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Major Article

Characteristics associated with hepatitis B vaccination initiation and completion among adults traveling to a country of high or intermediate endemicity

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Key Words:
Hepatitis B vaccination
Adults
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Coverage

Background: The hepatitis B (HepB) vaccine is recommended for adults traveling to a country of high or intermediate endemicity.
Methods: Data from the 2016 and 2017 National Health Interview Surveys were pooled.
Results: The weighted prevalence of HepB vaccination initiation (≥1 dose) was 37.67% in 2016 (weighted number: 30,581,813/81,192,803) and 40.20% in 2017 (weighted number: 34,509,993/85,849,427). The weighted prevalence of HepB vaccination completion (≥3 doses) was 29.97% in 2016 (weighted number: 24,331,218/81,192,803) and 31.78% in 2017 (weighted number: 27,282,536/ 85,849,427). Characteristics independently associated with HepB vaccination initiation (in descending order by odds ratio) included age, receipt of influenza vaccine, education, ever having lived with someone with hepatitis, class of worker, number of physician visits in the past 12 months, ratio of family income to the poverty threshold, region, sexual orientation, gender, heath insurance, computer use, physical activity, and Hispanic ethnicity. Similar results were found in the analysis for HepB vaccination completion, except that subjects born in the United States showed a higher likelihood of HepB vaccination completion.
Conclusions: HepB vaccination initiation and completion were associated with a number of characteristics that can be utilized to develop strategies to increase HepB vaccination coverage among adults traveling to a country of high or intermediate endemicity.

The global prevalence of hepatitis B surface antigen in the general population in 2016 was estimated to be 3.9%, corresponding to 291,992,000 infections.[1] Of these infections, around 10% were diagnosed, and only 5% of individuals eligible for treatment actually received antiviral therapy.[1]

From 2012 through 2016, 15,324 cases of acute hepatitis B virus (HBV) infection were reported in the United States, but the actual number of acute cases is believed to be 6.5 times the number of reported cases.[2] The incidence of acute hepatitis B (HepB) is greatest for persons 30 to 49 years of age (>2 per 100,000 population) in the United States.[2] Because no virological cure exists for HBV infection, the best way to prevent new HBV infections is by interrupting transmission through effective use of the HepB vaccine,[3,4] and ending transmission would require immunization of every susceptible person in a population.[5] To reduce the health burden of HepB among adults, the US Centers for Disease Control and Prevention Advisory Committee on Immunization Practices recommended routine HepB vaccination for adults who are at increased risk for infection, including adults traveling to a country of high or intermediate endemicity of HepB, or for any person wishing to obtain immunity.[6] Timely updates on vaccination coverage estimates is important to developing a better understanding of the factors that contribute to low vaccination rates and modifying strategies and interventions to improve vaccination coverage. The National Health Interview Survey (NHIS) serves as an important source of information on the health of the civilian, non-institutionalized population of the United States. From 2010 through 2015, HepB vaccination coverage in the United States

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decreased overall among adults who were ≥19 years of age.[5] The most recent national estimate of HepB vaccination coverage (≥3 doses), based on the 2015 NHIS, was 24.6% for adults who were ≥19 years of age.[7] In addition, information on factors associated with HepB vaccination coverage among US adults is limited.[8] Therefore, based on the 2016 and 2017 NHIS, the objective of this study was to identify characteristics associated with HepB vaccination among US adults traveling to a country of high or intermediate endemicity of HepB.

MATERIALS AND METHODS

The NHIS is a nationally representative, cross-sectional household interview survey. The sample design followed a multistage area probability design. To increase the sample size, we combined the merged data (Family, Person, and Sample Adult files) from the 2016 and 2017 NHIS. The conditional response rates for the Family section were 98.9% in 2016 and 98.9% in 2017, and they were 80.9% in 2016 and 80.7% in 2017 for the Sample Adult section. Questions related to adult HepB immunizations included asking if the respondent had ever received the HepB vaccine and the number of HepB shots received. The NHIS was approved by the Research Ethics Review Board of the National Center for Health Statistics. In this analysis, we limited the adults to those having traveled to regions with intermediate or high prevalence of HepB virus infection (defined as travel outside of the United States since 1995 to locations other than Europe, Japan, Australia, New Zealand, or Canada).[8,9]

In this analysis, persons self-reporting the receipt of 3 or more doses of HepB vaccine were considered to be fully vaccinated for HepB. Based on previous studies,[8,9] we included 6 demographic characteristics (gender, age, region, race, Hispanic ethnicity, and nativity disparity), 6 socioeconomic characteristics (marital status, class of worker, education, computer usage, health insurance coverage, and ratio of family income to the poverty threshold), 5 health behavior characteristics (smoking, drinking, light/moderate physical activity, pneumonia vaccine, influenza vaccine), and 1 health care characteristic (number of physician visits in the past 12 months). Specific risk factors of HepB infection included sexual orientation, chronic liver disease (defined as those who answered "yes" to the question, "Has a doctor or other health professional ever told you that you had any kind of chronic or long-term liver condition?"),[8] and ever having lived with someone with hepatitis. Characteristics with 3 or more categories were treated as indicator (dummy) variables in the logistic analysis. Characteristics were then included in the multivariate model if the P values were <.10 in individual univariate logistic models. The above-mentioned specific risk factors of HepB infection were included in the multivariate model regardless of the P values. According to the NHIS, survey procedures were used to account for the multistaged, clustered, and stratified sample design. In addition, to achieve annualized results the sampling weight for pooled data was adjusted by dividing by 2. Stata 12 software (StataCorp LLC; College Station, TX) was used, and $P \leq .05$ was considered statistically significant.

RESULTS

After excluding respondents who answered "don't know" or did not provide an answer (weighted percentage: 9.64%), this analysis included 19,123 adults (weighted number: 167,042,230) who were ≥18 years old and had traveled to a country of high or intermediate endemicity. The weighted prevalence of HepB vaccination initiation (≥1 dose) was 37.67% in 2016 (weighted number: 30,581,813/81,192,803) and 40.20% in 2017 (weighted number: 34,509,993/85,849,427). The weighted prevalence of HepB vaccination completion (≥3 doses) was 29.97% in 2016 (weighted number: 24,331,218/81,192,803) and 31.78% in 2017 (weighted number: 27,282,536/85,849,427). Detailed results from the univariate and multivariate analyses are shown in Table 1.

Adults who have a specific risk

In the multivariate analysis, those who had ever lived with someone with hepatitis (initiation: adjusted odds ratio [aOR], 1.60, 95% confidence interval [CI], 1.29-1.98; completion: aOR, 1.50, 95% CI, 1.19-1.89) and gay/lesbian/bisexual orientation (initiation: aOR, 1.30, 95% CI, 1.04-1.63; completion: aOR, 1.30, 95% CI, 1.00-1.68) showed a higher likelihood of HepB vaccination. Subjects with chronic liver disease showed a non-significantly higher likelihood of HepB vaccination initiation and completion.

Demographic characteristics

In multivariate analysis, subjects living in the Western United States (initiation: aOR, 1.31, 95% CI, 1.13-1.52; completion: aOR, 1.44, 95% CI, 1.23-1.68), who were female (initiation: aOR, 1.30, 95% CI, 1.18-1.42; completion: aOR, 1.31, 95% CI, 1.19-1.44), and who were of non-Hispanic ethnicity (initiation: aOR, 1.17, 95% CI, 1.01-1.35; completion: aOR, 1.27, 95% CI, 1.08-1.49) had a higher likelihood of HepB vaccination. Subjects who were ≥80 years of age (initiation: aOR, 0.09, 95% CI, 0.06-0.13; completion: aOR, 0.06, 95% CI, 0.04-0.10), 60 to 79 years of age (initiation: aOR, 0.23, 95% CI, 0.20-0.26; completion: aOR, 0.21, 95% CI, 0.19-0.25), and 40 to 59 years of age (initiation: aOR, 0.46, 95% CI, 0.41-0.51; completion: aOR, 0.44, 95% CI, 0.39-0.49) had a lower likelihood of HepB vaccination. Subjects born in the United States showed a higher likelihood of HepB vaccination completion (aOR, 1.19, 95% CI, 1.02-1.38) but not initiation (aOR, 1.11, 95% CI, 0.97-1.28).

Socioeconomic characteristics

In multivariate analysis, being employed by the government (initiation: aOR, 1.45, 95% CI, 1.30-1.61; completion: aOR, 1.49, 95% CI, 1.32-1.67), use of a computer on a daily basis (initiation: aOR, 1.23, 95% CI, 1.09-1.39; completion: aOR, 1.26, 95% CI, 1.10-1.45), education level of associate degree or higher (initiation: aOR, 1.65, 95% CI, 1.43-1.90; completion: aOR, 1.66, 95% CI, 1.42-1.95), having some college but no degree (initiation: aOR, 1.36, 95% CI, 1.17-1.58; completion: aOR, 1.36, 95% CI, 1.15-1.61), and having private health insurance (initiation: aOR, 1.28, 95% CI, 1.05-1.56; completion: aOR, 1.30, 95% CI, 1.05-1.60) were associated with higher adjusted odds of HepB vaccination. However, ratios of family income to the poverty threshold that were ≥4 (initiation: aOR, 0.74, 95% CI, 0.62-0.90; completion: aOR, 0.76, 95% CI, 0.63-0.93), 2 to 4 (initiation: aOR, 0.80, 95% CI, 0.67-0.96; completion: aOR, 0.81, 95% CI, 0.67-0.99), and 1 to 2 (initiation: aOR, 0.77, 95% CI, 0.64-0.94; completion: aOR, 0.77, 95% CI, 0.63-0.95) were associated with lower adjusted odds of HepB vaccination.

Health behavior characteristics

In multivariate analysis, subjects engaged in physical activity ≥5 times/week (initiation: aOR, 1.22, 95% CI, 1.09-1.36; completion: aOR, 1.18, 95% CI, 1.05-1.34) or 1 to 4 times/week (initiation: aOR, 1.18, 95% CI, 1.05-1.33; completion: aOR, 1.18, 95% CI, 1.04-1.34) and subjects ever receiving an influenza vaccine (initiation: aOR, 1.92, 95% CI, 1.75-2.11; completion: aOR, 2.05, 95% CI, 1.85-2.28) had a higher likelihood of HepB vaccination. In addition, current drinkers showed a marginally lower likelihood of HepB vaccination (initiation: aOR, 0.87, 95% CI, 0.76-1.00; completion: aOR, 0.86, 95% CI, 0.73-1.00).

Health care characteristic

Compared with those having no physician visit in the past 12 months, adults having 1 physician visit (initiation: aOR, 1.20, 95% CI,

Table 1
Characteristics associated with hepatitis B vaccination initiation and completion from weighted logistic regression among adults traveling to a country of high or intermediate endemicity (2016 and 2017 National Health Interview Surveys)

	Initiation (at least 1 dose) vs none					Completion (3 or more doses) vs none				
Characteristic	Unweighted N	Crude OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value	Unweighted N	Crude OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value
Chronic liver diseases										
No	18,856	1.00	—	1.00	—	17,415	1.00	—	1.00	—
Yes	256	1.28 (0.95-1.73)	.11	1.41 (0.92-2.17)	.12	234	1.26 (0.91-1.74)	.17	1.28 (0.79-2.06)	.31
Ever lived with someone with hepatitis										
No	17,698	1.00	—	1.00	—	16,376	1.00	—	1.00	—
Yes	777	1.58 (1.31-1.90)	<.01	1.60 (1.29-1.98)	<.01	700	1.54 (1.26-1.89)	<.01	1.50 (1.19-1.89)	<.01
Sexual orientation										
Not gay (male) or lesbian (female)	18,163	1.00	—	1.00	—	16,782	1.00	—	1.00	—
Gay (male), lesbian (female), bisexual	580	1.81 (1.46-2.25)	<.01	1.30 (1.04-1.63)	.02	517	1.82 (1.43-2.31)	<.01	1.30 (1.00-1.68)	.05
Gender										
Male	9128	1.00	—	1.00	—	8447	1.00	—	1.00	—
Female	9995	1.33 (1.24-1.44)	<.01	1.30 (1.18-1.42)	<.01	9213	1.35 (1.24-1.46)	<.01	1.31 (1.19-1.44)	<.01
Born in the United States										
No	4401	1.00	—	1.00	—	4027	1.00	—	1.00	—
Yes	14,718	1.30 (1.19-1.42)	<.01	1.11 (0.97-1.28)	.13	13,629	1.42 (1.29-1.57)	<.01	1.19 (1.02-1.38)	.03
Age										
18-39	7105	1.00	—	1.00	—	6390	1.00	—	1.00	—
40-59	6457	0.51 (0.47-0.56)	<.01	0.46 (0.41-0.51)	<.01	6001	0.50 (0.46-0.55)	<.01	0.44 (0.39-0.49)	<.01
60-79	4875	0.30 (0.27-0.33)	<.01	0.23 (0.20-0.26)	<.01	4611	0.29 (0.26-0.32)	<.01	0.21 (0.19-0.25)	<.01
≥80	686	0.12 (0.09-0.18)	<.01	0.09 (0.06-0.13)	<.01	658	0.10 (0.07-0.15)	<.01	0.06 (0.04-0.10)	<.01
Region										
Northeast	3108	1.00	—	1.00	—	2867	1.00	—	1.00	—
Midwest	4026	1.10 (0.96-1.26)	.16	1.07 (0.93-1.24)	.33	3735	1.11 (0.96-1.29)	.14	1.07 (0.92-1.25)	.39
South	6177	0.94 (0.83-1.06)	.31	0.97 (0.85-1.10)	.64	5664	0.91 (0.79-1.04)	.17	0.94 (0.82-1.09)	.42
West	5812	1.21 (1.06-1.37)	<.01	1.31 (1.13-1.52)	<.01	5394	1.28 (1.11-1.47)	<.01	1.44 (1.23-1.68)	<.01
Race										
Black	1437	1.00	—	1.00	—	1294	1.00	—	1.00	—
White	15,662	0.94 (0.82-1.09)	.43	0.85 (0.72-1.00)	.06	14,523	1.00 (0.85-1.17)	1.00	0.88 (0.73-1.05)	.16
Asian	1807	1.18 (1.00-1.39)	.05	0.96 (0.78-1.18)	.68	1647	1.21 (1.02-1.46)	.03	0.97 (0.78-1.21)	.78
Hispanic ethnicity										
Yes	2908	1.00	—	1.00	—	2659	1.00	—	1.00	—
No	16,215	1.32 (1.17-1.48)	<.01	1.17 (1.01-1.35)	.03	15,001	1.45 (1.26-1.66)	<.01	1.27 (1.08-1.49)	<.01
Marital status										
Never married	4051	1.00	—	1.00	—	3645	1.00	—	1.00	—
Married or living with partner	11,185	0.66 (0.60-0.74)	<.01	0.98 (0.87-1.10)	.69	10,373	0.67 (0.61-0.75)	<.01	0.99 (0.87-1.13)	.89
Widowed, divorced, or separated	3866	0.46 (0.40-0.53)	<.01	0.92 (0.79-1.08)	.29	3621	0.44 (0.39-0.51)	<.01	0.91 (0.77-1.07)	.24
Class of worker										
Employee of private company	14,692	1.00	—	1.00	—	13,593	1.00	—	1.00	—
Government employee	3659	1.42 (1.29-1.55)	<.01	1.45 (1.30-1.61)	<.01	3374	1.48 (1.33-1.64)	<.01	1.49 (1.32-1.67)	<.01
Computer use										
Not every day	4770	1.00	—	1.00	—	4448	1.00	—	1.00	—
Every day	14,281	1.99 (1.80-2.20)	<.01	1.23 (1.09-1.39)	<.01	13,147	2.17 (1.95-2.42)	<.01	1.26 (1.10-1.45)	<.01
Education										
High school or below	4147	1.00	—	1.00	—	3898	1.00	—	1.00	—
Some college, no degree	3546	1.76 (1.54-2.01)	<.01	1.36 (1.17-1.58)	<.01	3248	1.82 (1.57-2.11)	<.01	1.36 (1.15-1.61)	<.01
Associate degree or higher	11,395	2.15 (1.91-2.43)	<.01	1.65 (1.43-1.90)	<.01	10,480	2.31 (2.01-2.65)	<.01	1.66 (1.42-1.95)	<.01

(*continued on next page*)

Table 1 (*Continued*)

Characteristic	Initiation (at least 1 dose) vs none					Completion (3 or more doses) vs none				
	Unweighted N	Crude OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value	Unweighted N	Crude OR (95% CI)	*P* value	Adjusted OR (95% CI)	*P* value
Health insurance										
None	1339	1.00	—	1.00	—	1239	1.00	—	1.00	—
Private	14,786	1.71 (1.45-2.01)	<.01	1.28 (1.05-1.56)	.01	13,622	1.90 (1.60-2.27)	<.01	1.30 (1.05-1.60)	.02
Public	2932	0.96 (0.79-1.18)	.73	1.08 (0.86-1.36)	.52	2741	0.99 (0.79-1.24)	.95	1.07 (0.82-1.38)	.63
Ratio of family income to the poverty threshold										
<1	1806	1.00	—	1.00	—	1611	1.00	—	1.00	—
1-2	2168	0.68 (0.57-0.80)	<.01	0.77 (0.64-0.94)	<.01	1998	0.69 (0.57-0.83)	<.01	0.77 (0.63-0.95)	.02
2-4	4084	0.84 (0.72-0.98)	.03	0.80 (0.67-0.96)	.01	3771	0.89 (0.75-1.05)	.18	0.81 (0.67-0.99)	.04
≥4	8797	0.90 (0.79-1.04)	0.15	0.74 (0.62-0.90)	<0.01	8178	0.99 (0.85-1.15)	0.90	0.76 (0.63-0.93)	<0.01
Drinking										
Abstainer	2725	1.00	—	1.00	—	2502	1.00	—	1.00	—
Former	1877	0.82 (0.70-0.97)	.02	0.94 (0.78-1.14)	.52	1756	0.86 (0.72-1.03)	.10	0.96 (0.78-1.18)	.68
Current	14,406	1.08 (0.95-1.22)	.23	0.87 (0.76-1.00)	.06	13,296	1.11 (0.97-1.27)	.13	0.86 (0.73-1.00)	.05
Smoker										
Never	12,555	1.00	—	1.00	—	11,551	1.00	—	1.00	—
Current	1969	0.85 (0.75-0.97)	.01	1.11 (0.95-1.29)	.19	1832	0.84 (0.73-0.97)	.01	1.11 (0.94-1.31)	.23
Former	4589	0.70 (0.64-0.77)	<.01	0.93 (0.83-1.03)	.18	4267	0.69 (0.63-0.77)	<.01	0.92 (0.82-1.04)	.18
Light/moderate activity (times per week)										
Never	5000	1.00	—	1.00	—	4645	1.00	—	1.00	—
1-4	7099	1.46 (1.31-1.63)	<.01	1.18 (1.05-1.33)	<.01	6549	1.51 (1.34-1.70)	<.01	1.18 (1.04-1.34)	<.01
≥5	6279	1.45 (1.30-1.61)	<.01	1.22 (1.09-1.36)	<.01	5774	1.48 (1.32-1.67)	<.01	1.18 (1.05-1.34)	<.01
Pneumococcal vaccine*										
Never	13,687	1.00	—	—	—	12,677	1.00	—	—	—
Ever	4856	1.06 (0.97-1.16)	.19	—	—	4495	1.07 (0.97-1.17)	.20	—	—
Influenza vaccine										
Never	10,035	1.00	—	1.00	—	9294	1.00	—	1.00	—
Ever	9041	1.63 (1.50-1.77)	<.01	1.92 (1.75-2.11)	<.01	8324	1.74 (1.59-1.90)	<.01	2.05 (1.85-2.28)	<.01
Number of physician visits in the past 12 months										
0	2614	1.00	—	1.00	—	2413	1.00	—	1.00	—
1	3482	1.25 (1.09-1.44)	<.01	1.20 (1.02-1.40)	.03	3210	1.29 (1.11-1.49)	<.01	1.23 (1.04-1.46)	.02
2-3	5463	1.30 (1.15-1.48)	<.01	1.22 (1.05-1.41)	<.01	5052	1.36 (1.18-1.57)	<.01	1.23 (1.04-1.46)	.01
≥4	7544	1.40 (1.25-1.58)	<.01	1.40 (1.22-1.62)	<.01	6967	1.47 (1.29-1.68)	<.01	1.44 (1.23-1.69)	<.01

OR, odds ratio; *CI*, confidence interval.

*The pneumococcal vaccine variable was not included in the multivariate analysis.

1.02-1.40; completion: aOR, 1.23, 95% CI, 1.04-1.46), 2 to 3 physician visits (initiation: aOR, 1.22, 95% CI, 1.05-1.41; completion: aOR, 1.23, 95% CI, 1.04-1.46), or ≥4 physician visits (initiation: aOR, 1.40, 95% CI, 1.22-1.62; completion: aOR, 1.44, 95% CI, 1.23-1.69) in the past 12 months had a higher likelihood of HepB vaccination.

DISCUSSION

From 2010 through 2015, HepB vaccination coverage (≥3 doses) decreased overall among travelers to areas of high or intermediate endemicity who were ≥19 years of age (30.5% to 35.0%; test for trend, $P < .01$), and HepB vaccination coverage (≥3 doses) was 31.6% among international travels in 2015.[5] Similar HepB vaccination coverage (≥3 doses) occurred in 2016 (29.97%) and in 2017 (31.78%).[5] In addition to the specific risk factors for HepB infection, a number of other factors, including demographic, socioeconomic, health behavior, and health care characteristics, were found to be associated with HepB vaccination coverage.

Studies on characteristics associated with HepB vaccination among the US population are limited. Data from the 2000 NHIS showed that young age (18 to 29 years), never being married, having donated blood, and past human immunodeficiency virus (HIV) testing were independently associated with receiving vaccination (≥1 dose) for men.[10] For women, young age (18 to 29 years) and previous vaccinations were significant factors associated with receiving HepB vaccination (≥1 dose).[8] HepB vaccination did not differ significantly by race and educational level.[10] The 2009 NHIS showed that characteristics independently associated with a higher likelihood of HepB vaccination (≥1 dose) included the following: younger age, being female, achieving some higher education, having ≥2 physician contacts in the past year, ever being tested for HIV, being employed in health care, having received an influenza vaccination in the previous year, and ever having received hepatitis A vaccination.[11] There were no significant differences in HepB vaccine uptake (≥1 dose) by race or ethnicity, with the exception of Hispanic adults, who were less likely to be vaccinated, and there was no significant difference in HepB vaccine uptake (≥1 dose) by employment status, poverty level, or insurance status.[11] In addition, the 2015 NHIS showed that characteristics independently associated with HepB vaccination (≥1 dose) among travelers included age, race/ethnicity, educational level, duration of US residence, number of physician contacts in the past year, status of ever being tested for HIV, health care personnel status, and ever having lived with a hepatitis patient.[9]

For HepB vaccination completion, the 2009 NHIS showed that characteristics independently associated with a higher likelihood of HepB vaccination (≥3 doses) included younger age, being female, being non-Hispanic white, achieving some higher education, having ≥4 physician contacts in the past year, ever being tested for HIV, being employed in health care, having received an influenza vaccination in the previous year, and ever having received hepatitis A vaccination,[11] but there were no significant findings with marital status, employment status, poverty level, or health insurance.[11]

Among adults with chronic liver disease, receiving ≥3 doses of HepB vaccination was associated with age (18–49 years), having some college education or higher, living in the Midwest region, and being divorced or separated.[8] Among adults without chronic liver disease, receiving ≥3 doses of HepB vaccination was associated with age (18–49 years), being female, having a high school education or higher, being employed, living at or above the poverty level, having private health insurance, being of non-Hispanic race/ethnicity, living in the Midwest or West regions, never having been married, having received influenza vaccination in the past 12 months, having a primary doctor, having had at least 1 medical office visit in the past 12 months, having traveled to regions with intermediate or high prevalence of HBV infection, and not having diabetes.[6]

Among women of reproductive age, reported HepB vaccination (≥3 doses) was 33% lower for foreign-born (27.3%) than US-born (40.9%) women,[12] and factors associated with vaccination (≥3 doses) in both groups included education, income, and health insurance coverage.[12] Data from the 2015 NHIS showed that characteristics independently associated with vaccination (≥3 doses) among travelers included age, sex, race/ethnicity, educational level, region, duration of US residence, number of physician contacts in the past year, status of ever being tested for HIV, and employment in health care.[9]

This analysis of the most recent data from the NHIS confirmed that rates of HepB vaccination varied based on a number of characteristics. In addition, education, doctor recommendation, and physical activity were also of pivotal importance in acceptance of other recommended vaccines such as the influenza or pneumococcal vaccine.[13-16] This study has several limitations. First, HepB vaccination was based on self-report and may be subject to recall bias. Second, the intervals between doses of HepB vaccination were not available; therefore, the important issue of whether or not the multidose HepB vaccine was administered within the recommended schedule[17,18] cannot be assessed. Finally, knowledge and beliefs about vaccines have been found to be associated with other recommended vaccines;[19,20] however, such information is not available in this analysis.

CONCLUSIONS

To improve the rate of HepB vaccination initiation among adults traveling to a country of high or intermediate endemicity, in addition to focusing on the specific risk factors of HepB infection, policymakers, researchers, and primary care providers should also address the barriers of being older; living in the Northeastern, Midwestern, and Southern United States; being of Hispanic ethnicity; being employed by private companies; not having daily computer use; having a lower education; not having private insurance; having a higher ratio of family income to the poverty threshold; having less physical activity; not receiving an influenza vaccine; and having fewer numbers of physician visits. Overall, the above-mentioned recommendations could also be applicable to improving completion of HepB vaccination. Better education materials and communication methods focusing on these barriers could be developed to improve the coverage of HepB vaccination initiation and completion among adults traveling to a country of high or intermediate endemicity.

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References

1. Polaris Observatory Collaborators. Global prevalence, treatment, and prevention of hepatitis B virus infection in 2016: a modelling study. Lancet Gastroenterol Hepatol 2018;3:383-403.
2. Centers for Disease Control and Prevention. Viral Hepatitis. Available from: https://www.cdc.gov/hepatitis/statistics/. Accessed January 18, 2019.
3. Rosen HR, Ghany MG, Chung RT, et al. NAM 2017 report: a national plan to eliminate hepatitis B and C in the United States by 2030 and the AASLD's response. Hepatology 2017;66:1020-2.
4. Nayagam S, Thursz M, Sicuri E, et al. Requirements for global elimination of hepatitis B: a modelling study. Lancet Infect Dis 2016;16:1399-408.
5. Buckley GJ, Strom BL. What stands in the way of making hepatitis B and C rare diseases in the United States? Ann Intern Med 2016;165:284-5.
6. Centers for Disease Control and Prevention. Table 1. Recommended adult immunization schedule for ages 19 years or older, United States, 2019. Available from: https://www.cdc.gov/vaccines/schedules/hcp/imz/adult.html#f8. Accessed January 18, 2019.
7. Williams WW, Lu PJ, O'Halloran A, et al. Surveillance of vaccination coverage among adult populations - United States, 2015. MMWR Surveill Summ 2017;66:1-28.

8. Yue X, Black CL, O'Halloran A, et al. Hepatitis A and hepatitis B vaccination coverage among adults with chronic liver disease. Vaccine 2018;36:1183-9.
9. Lu PJ, O'Halloran AC, Williams WW, et al. Hepatitis B vaccination coverage among adults aged ≥18years traveling to a country of high or intermediate endemicity, United States, 2015. Vaccine 2018;36:2471-9.
10. Jain N, Yusuf H, Wortley PM, et al. Factors associated with receiving hepatitis B vaccination among high-risk adults in the United States: an analysis of the National Health Interview Survey, 2000. Fam Med 2004;36:480-6.
11. Lu PJ, Byrd KK, Murphy TV, et al. Hepatitis B vaccination coverage among high-risk adults 18-49 years, U.S., 2009. Vaccine 2011;29:7049-57.
12. Kilmer GA, Barker LK, Ly KN, et al. Hepatitis B vaccination and screening among foreign-born women of reproductive age in the United States: 2013-2015. Clin Infect Dis 2019;68:256-65.
13. Kyaw WM, Chow A, Hein AA, et al. Factors influencing seasonal influenza vaccination uptake among health care workers in an adult tertiary care hospital in Singapore: a cross-sectional survey. Am J Infect Control 2019;47:133-8.
14. Gallone MS, Infantino V, Ferorelli D, et al. Vaccination coverage in patients affected by chronic diseases: a 2014 cross-sectional study among subjects hospitalized at Bari Policlinico General Hospital. Am J Infect Control 2018;46:e9-11.
15. Gallone MS, Martino C, Quarto M, et al. Active offer of vaccinations during hospitalization improves coverage among splenectomized patients: an Italian experience. Am J Infect Control 2017;45:e87-9.
16. Tian C, Wang H, Wang W, et al. Characteristics associated with influenza vaccination uptake among adults. J Public Health (Oxf) 2018 Oct 20. [Epub ahead of print].
17. Ghaswalla PK, Patterson BJ, Cheng WY, et al. Hepatitis A, B, and A/B vaccination series completion among US adults: a claims-based analysis. Hum Vaccin Immunother 2018 Jun 20:1-6. [Epub ahead of print].
18. Trantham L, Kurosky SK, Zhang D, et al. Adherence with and completion of recommended hepatitis vaccination schedules among adults in the United States. Vaccine 2018;36:5333-9.
19. Adadan Guvenc I, Parildar H, Sahin MK, et al. Better knowledge and regular vaccination practices correlate well with higher seasonal influenza vaccine uptake in people at risk: promising survey results from a university outpatient clinic. Am J Infect Control 2017;45:740-5.
20. Lim DW, Lee LT, Kyaw WM, et al. Psychosocial determinants of influenza vaccination intention: a cross-sectional study on inpatient nurses in Singapore. Am J Infect Control 2017;45:e115-7.