Black adult men, associated with scarification [16,17]. At the time, Karim et al. [18] found no association with homosexual orientation. Data collected in 2014 and 2015 from adults aged 15–49 years, residing in KwaZulu Natal demonstrated a much lower overall HBV prevalence of 4%, with no difference between adults living in rural and urban areas. However, males across all age groups remained more at risk than females, and among those co-infected with HIV, the prevalence of HBV increased to 6.2%. Furthermore, it has been shown that HBsAg positivity is 5% in HIV-infected persons and significantly higher than in non-HIV-infected individuals [19].

Publications on risk factors associated with incident HBV infections are scarce. We identified a survey of acute hepatitis conducted in the US general population in 2007, which found that HBV incidence varied with age and sex over the years. The highest rate (2.9 cases per 100,000 population) was reported among persons aged 25–44 years, and the lowest (0.02 cases per 100,000 population) was reported among persons aged <15 years, with the greatest percentage decline among persons aged <15 years (from 1.2 cases per 100,000 population in 1990 to 0.02 cases per 100,000 population in 2007) [20]. While before 2007, the female-to-male ratio was stable (1.5–1.8), in 2007, the rate for males was about 1.6 times higher than that for females. Contrary to the US study, which was not among blood donors but rather reflects cases reported to the Centers for Disease Control and Prevention, we found more incident HBV infections in young female blood donors than in male donors, but in keeping with the US findings, sexual exposures were the predominant risk factors in both sexes. A South African study reporting on HIV and HBV co-infections found that male sex and active tuberculosis were risk factors for incident infection [7]. We only had two HIV-HBV co-infections and could not analyze HIV's effect on HBV infection. However, tuberculosis infection was not assessed in our study but was unlikely due to study population being pre-screened blood donors who are generally healthy.

We identified some unexpected risk factors in both male and female donors. Among males, the association with MSM was unexpected in the South African context as heterosexual behaviors are recognized as driving both the HIV epidemic as well as HIV/HBV co-infections. In addition, in females, exchanging sex for material gain and the use of anal preparation practices were risk factors that have not previously been described as a risk factor for incident HBV. However, it is perhaps expected as HIV transmission is driven by similar "blesser blesse" behaviors. This term describes relationships where older men have sexual relationships with younger women, who are given material benefit in exchange for sex, and is a common phenomenon in South Africa [21,22]. In a recent paper, Doyisa et al. [21] describe the HIV risk that such relationships posed to university students in Durban.

Self-reporting of percutaneous injuries was associated with incident HBV in both sexes. Other than intravenous drug use and needle sharing, well-known HBV risk factors in high-income countries, we did not identify reports of other percutaneous injury as risk factors [20]. Cultural scarification, tattooing, and piercings are hypothesized to be Africa-specific risks; however, injuries were not mentioned [13,17]. Unfortunately, our sample size was too small to definitively assess the latter. The reduced risk of HBV infection of lapsed blood donors is an additional unexpected finding as these donors have been found to be at higher risk for most other transfusion-transmitted viruses when compared to repeat donors. The finding may be due to chance because of the relatively small numbers of lapsed donors among the cases or the fact that there were relatively more first-time donors in the HBV cases vs controls (in contrast with more lapsed donors in the controls vs cases).

Some of the findings in our study differ from those found elsewhere. Incident HBV infection was not associated with lower education as reported from studies in African countries [9,12]. However, in our study, females (but not males) who had tertiary education were marginally protected from incident HBV, possibly indicating that education and socioeconomic status are important. Furthermore, we did not find a significant protective

association of vaccination with incident HBV, although there was a trend toward protection in women. The lack of significant effects in our study was likely due to recall bias relating to childhood vaccination or the fact that up to half of the incident HBV cases were born prior to EPI implementation in 1995 and unlikely to have benefited from EPI as described by Prabdial-Sing et al. [23]. Finally, although contact with an HBV-infected person was of borderline significance in the bivariate analysis for females, there were very few positive responses, and so we did not find evidence for this being a risk factor for incident HBV.

Potential limitations of the study include participant selection and participation bias. The blood donor selection process is specifically aimed at excluding persons at risk of transfusion-transmissible infections, and the demographic and geographic distribution of those who enrolled differed somewhat from those who did not enroll. Furthermore, the number of incident HBV cases was not large enough to provide adequate power to detect lesscommon risk factors. Although we enrolled almost 50% of incident HBV cases, overall HBV incidence was lower during enrollment than during the design stage of the study. In addition, controls were matched to incident HIV cases and not incident HBV cases, although this does not appear to have significantly affected the demographic comparability of HBV cases and controls. Finally, although the use of a confidential, self-administered ACASI probably enhanced disclosure of risk factors, there may still have been recall bias as in any retrospective study.

In conclusion, this study demonstrates that sexual exposures are the primary risk factor for incident HBV infection in South African blood donors, including the novel findings of MSM and sex for material gain in women. This re-enforces the need for continuous education and promotion of HBV preventative strategies to sexually active adults. The sex-specific risk factors for HBV infection identified in this study may be useful in making the donor history questionnaire more sensitive for excluding at-risk female and male donors in the local context. Currently, the SANBS donor history questionnaire does not enquire about “blesser-blessee” relationships, nor does it enquire about anal sexual practices or penetrating physical injuries. Finally, at least in South Africa, blood services may be less concerned about including questions on traditional scarification and tattooing in their donor history questionnaires.

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Table 1

Demographic comparison of incident hepatitis B virus cases and controls stratified by gender.

Total	Females				Males				Totals			
	Cases	%	Control	%	Cases	%	Control	%	Cases	%	Control	%
	56	(100.0)	439	(100.0)	37	(100.0)	438	(100.0)	93	(100.0)	877	(100.0)
Age												
<21	10	(17.9)	60	(13.7)	1	(2.7)	36	(8.2)	11	(11.8)	96	(10.9)
21–30	31	(55.4)	248	(56.5)	22	(59.5)	236	(53.9)	53	(57.0)	484	(55.2)
31–40	12	(21.4)	89	(20.3)	10	(27.0)	99	(22.6)	22	(23.7)	188	(21.4)
41+	3	(5.4)	41	(9.3)	4	(10.8)	66	(15.1)	7	(7.5)	107	(12.2)
Missing	0	(0.0)	1	(0.2)	0	(0.0)	1	(0.2)	0	(0.0)	2	(0.2)
Race												
White	3	(5.4)	17	(3.9)	2	(5.4)	18	(4.1)	5	(5.4)	35	(4.0)
Black	50	(89.3)	400	(91.1)	32	(86.5)	403	(92.0)	82	(88.2)	803	(91.6)
Asian/Indian	0	(0.0)	3	(0.7)	1	(2.7)	4	(0.9)	1	(1.1)	7	(0.8)
Colored	3	(5.4)	19	(4.3)	2	(5.4)	13	(3.0)	5	(5.4)	32	(3.6)
Donor Type												
New	15	(26.8)	85	(19.4)	6	(16.2)	35	(8.0)	21	(22.6)	120	(13.7)
Lapsed	6	(10.7)	101	(23.0)	3	(8.1)	43	(9.8)	9	(9.7)	144	(16.4)
Repeat	35	(62.5)	253	(57.6)	28	(75.7)	359	(82.0)	63	(67.7)	612	(69.8)
Unknown	0	(0.0)	0	(0.0)	0	(0.0)	1	(0.2)	0	(0.0)	1	(0.1)
Zone												
Egoli/Vaal	21	(37.5)	128	(29.2)	13	(35.1)	124	(28.3)	34	(36.6)	252	(28.7)
Northern	9	(16.1)	57	(13.0)	3	(8.1)	64	(14.6)	12	(12.9)	121	(13.8)
KwaZulu Natal	8	(14.3)	104	(23.7)	12	(32.4)	113	(25.8)	20	(21.5)	217	(24.7)
Mpumalanga	6	(10.7)	75	(17.1)	4	(10.8)	89	(20.3)	10	(10.8)	164	(18.7)
Eastern Cape	12	(21.4)	75	(17.1)	5	(13.5)	48	(11.0)	17	(18.3)	123	(14.0)

Table 2a

Potential risk factors for HBV infection in female cases vs controls.

	Female cases	%	Control	%	*P*-value
All females	56	(100.0)	439	(100.0)	
Race					0.74
White	3	(5.4)	17	(3.9)	
Black	50	(89.3)	400	(91.1)	
Asian/Indian		(0.0)	3	(0.7)	
Colored	3	(5.4)	19	(4.3)	
Education category					0.09
Up to Grade 10/Standard 8	5	(8.9)	27	(6.2)	
Up to Grade 12/Standard 10	34	(60.7)	213	(48.5)	
Tertiary education[a]	17	(30.4)	199	(45.3)	
Medical aid					0.19
No	39	(69.6)	262	(59.7)	
Yes	17	(30.4)	177	(40.3)	
Advised by health care worker to be tested for HBV					0.10
No	51	(91.1)	423	(96.4)	
Yes	5	(8.9)	14	(3.2)	
unknown			2	(0.5)	
Sexual orientation					0.29
Straight/Heterosexual	53	(94.6)	416	(94.8)	
Bisexual/Gay/Homosexual	2	(3.6)	22	(5.0)	
Unknown	1	(1.8)	1	(0.2)	
Number of sexual partners in the last 6 months					<0.00
0	9	(16.1)	175	(39.9)	
1	40	(71.4)	250	(56.9)	
2 to 3	6	(10.7)	13	(3.0)	
4+	1	(1.8)	1	(0.2)	
Sexual involvement with partners who would provide material benefit [b]					<0.000
No Partners	40	(71.4)	257	(58.5)	

	Female cases	%	Control	%	*P*-value
Some Partners	3	(5.4)	2	(0.5)	
All Partners	4	(7.1)	5	(1.1)	
unknown	9	(16.1)	175	(39.9)	
Endoscopy or colonoscopy in the last 6 months before the donation					0.18
No	54	(96.4)	434	(98.9)	
Yes			2	(0.5)	
unknown	2	(3.6)	3	(0.7)	
New tattoo or had one re-applied in the 6 months before donation					0.57
No	55	(98.2)	433	(98.6)	
Yes		(0.0)	3	(0.7)	
unknown	1	(1.8)	3	(0.7)	
Anus preparation practices before sex in the last 6 months [c]					0.01
Every time	7	(12.5)	14	(3.2)	
Some times	4	(7.1)	9	(2.1)	
Once	1	(1.8)	6	(1.4)	
Never	35	(62.5)	305	(69.5)	
Not Applicable	7	(12.5)	77	(17.5)	
unknown	2	(3.6)	28	(6.4)	
Received Raatib, ritual scarring, piercing, circumcision, blood sharing, or been stabbed in the last 6 months					0.69
No	56	(100.0)	429	(97.7)	
Yes			2	(0.5)	
unknown			8	(1.8)	
Injury in the last 6 months before donation [d]					0.01
No	49	(87.5)	425	(96.8)	
Yes	7	(12.5)	12	(2.7)	
unknown			2	(0.5)	
Intravenous drug usage					1.00
Yes					
No	56	(100.0)	437	(99.5)	
Unknown			2	(0.5)	
HBV vaccination					0.03

	Female cases	%	Control	%	*P*-value
Yes	2	(3.6)	62	(14.1)	
No	51	(91.1)	364	(82.9)	
Unknown	3	(5.4)	13	(3.0)	
HBV contact [e]					0.05
Yes	4	(7.1)	10	(2.3)	
No	46	(82.1)	417	(95.0)	
Unknown	6	(10.7)	12	(2.7)	

HBV: hepatitis B virus.

Definitions:

[a]Tertiary education means at least a college or university qualification.

[b]Becoming sexually involved with partners who provide some material benefit such as food, shelter, transport, school fees, or other goods.

[c]Frequency of using anything to dry, clean, or tighten anus before or after having sex.

[d]An injury such as a knife or stab wound or being in an accident with loss of blood in the last 6 months before donation.

[e]Hepatitis contact means having been in close contact in the last 6 months with anybody who has hepatitis (living or working with people who have hepatitis).

Table 2b

Potential risk factors for HBV infection in male cases vs controls.

	Male cases	%	Control	%	*P*-value
All males	37	(100.0)	438	(100.0)	
Race					0.26
White	2	(5.4)	18	(4.1)	
Black	32	(86.5)	403	(92.0)	
Asian/Indian	1	(2.7)	4	(0.9)	
Colored	2	(5.4)	13	(3.0)	
Education category					0.80
Up to Grade 10/Standard 8	2	(5.4)	26	(5.9)	
Up to Grade 12/Standard 10	20	(54.1)	208	(47.5)	
Tertiary education[a]	15	(40.5)	203	(46.3)	
Unknown			1	(0.2)	
Medical aid					0.01
No	30	(81.1)	263	(60.0)	
Yes	7	(18.9)	175	(40.0)	
Advised by health care worker to be tested for HBV					0.06
No	32	(86.5)	418	(95.4)	
Yes	5	(13.5)	19	(4.3)	
unknown			1	(0.2)	
Sexual orientation					0.01
Straight/Heterosexual	32	(86.5)	427	(97.5)	
Bisexual/Gay/Homosexual	5	(13.5)	9	(2.1)	
Unknown			2	(0.5)	
Number of sexual partners in the last 6 months					0.17
0	7	(18.9)	150	(34.2)	
1	27	(73.0)	253	(57.8)	
2 to 3	3	(8.1)	29	(6.6)	
4+			6	(1.4)	
Sexual involvement with partners who would provide material benefit [b]					0.11

	Male cases	%	Control	%	*P*-value
No Partners	30	(81.1)	278	(63.5)	
Some Partners				(0.0)	
All Partners			11	(2.5)	
unknown	7	(18.9)	149	(34.0)	
Endoscopy or colonoscopy in the last 6 months before the donation					0.08
No	36	(97.3)	436	(99.5)	
Yes			2	(0.5)	
unknown	1	(2.7)		(0.0)	
New tattoo or had one re-applied in the 6 months before donation					0.15
No	36	(97.3)	437	(99.8)	
Yes	1	(2.7)	1	(0.2)	
Anus preparation practices before sex in the last 6 months [c]					0.34
Every time	5	(13.5)	24	(5.5)	
Some times	1	(2.7)	5	(1.1)	
Once		(0.0)	2	(0.5)	
Never	17	(45.9)	211	(48.2)	
Not Applicable, no anal sex	11	(29.7)	153	(34.9)	
unknown	3	(8.1)	43	(9.8)	
Received Raatib, ritual scarring, piercing, circumcision, blood sharing, or been stabbed in the last 6 months					1.00
No	37	(100.0)	434	(99.1)	
Yes			1	(0.2)	
unknown			3	(0.7)	
Injury in the last 6 months before donation [d]					0.10
No	35	(94.6)	433	(98.9)	
Yes	2	(5.4)	5	(1.1)	
Intravenous drug usage					0.08
Yes					
No	36	(97.3)	438	(100.0)	
Unknown	1	(2.7)			
HBV vaccination					0.77
Yes	3	(8.1)	40	(9.1)	

	Male cases	%	Control	%	*P*-value
No	32	(86.5)	382	(87.2)	
Unknown	2	(5.4)	16	(3.7)	
HBV contact [e]					0.37
Yes	1	(2.7)	5	(1.1)	
No	34	(91.9)	423	(96.6)	
Unknown	2	(5.4)	10	(2.3)	

HBV: hepatitis B virus.

Definitions:

[a]Tertiary education means at least a college or university qualification.

[b]Becoming sexually involved with partners who provide some material benefit such as food, shelter, transport, school fees, or other goods.

[c]Frequency of using anything to dry, clean, or tighten anus before or after having sex in the last 6 months before donation.

[d]An injury such as a knife or stab wound or being in an accident with loss of blood.

[e]Hepatitis contact means having been in close contact in the last 6 months with anybody who has hepatitis (living or working with people who have hepatitis).

Table 3a

Independent risk factors for recent HBV infection in females.

Variable	Adjusted odds ratios	Lower 95% confidence limit	Upper 95% confidence limit
Sexual involvement with partners who would provide material benefit			
Not accepting	1.00	—	—
Accepting	6.00	1.74	20.61
Anus preparation practices			
Never	1.00	—	—
Not reported	1.05	0.45	2.48
Occasionally	3.96	1.24	12.65
Every time	3.04	1.03	8.95
Injury in past 6 months			
No	1.00	—	—
Yes	3.95	1.25	12.53
Race			
Black	1.00	—	—
Other	2.92	1.06	8.07
Educational status			
Primary or secondary	1.00	—	—
Tertiary	0.53	0.27	1.02
HBV vaccinated			
No	1.00	—	—
Yes	0.25	0.05	1.15
Number of male sexual partners in the last 6 months			
Zero	1.00	—	—
One	3.15	1.42	6.98
Two or more	10.27	3.08	34.24

HBV: hepatitis B virus.

Table 3b

Independent risk factors for recent HBV infection in males

Variable	Adjusted odds ratios	Lower 95% confidence limit	Upper 95% confidence limit
Sexual orientation			
Heterosexual	1.00	—	—
Homosexual / bisexual	7.97	2.24	28.34
Injury in past 6 months			
No	1.00	—	—
Yes	6.13	1.02	36.79
Advised by health care worker to be tested for HBV			
No	1.00	—	—
Yes	5.26	1.71	16.19
Race			
Black	1.00	—	—
Other	2.75	0.83	9.09
Having medical aid			
Yes	1.00	—	—
No	3.09	0.13	7.70
Number of male sexual partners in the last 6 months			
Zero	1.00	—	—
One	2.55	1.04	6.25
Two or more	3.59	0.93	13.80
HBV vaccinated			
No	1.00	—	—
Yes	1.03	0.25	4.21

HBV: hepatitis B virus.