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# Hepatitis B in the United States: ongoing missed opportunities for hepatitis B vaccination, evidence from the Behavioral Risk Factor Surveillance Survey, 2007

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## Abstract

**Purpose** In the USA, the burden of hepatitis B disproportionately affects high-risk adults who alone account for more than 75% of newly reported hepatitis B virus infections each year. Despite the localization of new infections in identifiable high-risk groups, vaccination rates in this subgroup, with the exception of health care workers, remain consistently low. The purpose of this study was to characterize those at risk for hepatitis B transmission and

quantify the association between missed opportunities and hepatitis B vaccination.

**Methods** Data from the 2007 Behavioral Risk Factor Surveillance Survey (BRFSS) of adults aged 18 years and older who were at high risk for hepatitis B infection ( $n = 15,432$ ) were analyzed. Multivariate regression analysis was conducted to determine factors independently associated with vaccination.

**Results** In a nationally representative sample, 51.4% of high-risk adults remained unvaccinated against hepatitis B and more than 50% had a missed opportunity for vaccination. High-risk adults who were vaccinated against pneumonia and influenza had a higher odds ratio of being vaccinated against hepatitis B than those not vaccinated against pneumonia and influenza (OR 2.27 and 1.67, respectively). Also, high-risk adults tested for human immunodeficiency virus (HIV) at a counseling and testing site or a drug treatment facility had a higher OR of being vaccinated than those who had not been tested for HIV (OR 1.78 and 1.73, respectively). The opposite relationship was true among individuals tested for HIV at a correctional facility (OR 0.60).

**Conclusions** The findings of this study underscore the inadequacy of vaccination coverage in high-risk adults and highlight advantageous opportunities to bridge gaps in vaccination coverage.

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**Keywords** Hepatitis B virus · Vaccination · Prevention · High-risk adults · Missed opportunities

## Introduction

Hepatitis B has been a vaccine preventable illness since the early 1980s. Yet, more than 1.25 million people in the USA

are chronically infected with hepatitis B virus (HBV), and every year almost 80,000 people become newly infected with hepatitis B [1, 2]. Approximately 25% of those who become chronically infected during childhood and 15% of those who develop chronic infections after childhood die prematurely of cirrhosis and/or hepatocellular carcinoma [3]. In the USA and most industrialized countries, hepatitis B disproportionately affects high-risk adults, including men who have sex with men, individuals with a history of sexually transmitted diseases (STD) or multiple sexual partners (>1 partner/6 months), incarcerated persons, sex contacts of HBV-infected persons, health care workers, and injection drug users. These groups alone account for between 75 and 95% of newly reported HBV infections each year [2, 3]. Despite the localization of new infections in identifiable high-risk groups, vaccination rates in these subsets of the population, with the exception of health care workers, remain consistently low and continuously fall short of national health objectives [2, 3].

Since the hepatitis B vaccine first became available in 1982, great strides have been made in vaccinating infants, children, and adolescents; however, very little progress has been made in raising hepatitis B vaccine coverage in high-risk adults. According to a national prevalence study using National Health and Nutrition Examination Survey (NHANES) data from 1999 to 2006, the burden of chronic hepatitis B remains the greatest among adults and has experienced little change in the past decade, despite vaccine availability and ostensible vaccine outreach [4]. Moreover, findings from a Centers of Disease Control and Prevention (CDC) surveillance study conducted between 1998 and 2001 showed that >95% of an estimated 51,000 new infections in 2000 occurred in high-risk adults, underscoring the inadequacy of vaccination coverage in this population [3]. Surprisingly, of those newly infected, >70% had a missed opportunity for vaccination in the form of prior contacts with the health system or periods of incarceration [5–7]. A study conducted among injection drug users attending a STD clinic in San Diego between 1998 and 2001 found that vaccination coverage among attendees was only 6%, highlighting the extent of missed opportunities in this population [8].

The Institute of Medicine's 2010 report on The National Strategy for Prevention and Control of Hepatitis B and C stressed the importance of capitalizing on opportunities to vaccinate these individuals when they come into contact with the health care system [9]. Previous literature has posited that missed opportunities are largely attributable to a lack of dedicated vaccination programs, understaffing at facilities serving high-risk populations, and physician noncompliance with recommended guidelines for

the identification and vaccination of high-risk adults [9]. A better understanding of these potential areas of deficiencies and predictors of immunization status is an essential first step to improving uptake to vaccination in high-risk populations.

The purpose of the study reported here was to quantify the association between missed opportunities and identify predictors for hepatitis B vaccine status among high-risk adults. The study replicates a prior analysis performed using the National Health Survey in 2000, adding additional information regarding access to care and sites of contact with the health system and an assessment of what progress has been made in addressing missed opportunities since the last assessment. [5]. It is anticipated that this study will provide insight to guide the development of programs to meet the immunization recommendations within the National strategy for prevention and control of Hepatitis B and C.

## Materials and methodology

### Survey design and data collection

Data for this study were obtained from the 2007 Behavioral Risk Factor Surveillance Survey (BRFSS) conducted by the CDC. The BRFSS is an ongoing, nationwide telephone survey system that has been tracking information on health conditions and risk behaviors of the non-institutionalized population in the USA annually since 1984 [10]. Data collected from survey respondents are adjusted to represent the population from which the sample is drawn. [11].

The questions of interest are a part of the BRFSS core modules, and data are included from individuals from all 50 U.S. states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam.

### Participant selection

The population of interest consisted exclusively of adults with behaviors that place them at high risk for hepatitis B infection and for whom HBV vaccine status could be specified. Operationally, adults were categorized as high risk if they answered affirmatively to the following question: “please tell me if any of these statements is true for you. Do not tell me which statement or statements are true for you, just if any of them are: you have hemophilia and have received clotting factor concentrate; you have had sex with a man who has had sex with other men, even just one time; you have taken street drugs by needle, even just one time; you traded sex for money or drugs, even just one time; you have tested positive for human

immunodeficiency virus (HIV); you have had sex (even just one time) with someone who would answer ‘yes’ to any of these statements; you had more than two sex partners in the past year” [12] ( $n = 20,431$ ).

For the purposes of this study, individuals who answered “Don’t know/not sure” or “Refused” to questions regarding high-risk behavior ( $n = 2,638$ ) or hepatitis B vaccine status ( $n = 2,361$ ) were excluded from the analysis; this exclusion yielded an analytic sample of 15,432 respondents. Specific to the final model, individuals who had missing data for a given predictor variable were excluded only for that variable. The total number of individuals excluded due to missing information on any given predictor variable was 3,599 respondents (see Fig. 1).

#### Variables of interest

#### Outcome variable

The study’s primary outcome variable was hepatitis B vaccine status. Operationally, vaccine status for a high-risk adult was specified by their answer to the following question: “have you ever received the hepatitis B vaccine? The hepatitis B vaccine is completed after the third shot is given” [12]. An affirmative answer to this question indicates that the respondent had completed the entire hepatitis B vaccine series.

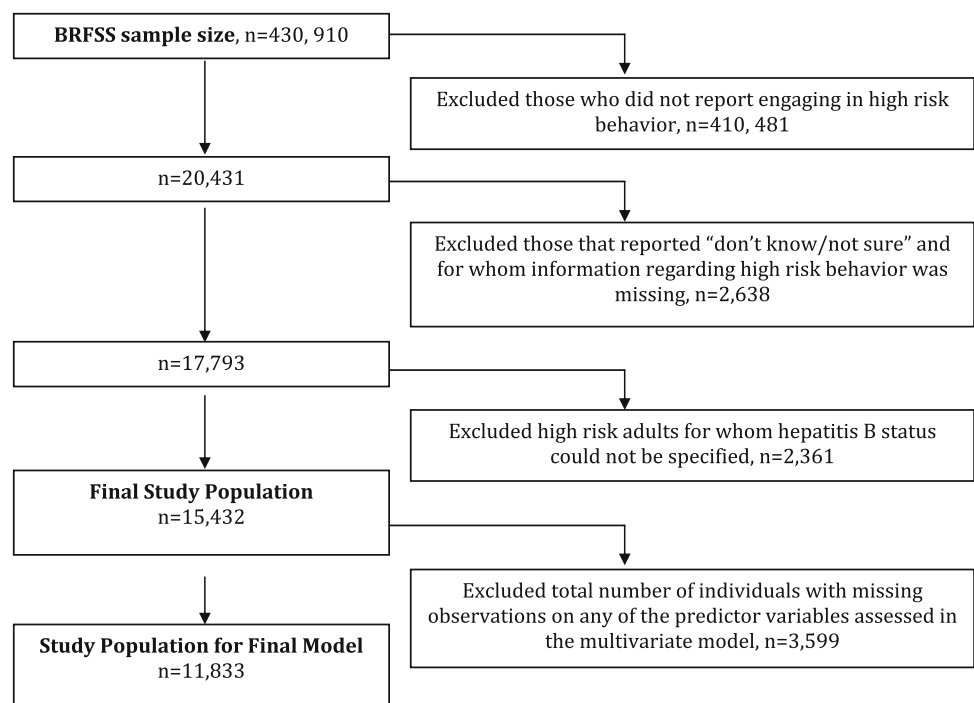
#### Predictor variables

Predictor variables considered in the analysis were categorized as demographic variables, access to health care variables, and health care utilization variables.

Sex, race, relationship status, income, age, and educational level were included among the demographic variables. Sex, race, income, and educational level were operationalized using the definitions specified by the BRFSS (see Table 1). These variables have previously been used to characterize high-risk adults and have yielded inconclusive evidence regarding their strength as predictors of hepatitis B vaccine status [5]. Relationship status was created from the original field “marital status” by dichotomizing the original fields into “in a relationship” (“married” or “member of an unmarried couple”) and “not in a relationship” (“divorced”, “widowed”, “single” or “separated”) to reflect both the extent of social support and the risk of acquisition or transmission of hepatitis B through sexual activity. Age was also redefined in order to distinguish between individuals who were eligible for catch-up vaccines at the time of the study and those who were not. The new categories included “18–33 years” and “older than 33 years of age”.

Variables included under access to health care collectively corresponded to barriers to establishing contact with the health care system, including health insurance status (“insured” or “uninsured”), established source of primary

**Fig. 1** Participant selection: illustration of the selection procedure of participants eligible for inclusion in the study. BRFSS Behavioral Risk Factor Surveillance Survey



**Table 1** Demographic, health care access, and health care utilization variables among high-risk adults, aged 18 years and older

Potential predictors	Vaccinated against hepatitis B ( <i>n</i> = 6,770; 44%)	Not vaccinated against hepatitis B ( <i>n</i> = 8,662; 56%)	<i>p</i> value for heterogeneity
<b>Demographics</b>			
<b>Sex</b>			
Male	47% ( <i>n</i> = 3,331)	53% ( <i>n</i> = 4,924)	0.01
Female	52% ( <i>n</i> = 3,439)	48% ( <i>n</i> = 3,738)	
<b>Race</b>			
Hispanic	46% ( <i>n</i> = 592)	54% ( <i>n</i> = 655)	0.68
White	48% ( <i>n</i> = 4,632)	52% ( <i>n</i> = 6,258)	
Black or African American	52% ( <i>n</i> = 948)	48% ( <i>n</i> = 1,043)	
Asian	49% ( <i>n</i> = 85)	51% ( <i>n</i> = 77)	
Native Hawaiian or Pacific Islander	52% ( <i>n</i> = 20)	48% ( <i>n</i> = 35)	
American Indian or Alaskan Native	58% ( <i>n</i> = 170)	42% ( <i>n</i> = 178)	
Other	46% ( <i>n</i> = 73)	54% ( <i>n</i> = 95)	
Multiracial	53% ( <i>n</i> = 207)	47% ( <i>n</i> = 222)	
<b>Relationship status</b>			
In a relationship (married, a member of an unmarried couple)	44% ( <i>n</i> = 1,465)	56% ( <i>n</i> = 1,974)	<0.01
Not in a relationship (single, divorced, widowed, separated)	51% ( <i>n</i> = 1,465)	49% ( <i>n</i> = 2,469)	
<b>Income</b>			
Less than \$10,000	44% ( <i>n</i> = 500)	56% ( <i>n</i> = 751)	0.05
Less than \$15,000	44% ( <i>n</i> = 402)	56% ( <i>n</i> = 663)	
Less than \$20,000	45% ( <i>n</i> = 538)	55% ( <i>n</i> = 714)	
Less than \$25,000	48% ( <i>n</i> = 666)	52% ( <i>n</i> = 800)	
Less than \$35,000	48% ( <i>n</i> = 809)	52% ( <i>n</i> = 1,041)	
Less than \$50,000	45% ( <i>n</i> = 942)	55% ( <i>n</i> = 1,251)	
Less than \$75,000	50% ( <i>n</i> = 913)	50% ( <i>n</i> = 1,180)	
More than \$75,000	51% ( <i>n</i> = 1,419)	49% ( <i>n</i> = 1,511)	
<b>Age (years)</b>			
18–33	61% ( <i>n</i> = 1,374)	39% ( <i>n</i> = 587)	<0.01
Older than 33	36% ( <i>n</i> = 1,509)	64% ( <i>n</i> = 1,243)	
<b>Education</b>			
Never attended school or only attended kindergarten	40% ( <i>n</i> = 15)	60% ( <i>n</i> = 15)	0.01
Elementary (Grade 1 through 8)	32% ( <i>n</i> = 98)	68% ( <i>n</i> = 320)	
Some high school (Grade 9 through 11)	44% ( <i>n</i> = 524)	56% ( <i>n</i> = 802)	
High school graduate (Grade 12 or GED)	47% ( <i>n</i> = 1,741)	53% ( <i>n</i> = 2,592)	
Some college or technical school (College 1 year to 3 years)	52% ( <i>n</i> = 2,115)	48% ( <i>n</i> = 2,345)	
College graduate (College 4 years or more)	51% ( <i>n</i> = 2,271)	49% ( <i>n</i> = 2,563)	
<b>Access to health care</b>			
<b>Health insurance coverage</b>			
Insured	51% ( <i>n</i> = 1,365)	49% ( <i>n</i> = 2,019)	<0.01
Uninsured	43% ( <i>n</i> = 5,372)	57% ( <i>n</i> = 6,620)	
<b>Regular provider</b>			
No	46% ( <i>n</i> = 1,530)	54% ( <i>n</i> = 2,173)	0.12
Yes, only one	50% ( <i>n</i> = 4,643)	50% ( <i>n</i> = 5,760)	
Yes, more than one	46% ( <i>n</i> = 574)	54% ( <i>n</i> = 707)	
<b>Could not see a doctor because of cost</b>			
No	50% ( <i>n</i> = 5,243)	50% ( <i>n</i> = 6,531)	<0.01
Yes	43% ( <i>n</i> = 1,521)	57% ( <i>n</i> = 2,107)	

**Table 1** continued

Potential predictors	Vaccinated against hepatitis B ( <i>n</i> = 6,770; 44%)	Not vaccinated against hepatitis B ( <i>n</i> = 8,662; 56%)	<i>p</i> value for heterogeneity
Health care utilization			
Last time you had a routine check-up			
Never	39% ( <i>n</i> = 68)	61% ( <i>n</i> = 159)	<0.01
Within the past year	52% ( <i>n</i> = 4,350)	48% ( <i>n</i> = 5,125)	
Within the past 2 years	49% ( <i>n</i> = 1,039)	51% ( <i>n</i> = 1,207)	
Within the past 5 years	51% ( <i>n</i> = 702)	49% ( <i>n</i> = 915)	
5 years or more	32% ( <i>n</i> = 542)	68% ( <i>n</i> = 1,097)	
Influenza vaccine in past 12 months			
No	45% ( <i>n</i> = 4,188)	55% ( <i>n</i> = 6,089)	<0.01
Yes	57% ( <i>n</i> = 2,541)	43% ( <i>n</i> = 2,543)	
Ever had a pneumonia vaccine			
No	44% ( <i>n</i> = 4,169)	56% ( <i>n</i> = 6,386)	<0.01
Yes	61% ( <i>n</i> = 1,682)	39% ( <i>n</i> = 1,555)	
Location of HIV testing			
Not tested	56% ( <i>n</i> = 2,764)	44% ( <i>n</i> = 1,654)	<0.01
Private doctor or HMO	66% ( <i>n</i> = 1,805)	34% ( <i>n</i> = 1,748)	
Counseling or testing site	50% ( <i>n</i> = 248)	50% ( <i>n</i> = 272)	
Hospital	63% ( <i>n</i> = 729)	37% ( <i>n</i> = 672)	
Clinic	51% ( <i>n</i> = 1,233)	49% ( <i>n</i> = 1,273)	
Jail or prison or other correctional facility	29% ( <i>n</i> = 89)	71% ( <i>n</i> = 144)	
Drug treatment facility	44% ( <i>n</i> = 57)	56% ( <i>n</i> = 64)	
At home	30% ( <i>n</i> = 61)	70% ( <i>n</i> = 113)	
Somewhere else	62% ( <i>n</i> = 324)	38% ( <i>n</i> = 259)	

HIV, Human immunodeficiency virus; HMO, health maintenance organization

care (“no”, “yes, only one”, and “yes, more than one”), and cited financial barrier to necessary care (“yes” or “no”).

Finally, variables that reflected points of contact with the health care system or health care utilization, included recency of last routine checkup (“never”, “within the last year”, “within the past 2 years”, “within the past 5 years”, “5 years or more”), a vaccination against influenza in the past 12 months, ever being vaccinated against pneumonia, and HIV testing status and location (“never tested”, “private doctor/health maintenance organization (HMO)”, “counseling or testing site”, “hospital”, “clinic”, “jail/prison/correctional facility”, “drug treatment facility”, “home”, “somewhere else”) were considered as potential missed opportunities.

#### Statistical analysis

The STATA statistical software program version 10 was used for all analyses [13]. Survey commands were used to account for sampling weights and to obtain standard errors that take complex survey designs into consideration. Weighted proportions were used to describe the

distribution of demographic characteristics with respect to vaccine status. Potential predictors for vaccine receipt among high-risk adults were first analyzed univariately using the chi-square statistic for homogeneity across proportions. Variables with a *p* value of <0.25 were considered for inclusion into the final logistic model. The relationship between multiple covariates and the outcome was assessed using backward-selection multivariate logistic regression. Covariates with at least one coefficient significant at a *p* value of  $\leq 0.05$  were retained in the model. Weak predictors (*p* value between 0.05 and 0.25) with a significant theoretical potential for confounding were also retained. A weak predictor was considered to be a confounder if it changed any coefficient by at least 10%. Estimates of association between potential predictors and hepatitis B vaccine status were calculated using odds ratios (ORs).

Sensitivity analysis was performed to determine if individuals with missing information with regard to hepatitis B immunization status differed significantly from those with information on vaccine status. This was done by repeating the analysis first with individuals with missing hepatitis B immunization status coded as immunized and

then with those with individuals coded as eligible for immunization. If the conclusions were not altered by assigning all missing observations to immunized or not (worst case scenario), then the observed relationships were considered to be robust.

## Results

Among high-risk respondents (20,431 adults ages 18 years and older), information regarding hepatitis B vaccine status was available for 15,432 respondents, of whom 6,770 (44%) reported being vaccinated against hepatitis B and 8,662 (56%) reported being unvaccinated against hepatitis B.

Results from the univariate analysis (Table 1) indicate that the proportion of high-risk adults vaccinated against hepatitis B compared to those who were not vaccinated against hepatitis B varied significantly by relationship status, age, health insurance status, cost as cited barrier to needed care, influenza and pneumonia vaccine receipt, and HIV testing location status ( $p < 0.01$ ).

In this cohort, a greater percentage of individuals who were aged 18–33 years (those eligible for catch-up vaccination) reported being vaccinated against hepatitis B (61%) in comparison to adults older than 33 (36%). Conversely, a smaller percentage of individuals who reported being in a relationship were vaccinated against hepatitis B (44%) in comparison to those who reported not being in a relationship (51%). In addition to being statistically significantly different by vaccination status, age and relationship status were also identified as confounders. As such, they were accounted for in the final adjusted logistic regression model (Table 2).

In terms of health care utilization, a greater percentage of individuals with prior receipt of either the influenza or pneumonia vaccine (57 and 61%, respectively) reported being vaccinated against hepatitis B in comparison to those who had not been immunized against either influenza or pneumonia (45 and 44%, respectively). When HIV testing location was stratified by hepatitis B vaccine status, a smaller percentage of individuals who had been tested for HIV at a jail/prison/correctional facility or a drug treatment facility reported being vaccinated against hepatitis B (29 and 44%, respectively) in comparison to individuals who had been tested for HIV at a private doctor/HMO, hospital, clinic, or counseling and testing site (66, 63, 51, and 50%, respectively).

### Predictors of hepatitis B vaccine coverage in high-risk adults

When other predictors in the model were controlled for, high-risk adults who were vaccinated against pneumonia and influenza had an increased OR of being vaccinated

**Table 2** Potential predictors for hepatitis B vaccine receipt among high-risk adults

Predictors for vaccine status	Adjusted odds ratio (95% confidence interval)
Ever had a pneumonia shot	
No	1.00 (reference)
Yes	2.27 (1.80–2.87)
Influenza vaccine in the past 12 months	
No	1.00 (reference)
Yes	1.67 (1.38–2.03)
Location of HIV testing	
Not tested	1.00 (reference)
Somewhere else	2.12 (1.29–3.50)
Private doctor or HMO	1.89 (1.47–2.41)
Counseling and testing site	1.78 (0.93–3.45)
Hospital	1.54 (1.17–2.04)
Clinic	1.35 (1.03–1.76)
Jail or prison	0.60 (0.33–1.08)
Drug treatment facility	1.73 (0.64–4.68)
At home	1.08 (0.60–1.95)
Health Insurance status	
Uninsured	1.00 (reference)
Insured	1.39 (1.08–1.79)
Age (eligible for catch-up vaccination)	
18–33 years	1.00 (reference)
Older than 33 years	0.33 (0.27–0.40)
Relationship status	
Not in a relationship	1.00 (reference)
In a relationship	1.21 (1.00–1.45)
Could not see a doctor because of cost	
No	1.00 (reference)
Yes	0.77 (0.60–0.98)
Sex	
Male	1.00 (reference)
Female	0.84 (0.70–1.01)

against hepatitis B compared to those who had not vaccinated against pneumonia and influenza [OR 2.27, 95% confidence interval (CI) 1.80–2.87] and OR 1.68, 95% CI 1.39–2.03, respectively). Similarly, individuals with health insurance had a higher OR of being vaccinated against hepatitis B than those without insurance (OR 1.39, 95% CI 1.08–1.80). By contrast, individuals who reported being unable to see a doctor because of cost had a lower OR of being vaccinated against hepatitis B (OR 0.77, 95% CI 0.60–0.98).

Lastly, HIV testing location was an important predictor of hepatitis B vaccine status. High-risk adults who had been tested for HIV at a private doctor's office or HMO, a counseling and testing site, a hospital, a clinic, a drug treatment facility, or somewhere else had a higher OR of



being vaccinated than those who had not been tested for HIV (OR 1.88, 95% CI 1.47–2.41; OR 1.79, 95% CI 0.93–3.41; OR 1.54, 95% CI 1.17–2.04; OR 1.34, 95% CI 1.03–1.76; OR 1.74, 95% CI 0.64–4.68; OR 2.12, 95% CI 1.29–3.50, respectively). The opposite relationship was true among individuals tested for HIV at a correctional facility (OR 0.60, 95% CI 0.33–1.07). However, associations observed between hepatitis B vaccine receipt and HIV testing at a testing and counseling site, a drug treatment facility, and jails/correctional facilities were not significant, possibly partially reflecting the fact that the total number of people who reported being tested at these sites was low ( $n = 526, 233, \text{ and } 121$ , respectively). A strong relationship between being tested in other unclassified settings (reported as “somewhere else”) was observed despite comparably low sample sizes ( $n = 583$ ), thereby reflecting the strength of the identified association.

Sex was a weak predictor ( $p = 0.061$ ) but was retained in the model due to the potential impact it has on patterns of health care utilization.

Sensitivity analysis conducted on individuals with missing information with regard to hepatitis B vaccine status indicated that the observed conclusions were not altered when extreme values were assumed for the missing data.

## Discussion

This study provides a nationally representative estimate for hepatitis B vaccine coverage among high-risk adults ( $\geq 18$  years of age) in the USA. The 2007 BRFSS data indicate that receipt of the complete hepatitis B vaccine series continues to be low in this population, with over half of respondents reporting that they were never vaccinated against hepatitis B (56.13%). Consistent with past research, missed opportunities were frequent in this population, particularly among those adults who reported being tested for HIV at jails or correctional facilities (71%). Other factors that were significantly associated with completing the hepatitis B vaccine series included receipt of previous vaccines (pneumonia and influenza), health insurance status, prohibitive costs associated with seeing a doctor, age group, sex, and being in a relationship. The increased likelihood of hepatitis B vaccine receipt observed among adults 18–33 years of age likely reflects policy amendments made in the early 1990s, which universalized hepatitis B vaccination at birth in the USA and initiated catch-up vaccination programs for children and adolescents. Past studies, both domestically in Alaska as well as internationally, have documented similar distributions in hepatitis B vaccine receipt, where younger adults were more likely to have been vaccinated due to catch-up

vaccination programs than older adults [14, 15]. The associations between sex and relationship status may reflect previously documented increased utilization of health services by women and by those in relationships [16, 17].

Previous receipt of other vaccines was an independent predictor of hepatitis B vaccine status, where adults who reported prior receipt of immunizations against pneumonia and/or influenza also had a greater OR of being vaccinated against hepatitis B. This association could be a reflection of provider or patient practices [18]. Since chronic liver disease due to causes other than hepatitis B is indicator for influenza and pneumonia vaccination, one may expect a significant correlation—at least amongst this subgroup [5]. Alternatively, one could posit that patients who reported receiving the influenza and/or pneumonia vaccine have a heightened awareness of the utility and importance of vaccines in disease prevention and therefore were more likely to accept or request a vaccine against hepatitis B [19].

By contrast, individuals who reported being uninsured were less likely to be vaccinated against hepatitis B. This finding is not unexpected given the paucity of federal public funds allocated to purchasing vaccines for the uninsured adult population in the USA and the often suboptimal coverage for adult vaccines under private insurance plans [20, 21]. In 2005, a total of only 4.5% of the \$234,897,000 funds appropriated for the purchase of vaccines was used for adult populations, yielding a funding shortfall of approximately \$160 million [20]. This translates into a substantial proportion of uninsured adults being unable to access recommended immunization services through federally funded vaccination programs. Without health insurance, each dose of the hepatitis B vaccine can cost up to \$100.00, including the fee for administration [22]. For individuals with government-sponsored insurance (Medicaid), the fee for vaccination is between \$0.50 and \$6.00 for each hepatitis B vaccine, depending on the U.S. state of residence [23]. However, strict eligibility criteria for Medicaid may prevent a large proportion of high-risk adults from benefiting from subsidized vaccination rates. As a result, high costs associated with this vaccine may discourage uptake in this population. This may explain, in part, why immunization rates have remained consistently low among uninsured high-risk adults.

In addition to inadequate insurance coverage for hepatitis B vaccination, low rates of vaccination, even amongst the insured may indicate poor levels of physician adherence to clinical practice guidelines. In a 2007 review by Cabana et al. [26] and a 2009 national survey that specifically addressed provider adherence to hepatitis B guidelines, external barriers, including lack of a reminder



**Table 3** Recommendation 4-3 from the 2010 Institute of Medicine report—additional federal and state resources should be devoted to increasing hepatitis B vaccination of at-risk adults

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Correctional institutions should offer hepatitis B vaccination to all incarcerated persons
Accelerated schedules for vaccine administration should be considered for jail inmates
Organizations that serve high-risk people should offer the hepatitis B vaccination series
Efforts should be made to improve identification of at-risk adults
Health care providers should routinely seek risk histories from adult patients through direct questioning and self assessment
Efforts should be made to increase rates of completion of the vaccine series in adults
Federal and state agencies should determine gaps in hepatitis B vaccine coverage among at-risk adults annually and estimate the resources needed to fill the gaps

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system, lack of counseling materials, insufficient staff or consultant support, poor reimbursement, increased practice costs, and increased liability, were found to undermine physician adherence to established guidelines, even among physicians with an awareness of and familiarity with clinical guidelines [24–26]. Their findings suggest that low levels of physician adherence may reflect broader resource limitations and structural problems in the financing of health care. Thus, in order for physician care visits to be an effective point of delivery for immunization services, concerns regarding resource constraints and inadequate reimbursement for vaccinating under- and uninsured populations need to be addressed.

Finally, missed opportunities for hepatitis B vaccination continue to occur in vaccine delivery settings frequented by high-risk adults, such as prisons and jails, drug treatment centers, and HIV counseling and testing sites. The importance of capitalizing on contacts with the health care system to improve hepatitis B vaccine coverage is stressed in both the 2006 comprehensive immunization strategy to eliminate transmission of hepatitis B virus in the USA issued by the CDC and the 2010 Institute of Medicine (IOM) report on the “national strategy for prevention and control of hepatitis B and C” [3, 9]. In the IOM report, committee members place special emphasis on eradicating missed opportunities for hepatitis B vaccine receipt, particularly in facilities such as prisons and jails, STD clinics, and drug treatment centers that experience high rates of recidivism and a high degree of overlap in persons seen at these locations [2, 9]. The routine use of standing orders and targeted education has been recommended as a means of improving vaccination coverage in these settings; however, perpetual underfunding and understaffing limits the ability of immunization programs to implement these strategies [2, 3]. Scarcity of funding and systematic vaccination of high-risk adults when they come into contact with the health care system are collectively addressed in the recommendations issued by the IOM (Table 3).

Our findings confirm the inadequacy of vaccine service provision at the key care access points highlighted in the IOM report. Among all locations assessed, individuals who

received their HIV testing at correctional facilities were the least likely to be vaccinated against hepatitis B in comparison to those who had not been tested for HIV. This finding is of great concern in light of that fact that at least 20 U.S. states have mandated hepatitis B vaccination of all incarcerated populations [9]. Future research should assess the effectiveness of state prison mandates in a stratified analysis of vaccine receipt in U.S. states with and without vaccine mandates.

#### Limitations

There are several important limitations to this study. First, the BRFSS relies on self-reported data. As such, it is impossible to assess the accuracy of information provided about an individual’s immunization history. Second, the BRFSS asks participants to respond affirmatively to “Have you ever been vaccinated against hepatitis?” only if they have completed the vaccine series. This excludes valuable information about individuals who may be in the course of completing the vaccine series or who may have received immunity from a partial series in the past. Though the response may not be as durable, one dose confers immunity in 55% of those tested, and two doses confers immunity in 85% of those tested [2, 9]. Third, the multi-component BRFSS question on high-risk behavior does not allow for determination of whether vaccination coverage differs within distinct subgroups of high-risk adults. Fourth, the multi-component question about HIV testing locations did not specify the types of clinics included under the category “clinics”. Individual interpretation of the word “clinic” may vary. For some respondents a clinic could mean a free clinic, needle-exchange, STD, or simply a walk-in clinic that does not require that everyone be an established patient. This also limits the ability to target interventions based on the observed low vaccination rates in this group.

#### Conclusions

The results of this study, in combination with recommendations issued by the IOM, underscore the inadequacy of

vaccination coverage in high-risk adults and highlight areas of opportunity to bridge gaps in vaccination coverage. Locations serving high-risk populations need to be made key partners in the national effort to reduce hepatitis B transmission. A significant part of this effort will involve collaboration with such facilities to determine and address deficits in human resources, organizational capacity, vaccine availability, and reimbursement that limit systematic vaccination of high-risk adults. Given burgeoning ranks of the uninsured and underinsured, support for programs through U.S. state and local departments of health that provide vaccines to at-risk populations will be critical. By working together to address these barriers, immunization uptake among high-risk adults can be markedly improved, in turn diminishing the burden of hepatitis B disease in the USA.

**Conflict of interest** None.

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