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The burden and epidemiology of hepatitis B and hepatitis D in Georgia: findings from the national seroprevalence survey

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Abstract

Objectives—The burden of hepatitis B virus (HBV) and hepatitis D virus (HDV) infections is unknown in Georgia. This analysis describes the prevalence of hepatitis B and coinfection with HDV and the demographic characteristics and risk factors for persons with HBV infection in Georgia.

Study Design—A cross-sectional seroprevalence study.

Methods—A cross-sectional, nationwide survey to assess hepatitis B prevalence among the general adult Georgian population (age ≥18 years) was conducted in 2015. Demographic and risk behavior data were collected. Blood specimens were screened for antiehepatitis B core total antibody (anti-HBc). Anti-HBc-positive specimens were tested for hepatitis B surface antigen (HBsAg). HBsAg-positive specimens were tested for HBV and HDV nucleic acid. Nationally weighted prevalence estimates and adjusted odds ratios (aORs) for potential risk factors were determined for anti-HBc and HBsAg positivity.

Results—The national prevalence of anti-HBc and HBsAg positivity among adults were 25.9% and 2.9%, respectively. Persons aged ≥70 years had the highest anti-HBc positivity (32.7%), but the lowest HBsAg positivity prevalence (1.3%). Anti-HBc positivity was associated with injection drug use (aOR = 2.34; 95% confidence interval [CI] = 1.46–3.74), receipt of a blood transfusion

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Competing interests

None declared.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the U.S. Centers for Disease Control and Prevention.

Ethical approval

Ethical approval was not required. This survey was deemed by the Centers for Disease Control and Prevention to be a routine public health activity for public health surveillance and therefore judged to not involve human subject research.

(aOR = 1.68; 95% CI = 1.32–2.15), and sex with a commercial sex worker (aOR = 1.46; 95% CI = 1.06–2.01). HBsAg positivity was associated with receipt of a blood transfusion (aOR = 2.72; 95% CI = 1.54–4.80) and past incarceration (aOR = 2.72; 95% CI = 1.25–5.93). Among HBsAg-positive persons, 0.9% (95% CI = 0.0–2.0) were HDV coinfected.

Conclusions—Georgia has an intermediate to high burden of hepatitis B, and the prevalence of HDV coinfection among HBV-infected persons is low. Existing infrastructure for hepatitis C elimination could be leveraged to promote hepatitis B elimination.

Keywords

Georgia; Hepatitis B; Hepatitis D; Prevalence; Risk Factors

Introduction

Globally, an estimated 257 million persons (3.5% of the world's population) were living with chronic hepatitis B virus (HBV) infection in 2015,[1] and an estimated 900,000 persons died from HBV infection, primarily from the sequelae of chronic infection, liver failure and hepatocellular carcinoma.[1] Superinfection with hepatitis D virus (HDV) worsens the outcome of HBV infection, and an estimated 5% of HBV-infected persons are also coinfected with HDV.[1]

Introduction of hepatitis B vaccine into the childhood vaccination schedule has dramatically reduced the prevalence of chronic HBV infection from 4.7% to 1.3% in 2015 in children <5 years of age globally.[1] HBV infection occurring during birth and early childhood accounts for most of the burden of chronic hepatitis B; the majority of people currently living with HBV infection were born before hepatitis B vaccine was widely available.[1] In 2018, global coverage of three doses of hepatitis B vaccine was 84%, however, birth dose coverage was only 42%; many developing countries are not using birth dose of hepatitis B vaccine as part of their national strategy.[2] In 2016, the World Health Assembly endorsed viral hepatitis elimination goals, defined as a reduction of 90% in incidence and 65% in mortality worldwide of both hepatitis B and hepatitis C by 2030.[1,3]

Georgia, a lower-middle-income country with a population of 3.7 million situated at the crossroads of Europe and Asia, implemented a national program in 2015 to eliminate hepatitis C by 2020.[4–6] To inform this effort, the country conducted a national seroprevalence survey in 2015 to estimate the burden of hepatitis C virus (HCV) infection, but also included testing for HBV infection.[7–9] The hepatitis B vaccine has been included in Georgia's national immunization schedule since 2002, and the birth dose has been included since 2003. Coverage for routine vaccination has been >90% for most years during 2005–2018.[10] This article describes the national prevalence of HBV infection and associated risk factors, as well as coinfection with HDV, in Georgia's adult population born before 1998.

Methods

Study population

A cross-sectional, nationwide survey for hepatitis B and hepatitis C prevalence among the general population aged ≥18 years was conducted in Georgia in 2015 using a stratified, multi-stage cluster design with random sampling.[9] A sample size of 7000 was based on an estimated HCV prevalence of 6.7%, a design effect of 2, and a 70% anticipated response rate.[9] After obtaining informed consent from study participants, interviewers collected demographic information, medical and behavioral history, information about potential risk factors and exposures, knowledge about HBV infection, and vaccination information. A blood sample was collected from the study participants. Trained interviewers verbally administered the survey in the language of the participant (either Georgian, Armenian, Russian or Azerbaijani). Data were entered into hand-held electronic devices in real time and uploaded to a secure database. The details of sampling methods, specimen and data collection details, and hepatitis C testing and statistical methods are described in the study by Hagan et al.[9]

Laboratory methods

Blood specimens were centrifuged, and serum was separated, aliquoted, and stored at −20 °C. Weekly, the specimens were shipped on dry ice to the Lugar Center, Georgia's national reference laboratory, where they were stored at −70 °C until tested. The specimens were screened for anti-hepatitis B core total antibody (anti-HBc) by enzyme-immunoassay (anti-HBc Ab, EIA *IVD*, Dia.Pro. Diagnostic Bioprobes Srl., Italy).[11] Anti-HBc-positive specimens were tested for hepatitis B surface antigen (HBsAg) (EIA *IVD*, Dia.Pro. Diagnostic Bioprobes Srl., Italy).[12] To confirm the presence of HBsAg, all HBsAg-positive samples were tested with the HBsAg confirmation neutralization assay (EIA *IVD*, Dia.Pro. Diagnostic Bioprobes Srl., Italy).[13] The Diagnostic Reference Team of the Division of Viral Hepatitis Laboratory Branch at the US Centers for Disease Control and Prevention (CDC) retested all anti-HBc-positive specimens and a comparable-size subset of negative specimens using the highly sensitive, Food and Drug Administration-licensed VITROS Immunodiagnostic System (aHBc and HBsAg, *IVD*, Ortho Clinical Diagnostics, Raritan, NJ, USA).[14–15] Specimens that tested positive for HBsAg were tested at the CDC using nucleic acid tests (NATs) for HBV DNA and for HDV RNA. NAT-positive samples were sequenced and genotyped using previously established procedures.[16] HBsAg-positive samples with undetectable HBV DNA using a laboratory developed test (LDT) with a lower limit of detection (LOD) of 500 IU/mL were further tested by ion vapor deposition (IVD) assay with LOD <20 IU/mL.

Definitions

Persons testing negative for anti-HBc were classified as 'never infected with HBV,' those testing positive for anti-HBc were considered 'ever infected with HBV.' Persons positive for both anti-HBc and HBsAg were classified as 'currently infected.' Patients with incomplete or missing anti-HBc results were excluded from the analysis.

Statistical analyses

All data were weighted at cluster, household, and individual levels using 2014 Georgia census data to account for selection probability, non-response, and sampling differences between regions to produce nationally representative estimates. We estimated the national prevalence of anti-HBc and HBsAg positivity as well as coinfections with HCV (both antibody to HCV [anti-HCV] and HCV RNA) and HDV. The results are presented as weighted percentages with 95% confidence intervals (CIs). Statistically significant bivariate associations between anti-HBc/HBsAg positivity and demographic and other risk factors were determined using chi-square tests. All factors found to be statistically significant ($P < 0.05$) were included in a multivariable logistic regression model. Statistical analysis was conducted using SAS version 9.4 (Cary, North Carolina, USA).

Results

Of the 7000 persons selected to participate in the study, 6296 (89.9%) gave consent and completed the questionnaire, and 6014 (85.9%) completed both the questionnaire and provided a blood specimen. Seven of these respondents were excluded for having missing or inconclusive hepatitis B test results; the final sample comprised valid anti-HBc and HBsAg results from 6007 adults. Demographic and exposure history for the overall sample of study participants is described in the study by Hagan et al.[9] In the sample, total anti-HBc positivity was detected in 1634 specimens, of which 188 tested positive for HBsAg. Overall, the weighted prevalence of anti-HBc positivity among adults was 25.9% (95% CI = 24.2–27.6), and the prevalence of HBsAg positivity was 2.9% (95% CI = 2.4–3.5), corresponding to an estimated 80,000 adults living with chronic HBV infection in Georgia. Of 174 HBsAg-positive specimens tested for HBV DNA using the LDT, 97 (55.7%) were positive and 77 had undetectable HBV DNA levels. Of those 77 samples, 40 samples had sufficient volume for an IVD assay test, with 28 (70.0%) testing positive. Thus, out 137 HBsAg-positive specimens that were tested by both HBV DNA assays, 125 (91.2%) tested positive for HBV DNA. Of those, 77 were successfully genotyped; HBV genotype A was identified in 28 (36.4%) specimens, and genotype D was identified in 49 (63.6%) specimens.

Anti-HBc positivity prevalence and risk factors

Anti-HBc positivity prevalence differed significantly by age, with the lowest prevalence among persons aged 18–29 years (11.9%; 95% CI = 9.2–14.5), and highest among those aged ≥70 years (32.7%; 95% CI = 28.4–36.9) ($P < .0001$) but did not differ by sex (Table 1). Anti-HBc positivity prevalence differed by geographic region, ranging from a low of 18.8% (95% CI = 12.4–25.2) to a high of 33.0% (95% CI = 29.2–36.9; $P < .001$) (Fig. 1).

Bivariate analysis revealed that testing positive for anti-HBc was associated with the type of provider (i.e., a healthcare worker, dentist, or family member) who administered the last therapeutic (medical or dental) injection that a participant reported receiving, history of renal dialysis, ever having received a blood transfusion, history of any other chronic disease, past or present injection-drug use, the number of lifetime sexual partners, having engaged in sex with a commercial sex worker, condom use, history of incarceration, and having a body piercing ($P < 0.05$ for all) (Table 1).

After adjusting for covariates in a model, significant risk factors for anti-HBc positivity included ever injecting drugs (adjusted odds ratio [aOR] = 2.34; 95% CI = 1.46–3.74); ever having received a blood transfusion (aOR = 1.68; 95% CI = 1.32–2.15); ever having sex with a commercial sex worker (aOR = 1.46; 95% CI = 1.06–2.01); and receipt of last medical injection by a neighbor or family member vs. a healthcare worker (aOR 1.31; 95% CI = 1.07–1.62) (Table 2).

HBsAg positivity prevalence and risk factors

HBsAg positivity prevalence varied by age, with the highest prevalence of infection among the youngest age-groups including those aged 18–29 years (4.2%; 95% CI = 2.7–5.7) and 30–39 years (4.5%; 95% CI = 3.2–5.8), whereas the lowest prevalence was among those aged ≥70 years (1.3%; 95% CI = 0.4–2.2) (Table 1). HBsAg positivity prevalence was significantly higher (4.6%; 95% CI = 3.1–6.4) among those who self-reported being unemployed at the time of the survey than among others (2.5%; 95% CI = 2.0–3.1) ($P < 0.001$). In bivariate analysis, testing positive for HBsAg was associated with ever having received a blood transfusion ($P < 0.01$) and a history of incarceration ($P < 0.01$). These associations remained significant after adjusting for all covariates significant in bivariate analysis, with aORs of 2.72 (95% CI = 1.54–4.80) and 2.72 (95% CI = 1.25–5.93), respectively.

Coinfection with hepatitis C or hepatitis D

Anti-HBc positivity was associated with both past and current HCV infection. Among anti-HBc-positive persons, 12.9% (95% CI = 10.2–15.5) were anti-HCV positive, compared to 5.9% (95% CI = 4.8–7.0) of anti-HBc-negative persons ($P < 0.0001$; data not shown). Likewise, 9.2% (95% CI = 6.9–11.6) of anti-HBc-positive persons were HCV RNA positive, compared with 4.1% (95% CI = 3.2–4.9) among those never infected with HBV ($P < 0.0001$).

Among HBsAg-positive persons, 13.3% (95% CI = 5.8–20.8) were anti-HCV positive and 9.8% (95% CI = 2.6–17.0) were HCV RNA positive, although these were not significantly higher than those in HBsAg-negative persons (7.5%; 95% CI = 6.4–8.6 and 5.3%; 95% CI = 4.4–6.2, respectively [$P > 0.05$]).

Among HBsAg positive persons, 0.9% (95% CI = 0.0–2.0) were positive for HDV RNA (n = 4/175 [2.3%] of samples tested). All HDV specimens were genotype 1.

Hepatitis B vaccination

Overall, 1.1% (95% CI = 0.8–1.4) of the surveyed population reported ever having been vaccinated against hepatitis B (data not shown), although the number of doses received could not be verified. Vaccination coverage was highest (2.1%) among those aged 18–29 years, and lowest (0.2%) among those aged ≥60 years ($P < 0.001$). Of the 798 participants aged ≥70 years, none could recall having been vaccinated against hepatitis B.

Hepatitis B-related knowledge

Slightly more than one third of participants (36.7%; n = 2004) had ever heard of hepatitis B or HBV. About one in five participants (20.6%; n = 1093) was aware that HBV could be transmitted by sharing needles or syringes, and 18.7% (n = 1010) were aware HBV could be transmitted by sharing household objects such as razors. Only 8.7% (n = 461) knew it was vaccine-preventable and 15.4% (n = 819) knew that condom use could prevent HBV infection. Of those who had heard of HBV, 42.8% (n = 884) were aware that this infection could be treated, and 42.5% (n = 849) knew that it could be asymptomatic.

Discussion

This is the first serosurvey to report hepatitis B prevalence on a national scale in Georgia. Overall, the rate of current or past HBV infection (anti-HBc) was 25.9%, and the prevalence of chronic HBV infection, defined by prevalence of HBsAg positivity, was 2.9%. A study conducted in 2006–2007 among healthcare workers in Georgia found similar prevalence of anti-HBc (29%) and HBsAg (2%) positivity.[17]

Georgia's anti-HBc positivity prevalence is high, but the country has low to intermediate HBsAg positivity prevalence (defined as 2.00%–4.99%) compared to other countries in the World Health Organization European region.[18] Risk factors associated with HBV infection included injection drug use, receipt of a blood transfusion, history of incarceration, sex with a commercial sex worker, and receipt of therapeutic injections from family members. Overall, these findings highlight the need to address blood safety, harm reduction for people who inject drugs, and unsafe infection control practices — issues currently being addressed by the hepatitis C elimination program.[4]

A quarter of respondents reported that their last therapeutic injection was from a neighbor or family member, suggesting the need to better understand the degree to which 'informal' healthcare practices are used in the country and to better communicate the risk of unsafe injections in transmitting HBV and HCV.

This analysis is the first to our knowledge to report nationally representative data on HBV/HDV coinfection. HDV infection burden is reported to be substantial in several countries of Eastern Europe and Central Asia.[19–20] Globally, approximately 5% of HBsAg carriers are estimated to be coinfected with HDV.[21] Although nationally representative data are lacking from most countries, several studies indicate that HDV coinfection burden covers a large spectrum, from 1.6% in Central Asia (South Kazakhstan),[22] 18.3% in Eastern Europe (Moldova),[23] to 57% in Mongolia.[24] In comparison, hepatitis D prevalence in Georgia among those currently infected with HBV is low (0.9%).

It is noteworthy that HBsAg positivity prevalence was highest and anti-HBc positivity prevalence was lowest among the youngest age cohorts (age of 18–39 years). This finding suggests that most HBV infections in Georgia likely occurred either perinatally from mother to child or horizontally during childhood when the risk of chronic infection is highest.[2] Routine hepatitis B vaccination was included in the national immunization schedule in 2002, and the hepatitis B birth dose was introduced in 2003, so persons in this survey would not

have benefitted from childhood and birth dose vaccination programs. Cohorts of Georgian children born after 2002 and 2003 will benefit from the protection of hepatitis B vaccination.[25] In addition, a dose of hepatitis B immunoglobulin (HBIG) is administered to infants born to pregnant women who have been screened and test positive for HBsAg since August 2006.[26] In 2017–2018, out of 103,828 registered live births, HBIG was administered to 1532 (1.5%) newborns.[25] Given these development, Georgia could consider implementation of a hepatitis B serosurvey among cohorts born after vaccine introduction to assess the impact of vaccination on disease burden and report on progress towards the achievement of the European region hepatitis B control goal of HBsAg <0.5% among vaccinated cohorts by 2020[27] and global goal of elimination which is defined as HBsAg<0.1% among children aged 5 years by 2030.[1] In addition, in 2019, the government of Georgia approved a decree mandating hepatitis B vaccination be made available to all healthcare workers.[28] Fewer than 9% of persons were aware that hepatitis B can be prevented with a vaccine, suggesting public awareness campaigns could boost vaccination uptake among older populations.

Several key risk factors for HBV infection identified in this analysis were also found to be associated with HCV infection in Georgia, including history of incarceration (in bivariate analyses), receipt of a blood transfusion, and past or current injection-drug use.[9] HBV and HCV, both blood-borne pathogens, are known to have similar modes of transmission,[29] and nearly 10% of HBsAg-positive persons in this analysis were coinfected with HCV. Coinfection can increase the likelihood of developing cirrhosis, decompensated liver disease, and hepatocellular carcinoma.[30] Georgia's hepatitis C elimination program was launched in 2015 and offers hepatitis C treatment free of charge; however, there is currently no such program for hepatitis B treatment. Nonetheless, the public health infrastructure established for hepatitis C screening and treatment as part of the hepatitis C elimination program could be leveraged to support hepatitis B elimination as well.[4–6] Furthermore, Georgia can take advantage of reductions in the price of hepatitis B antivirals observed globally to improve treatment access.[31] Cost-effectiveness studies and modeling for hepatitis B elimination are needed to further inform the Georgian government's consideration of undertaking hepatitis B elimination.

This analysis was subject to several limitations. Owing to its cross-sectional design, causal associations are difficult to be made; hepatitis B could have been acquired at any time and in any setting before survey participation. Risk factor data were self-reported and could not be independently verified and could be subject to recall and social desirability bias. Our survey only included persons ≥18 years of age who were not eligible for hepatitis B vaccination at the time of birth, so hepatitis B prevalence could not be estimated for persons in younger age-groups and children who were born after vaccine introduction. However, lower HBV infection rates are anticipated among children born after hepatitis B vaccine introduction. In addition, currently incarcerated persons were not surveyed in this analysis, which could lead to underestimation of national prevalence of hepatitis B. Demographic and behavioral differences between survey participants who did or did not provide a blood specimen could have skewed results. The relatively low number of HBsAg-positive persons sampled prevented reliable analysis of regional HBsAg prevalence and likely affected risk factor analysis, which could explain differences observed between anti-HBc and HBsAg positivity, especially with respect to injection drug use (IDU) and sex with a commercial sex worker.

The sampling method of this study was not designed to produce precise prevalence estimates for HDV infection; owing to low prevalence among the sampled population, national estimates should be interpreted with caution.

To conclude, the overall rate of exposure to HBV in Georgia is high, suggesting significant transmission, although the prevalence of chronic HBV infection is low to intermediate. Considering the overlap in population and risk factors for HCV and HBV infection, existing programs and efforts within the ongoing national hepatitis C elimination program may be mitigating the risk of continued HBV transmission in the country; preventive measures aimed at reducing the risk of HCV transmission will also reduce the risk of HBV infection. The future burden of hepatitis B in Georgia will also decrease as a result of childhood vaccinations begun in the early 2000s. Nevertheless, more than 80,000 adults are estimated to be living with chronic HBV infection and are at risk for sequelae including cirrhosis and hepatocellular carcinoma, as well as continued transmission to additional susceptible individuals. Incorporating hepatitis B into Georgia's successful ongoing hepatitis C elimination efforts offers an opportunity for Georgia to be among the first countries in the region to undertake hepatitis B elimination. Studies to assess the feasibility and cost-effectiveness of undertaking hepatitis B elimination in Georgia could help inform policy decisions.

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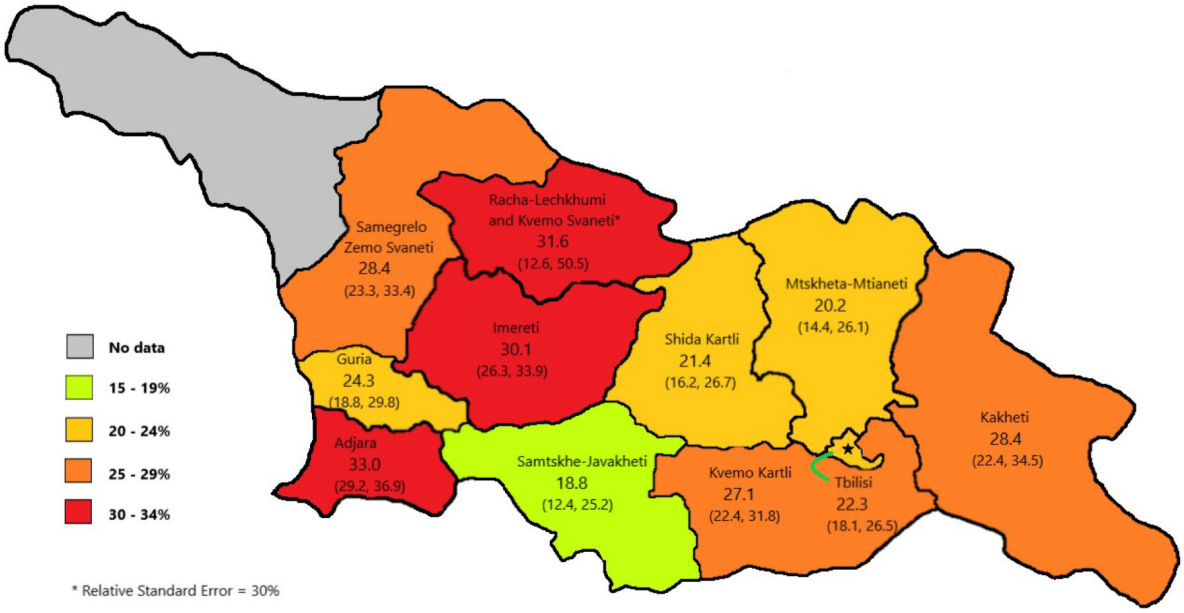

Figure 1.

Estimated anti-hepatitis B core total antibody positivity prevalence (95% confidence intervals) by region, Georgia serosurvey, 2015

Table 1.

Characteristics associated with anti-HBc and HBsAg positivity, Georgia seroprevalence survey, 2015

Demographic characteristics	Total sample		Anti-HBc+			HBsAg+		
	No.	Weighted %	No.	Weighted % (95% CI)	P-Value	No.	Weighted % (95% CI)	P-Value
Overall	6,007	100.0	1,634	25.9 (24.2, 27.6)		188	2.9 (2.4, 3.5)	
Sex								
Male	2,338	46.9	676	27.0 (24.5, 29.6)	0.15	85	3.4 (2.5, 4.3)	0.10
Female	3,669	53.1	958	24.9 (22.9, 26.9)		103	2.5 (1.9, 3.2)	
Age (years)								
18–29	1,063	19.2	138	11.9 (9.2, 14.5)	<0.0001	45	4.2 (2.7, 5.7)	0.001
30–39	1,140	19.9	329	27.5 (23.9, 31.2)		64	4.5 (3.2, 5.8)	
40–49	1,026	18.5	320	31.1 (26.9, 35.4)		27	2.7 (1.2, 4.1)	
50–59	1,096	16.9	327	28.3 (25.0, 31.7)		30	2.4 (1.3, 3.5)	
60–69	884	13.6	262	27.2 (23.5, 30.9)		12	1.4 (0.4, 2.4)	
70+	798	12.0	258	32.7 (28.4, 36.9)		10	1.3 (0.4, 2.2)	
Urban vs Rural								
Urban	3,154	55.8	848	24.8 (22.3, 27.3)	0.16	108	3.1 (2.2, 3.9)	0.67
Rural	2,853	44.2	786	27.3 (24.9, 29.7)		80	2.8 (2.1, 3.5)	
Employment status								
Employed, student, homemaker, retired	4,940	80.2	1,335	25.8 (23.8, 27.7)	0.73	135	2.5 (2.0, 3.1)	0.001
Unemployed	1,065	19.8	298	26.4 (23.0, 29.8)		53	4.6 (3.1, 6.1)	
Highest level of education completed								
Elementary/primary school or less	621	9.2	162	26.0 (21.4, 30.5)	0.047	15	2.9 (1.3, 4.6)	0.13
Secondary school	2,464	40.5	697	27.3 (24.5, 30.0)		92	3.7 (2.7, 4.7)	
Professional/technical school	1,110	16.7	322	28.2 (24.8, 31.6)		27	2.4 (1.3, 3.4)	
University/college or higher	1,811	33.6	453	23.1 (20.4, 25.8)		54	2.4 (1.6, 3.2)	
Healthcare worker, ever								
Yes	315	5.1	91	26.5 (19.5, 33.4)	0.87	-†	1.7 (0.0, 3.7)	0.35
No	5,687	94.9	1,542	25.9 (24.1, 27.6)		183	3.0 (2.4, 3.6)	
Provider who administered last injection								
Healthcare worker	2,381	49.7	627	24.4 (22.0, 26.8)	0.01	63	2.3 (1.6, 3.0)	0.43

Demographic characteristics	Total sample		Anti-HBc+			HBsAg+		
	No.	Weighted %	No.	Weighted % (95% CI)	P-Value	No.	Weighted % (95% CI)	P-Value
Dentist	929	19.2	213	24.1 (20.2, 28.0)		33	3.2 (1.9, 4.6)	
Pharmacist	8	0.1	-*	33.2 (0.0, 70.9)		-†	9.9 (0.0, 27.4)	
Non-healthcare worker (family/neighbor)	1,358	25.9	421	30.7 (27.4, 33.9)		43	3.1 (1.9, 4.3)	
Myself	281	5.1	98	29.4 (22.1, 36.6)		13	2.8 (0.8, 4.7)	
Ever received kidney dialysis								
Yes	17	0.3	-†	57.8 (26.3, 89.4)	0.02	-†	15.1 (0, 38.4)	0.06
No	5,973	99.5	1618	25.7 (24.0, 27.4)		187	2.9 (2.4, 3.5)	
Ever received blood transfusion								
Yes	447	7.1	158	38.3 (32.8, 43.9)	<0.0001	22	6.0 (3.0, 8.9)	0.003
No	5,555	92.9	1,475	24.9 (23.2, 26.7)		166	2.7 (2.2, 3.3)	
Frequency of dental cleanings								
Once/year or more	671	15.1	155	23.5 (19.1, 27.9)		19	2.6 (1.0, 4.3)	
Less than once/year	593	11.2	167	25.4 (21.0, 29.9)	0.23	14	2.1 (0.7, 3.5)	0.44
Never	4,174	73.8	1,185	27.2 (25.3, 29.2)		140	3.3 (2.5, 4.0)	
Ever injected drugs								
Yes	205	4.5	107	48.1 (38.6, 57.6)	<0.0001	15	5.6 (0.7, 10.5)	0.12
No	5,763	95.5	1,518	24.9 (23.2, 26.6)		172	2.8 (2.3, 3.3)	
Number of lifetime sexual partners								
0	411	7.2	67	16.0 (11.4, 20.6)		-†	3.0 (0.3, 5.7)	
1–5	3,958	60.8	1,057	25.4 (23.3, 27.4)	<0.0001	113	2.5 (1.9, 3.1)	0.21
> 5	1,630	32.1	507	29.0 (26.1, 31.9)		65	3.8 (2.5, 5.0)	
Ever had sex with a commercial sex worker (among males)								
Yes	357	15.3	120	34.0 (27.8, 40.1)	0.003	16	5.2 (2.3, 8.1)	0.08
No	1,979	84.7	556	25.8 (23.1, 28.4)		69	3.1 (2.2, 4.0)	
Use condoms with sexual partners								
Always	382	8.9	78	18.5 (13.6, 23.5)		17	3.2 (1.1, 5.2)	
Sometimes/Often	1,617	33.3	436	25.2 (21.9, 28.4)	0.003	56	3.0 (2.0, 4.0)	0.99
Never	2,993	49.4	864	28.3 (26.1, 30.5)		89	3.0 (2.2, 3.9)	
Ever incarcerated								
Yes	236	4.8	100	39.5 (30.3, 48.7)	<0.001	15	8.0 (2.2, 13.7)	0.003

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Demographic characteristics	Total sample		Anti-HBc+			HBsAg+		
	No.	Weighted %	No.	Weighted % (95% CI)	P-Value	No.	Weighted % (95% CI)	P-Value
No	5,758	95.2	1,530	25.2 (23.4, 26.9)		172	2.7 (2.2, 3.2)	
Any body piercings								
Yes	2,714	38.9	691	23.2 (21.3, 25.2)	0.002	81	2.6 (1.9, 3.3)	0.29
No	3,284	61.1	939	27.5 (25.2, 29.9)		106	3.1 (2.4, 3.9)	
History of any chronic disease								
Yes	2,791	44.0	828	27.6 (25.5, 29.7)	0.04	81	2.7 (1.9, 3.4)	0.33
No	3,211	56.0	805	24.5 (22.2, 26.9)		107	3.2 (2.4, 4.0)	

†Suppressed because of small sample size (<10)

Abbreviations: anti-HBc = anti-hepatitis B core total antibody; HBsAg = hepatitis B surface antigen; CI = confidence interval

Table 2.

Results of multivariate regression models of the association of anti-HBc and HBsAg positivity with selected variables, Georgia seroprevalence survey, 2015

Characteristic	Anti-HBc		HBsAg	
	Unadjusted OR (95%CI)	Adjusted OR† (95%CI)	Unadjusted OR (95%CI)	Adjusted OR† (95%CI)
Age (years)				
18–29	Ref	Ref	Ref	Ref
30–39	2.83 (2.08, 3.84)	2.71 (2.00, 3.68)	1.07 (0.66, 1.72)	1.03 (0.65, 1.63)
40–49	3.36 (2.51, 4.50)	2.90 (2.15, 3.90)	0.63 (0.31, 1.25)	0.57 (0.30, 1.10)
50–59	2.94 (2.17, 4.00)	2.55 (1.88, 3.46)	0.56 (0.30, 1.03)	0.50 (0.28, 0.89)
60–69	2.78 (2.04, 3.79)	2.49 (1.78, 3.48)	0.33 (0.15, 0.74)	0.33 (0.14, 0.75)
70+	3.61 (2.66, 4.88)	3.10 (2.19, 4.41)	0.31 (0.14, 0.67)	0.32 (0.14, 0.74)
Employment status				
Employed, student, homemaker, retired	_≠	--	Ref	Ref
Unemployed (able or unable to work)	--	--	1.88 (1.28, 2.74)	1.41 (0.96, 2.09)
Highest level of education completed				
Elementary/primary school or less	1.17 (0.88, 1.55)	1.10 (0.81, 1.49)	--	--
Secondary school	1.25 (1.03, 1.51)	1.24 (1.03, 1.50)	--	--
Professional/technical school	1.25 (1.03, 1.51)	1.24 (0.99, 1.57)	--	--
University/college or higher	Ref	Ref	--	--
Provider who administered last injection				
Healthcare worker	Ref	Ref	--	--
Dentist	0.99 (0.78, 1.24)	1.10 (0.86, 1.40)	--	--
Pharmacist	1.54 (0.28, 8.33)	1.55 (0.24, 10.05)	--	--
Non-HCW (family/neighbor)	1.37 (1.12, 1.68)	1.31 (1.07, 1.62)	--	--
Myself	1.29 (0.89, 1.87)	1.04 (0.71, 1.51)	--	--
Ever received kidney dialysis				
Yes	3.97 (1.08, 14.53)	2.53 (0.76, 8.47)	--	--
No	Ref	Ref	--	--
Ever received blood transfusion				
Yes	1.87 (1.48, 2.37)	1.68 (1.32, 2.15)	2.28 (1.31, 4.00)	2.72 (1.54, 4.80)

Characteristic	Anti-HBc		HBsAg	
	Unadjusted OR (95%CI)	Adjusted OR[†] (95%CI)	Unadjusted OR (95%CI)	Adjusted OR[†] (95%CI)
No	Ref	Ref	Ref	Ref
Injection drug use (ever)				
Yes	2.80 (1.91, 4.09)	2.34 (1.46, 3.74)	--	--
No	Ref	Ref	--	--
Number of lifetime sexual partners				
0	Ref	Ref	--	--
1–5	1.78 (1.25, 2.54)	0.84 (0.51, 1.37)	--	--
> 5	2.14 (1.47, 3.12)	0.86 (0.49, 1.50)	--	--
Sex with a commercial sex worker (among males)				
Yes	1.48 (1.10, 1.99)	1.46 (1.06, 2.01)	--	--
No	Ref	Ref	--	--
Use condoms with sexual partners				
Always	Ref	Ref	--	--
Sometimes/Often	1.48 (1.02, 2.15)	1.24 (0.83, 1.86)	--	--
Never	1.74 (1.25, 2.42)	1.48 (1.00, 2.17)	--	--
Ever incarcerated				
Yes	1.94 (1.32, 2.86)	1.33 (0.88, 2.02)	3.14 (1.41, 6.99)	2.72 (1.25, 5.93)
No	Ref	Ref	Ref	Ref
Any body piercings				
Yes	0.80 (0.69, 0.92)	0.90 (0.74, 1.10)	--	--
No	Ref	Ref	--	--
History of any chronic disease				
Yes	1.17 (1.01, 1.36)	0.95 (0.81, 1.12)	--	--
No	Ref	Ref	--	--

[†]Adjusted models included all variables associated with the outcome ($p<0.05$) in bivariate analysis

[‡]Omitted due to lack of association in bivariate analysis

Abbreviations: anti-HBc = anti-hepatitis B core total antibody; HBsAg = hepatitis B surface antigen; OR = odds ratio; CI = confidence interval; HCW = healthcare worker