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Hepatitis A and Hepatitis B vaccination coverage among adults with chronic liver disease

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Abstract

Background—Infection with hepatitis A and hepatitis B virus can increase the risk of morbidity and mortality in persons with chronic liver disease (CLD). The Advisory Committee on Immunization Practices recommends hepatitis A (HepA) and hepatitis B (HepB) vaccination for persons with CLD.

Methods—Data from the 2014 and 2015 National Health Interview Surveys (NHIS), nationally representative, in-person interview surveys of the non-institutionalized US civilian population, were used to assess self-reported HepA (≥1 and ≥2 doses) and HepB vaccination (≥1 and ≥3 doses) coverage among adults who reported a chronic or long-term liver condition. Multivariable logistic regression was used to identify factors independently associated with HepA and HepB vaccination among adults with CLD.

Results—Overall, 19.4% and 11.5% of adults aged ≥18 years with CLD reported receiving ≥1 dose and ≥2 doses of HepA vaccine, respectively, compared with 14.7% and 9.1% of adults without CLD ($p<0.05$ comparing those with and without CLD, ≥1dose). Age, education, geographic region, and international travel were associated with receipt of ≥2 doses HepA vaccine among adults with CLD. Overall, 35.7% and 29.1% of adults with CLD reported receiving ≥1 dose and ≥3 doses of HepB vaccine, respectively, compared with 30.2% and 24.7% of adults without CLD ($p<0.05$ comparing those with and without CLD, ≥1 dose). Age, education, and receipt of influenza vaccination in the past 12 months were associated with receipt of ≥3 doses HepB vaccine among adults with CLD. Among adults with CLD and ≥10 provider visits, only 13.8% and 35.3% had received ≥2 doses HepA and ≥3 doses HepB vaccine, respectively.

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Conflict of Interest Statement

All authors have no conflicts of interest to be stated.

Conclusions—HepA and HepB vaccination among adults with CLD is suboptimal and missed opportunities to vaccinate occurred. Providers should adhere to recommendations to vaccinate persons with CLD to increase vaccination among this population.

Keywords

Hepatitis A vaccination; Hepatitis B vaccination; chronic liver disease; National Health Interview Survey

Introduction

Chronic liver disease (CLD) is one of the leading causes of mortality in the United States, with an estimated 33,000 CLD-related deaths occurring in 2011 [1]. The prevalence of hepatitis A infection is higher in patients with chronic liver disease than in the general population [2]. Infection with hepatitis A virus (HAV) or hepatitis B virus (HBV) can result in severe complications and increase the morbidity and mortality in patients with chronic liver disease [3].

Both hepatitis A (HepA) and hepatitis B (HepB) vaccines are safe and effective in patients with mild to moderate CLD [4–6]. To reduce HAV and HBV super-infection in patients with chronic liver disease, the Advisory Committee on Immunization Practices (ACIP) recommends HepA and HepB vaccinations [7, 8]. A 2014 study showed that overall HepA vaccination coverage (≥2 doses) among adults aged ≥19 years with chronic liver conditions was 13.8%, and overall HepB vaccination coverage (≥ 3 doses) among adults aged ≥19 years with chronic liver conditions was 29.8% [9]. However, information on factors associated with HepA and HepB vaccination coverage among adults with CLD is limited. This study assessed HepA and HepB vaccination coverage and factors associated with vaccination among adults aged ≥18 years with chronic liver disease. This information can be utilized to develop strategies to increase HepA and HepB vaccination coverages among persons with CLD.

Methods

Study sample

Data were analyzed from respondents aged ≥18 years from the 2014 and 2015 National Health Interview Survey (NHIS), a probability-based annual household survey conducted by the National Center for Health Statistics of the Centers for Disease Control and Prevention [10, 11]. Four core modules were included in the surveys: the household composition section, family core, sample adult core, and sample child core. One adult per family in each sampled household of the sample adult core was randomly selected and asked to complete the sample adult questionnaire, including questions about receipt of vaccination. Survey methods were similar in both years and have been published previously [12]. All analyses are based on combined data from the 2014 and 2015 NHIS. The final response rates for the sample adult core were 58.9% and 55.2% for 2014 and 2015, respectively.

Respondents were asked “Have you ever received the hepatitis B vaccine?” and, if yes, “Did you receive at least 3 doses of the hepatitis B vaccine, or less than 3 doses?”; “Have you ever

received the hepatitis A vaccine?" and, if yes, "How many hepatitis A shots did you receive?"; and "Has a doctor or other health professional ever told you that you had any kind of chronic, or long-term liver condition?" For this study, persons self-reporting receipt of 2 doses of HepA or 3 doses of HepB vaccine were considered to be fully vaccinated for HepA or HepB. Respondents with CLD were 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?"; otherwise they were considered to be without CLD. Additional NHIS questions were used to stratify vaccination coverage by age, sex, education, employment status, poverty status, health insurance coverage, race/ethnicity, region of residence, marital status, receipt of influenza vaccination in the past 12 months, whether or not respondent has a primary doctor, number of medical office visits in the past 12 months, having traveled to regions with intermediate or high prevalence of HAV or HBV infection (defined as travel outside of the USA since 1995 to location other than Europe, Japan, Australia, New Zealand, or Canada), and whether or not the respondent has diabetes.

Statistical analysis

All analyses were performed using SAS (version 9.3.2) callable SUDAAN (version 11.0.0). Point estimates for vaccination coverage and 95% confidence intervals were calculated. Estimates were weighted by age, sex and race/ethnicity to represent the U.S. non-institutionalized civilian adult population. Survey procedures were used to account for the multi-staged, clustered and stratified sample design in NHIS. Bivariate analyses were conducted using Pearson chi-square tests to compare population distributions between those with and without CLD. T-tests were conducted to test differences in vaccination coverage between those with and without CLD status and differences within each demographic subgroup among those with and without CLD. Multivariable logistic regression models were used to assess factors independently associated with ≥2 dose HepA or ≥3 dose HepB vaccination coverage among adults with and without CLD. Adjusted prevalence differences and 95% confidence intervals for the associations between these factors and HepA or HepB vaccination coverage are presented.

Results

A total of 68,995 adults aged ≥ 18 years were included in the study, of which 927 (1.2% weighted) reported having CLD (Table 1). The majority of persons with CLD were aged ≥50 years (69.6%), female (51.4%), not in the work force (57.2%), lived at or above poverty level (78.1%), had private or public insurance (48.3%, 42.9%, respectively), were non-Hispanic white (67.7%), married (51.2%), received influenza vaccination within the past 12 months (55.2%), had a primary doctor for health care (91.8%), and visited a doctor's office at least once in the past 12 months (90.9%). Compared with those without CLD, persons with CLD were older, less educated, less likely to be employed and to ever have been married, and more likely to be below poverty level, have public health insurance, be divorced or separated, have received influenza vaccination in the past 12 months, have a primary doctor, have ≥10 medical office visits in the past 12 months, and have diabetes (Table 1).

Overall, 19.4% of adults aged ≥18 years with CLD reported receiving at least 1 dose of HepA vaccine compared with 14.7% of those without CLD ($p<0.05$ comparing those with and without CLD for ≥1 dose, data not shown). Among adults aged ≥18 years with and without CLD, 11.5% and 9.1% reported receiving ≥2 doses of HepA vaccine, respectively (Table 2). Among adults with CLD, higher ≥2 dose HepA vaccination was associated with age 18–49 years, being a high school graduate, having a college education or higher, living in the West, and having traveled to regions with intermediate or high prevalence of HAV infection (Table 2). Among adults without CLD, higher ≥2 dose HepA vaccination was associated with age 18–49 years, having a high school education or higher, being employed, having private health insurance, being of non-Hispanic other race/ethnicity, living in regions other than the Northeast, never having been married, having received influenza vaccination in the past 12 months, having had at least one medical office visit in the past 12 months, and having traveled to regions with intermediate or high prevalence of HAV infection (Table 2).

In multivariable analysis, among adults with CLD, ≥2 dose HepA vaccination coverage was 7.9 percentage points lower among those aged ≥65 years compared with those aged 18–49 years. Coverage was 12.4 and 7.6 percentage points higher, respectively, among those with a high school education or a college degree or higher compared with those with less than a high school education, 12.1 percentage points higher among those from the western region compared with those from the Northeast, and 11.8 percentage points higher among those who had traveled to regions with intermediate or high prevalence of HAV infection compared with those who had not traveled to these regions, controlling for all other factors. Among adults without CLD, characteristics similar to those in persons with CLD that had differences in adjusted coverage compared with the respective reference groups included age, education, regions of residence and travel to regions with intermediate or high prevalence of HAV infection (Table 2).

Overall, 35.7% of adults with CLD reported receiving at least 1 dose of HepB vaccine compared with 30.2% of those without CLD ($p<0.05$ comparing those with and without CLD for ≥1 dose, data not shown). Among adults aged ≥18 years with and without CLD, 29.1% and 24.7% reported receiving ≥3 doses of HepB vaccine, respectively (Table 3). Among adults with CLD, higher ≥3 dose 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 (Table 3). Among adults without CLD, higher ≥3 dose 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 other 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 one medical office visit in the past 12 months, having traveled to regions with intermediate or high prevalence of HBV infection, and not having diabetes (Table 3).

In multivariable analysis, among adults with CLD, those aged ≥65 years had ≥3 dose HepB vaccination coverage 24.9 percentage points lower compared with those aged 18–49 years, those with some college or a college degree or higher had coverage 14.4 and 16.9 percentage points higher, respectively, compared with those with less than a high school education, and

those who received influenza vaccination within the past 12 months had coverage 8.0 percentage points higher compared with those who had not received an influenza vaccination in the past 12 months, controlling for all other factors (Table 3). Among adults without CLD, characteristics similar to those in persons with CLD that had differences in adjusted coverage compared with the respective reference groups included age, education, and receipt of influenza vaccination in the past 12 months (Table 3). Having diabetes was not independently associated with HepB vaccination among persons with or without CLD.

Among adults with CLD and at least one or more visits with a provider during the previous 12 months, 86.2% – 89.4% had not received HepA vaccine (Table 2); 64.7% – 74.0% had not received Hep B vaccine (Table 3). Among those with CLD and diabetes, 71.5% reported visits with a provider during the previous 12 months but were not vaccinated with HepB vaccine. Among adults with CLD with ≥10 office visits in the past 12 months, only 13.8% were fully vaccinated with HepA vaccine (Table 2) and only 35.3% were fully vaccinated with HepB vaccine (Table 3).

Discussion

A previous national survey reported that coverage with ≥1 dose HepA vaccine among adults with chronic liver disease increased from 13% in 1999 to 20% in 2008, and coverage with ≥1 dose HepB vaccine among adults with chronic liver disease increased from 23% to 32% [13]. The findings in this report using combined data from 2014–2015 show coverage similar to that reported from 2008, with 19.4% of adults with CLD reporting receipt of ≥1 dose HepA vaccine and 35.7% reporting receipt of ≥1 dose HepB vaccine. Unlike the previous survey, which found no differences in ≥1 dose HepA or HepB vaccination coverage between persons with and without CLD, we found that adults with CLD had significantly higher coverage of ≥1 dose of both vaccines compared with adults without CLD. However, full coverage for both vaccines did not differ between those with and without CLD, and remains suboptimal, with only 11.5% and 29.1% of adults with CLD reporting completion of the 2-dose HepA and 3-dose HepB vaccine series, respectively.

Missed opportunities for vaccination of persons with CLD have been previously reported, with physicians infrequently adhering to hepatitis vaccination guidelines [14–16]. A previous survey found that hepatologists recommended HepA vaccine for 63% and HepB vaccine for 60% of eligible patients with chronic liver disease referred to a liver clinic [15]. Among primary care physicians, one survey found that 31% reported assessing adult patients for hepatitis B risk factors and vaccinating those identified as high risk [17]. Another survey found that 30–40% of primary care physicians reported routine assessment of HepA vaccination status for all adult patients and 40–60% reported routine assessment of HepB vaccination status [18]. The current study highlights numerous missed opportunities for HepA or HepB vaccination of persons with CLD, including missed opportunities for HepB vaccination of those with both CLD and diabetes. HepB vaccination is recommended for all adults aged 19–59 years with diabetes mellitus (type 1 and type 2) as soon as possible after receiving a diagnosis of diabetes; unvaccinated adults aged ≥60 years may be vaccinated at the discretion of the treating physician after assessing their risk and the likelihood of an adequate immune response to vaccination [19]. Although >90% of

respondents with CLD report having a primary doctor, only 13.8% and 35.3% of those who had 10 or more doctor visits in the past 12 months were fully vaccinated with HepA or HepB vaccines, respectively, and only 27.1% of those with both CLD and diabetes were fully vaccinated with HepB vaccine. The findings in this report underscore the need to improve awareness among providers of the recommendation for HepB vaccination among persons with diabetes and to increase HepB vaccination in this population, particularly those with CLD.

Time constraints, cost and lack of adequate reimbursement for vaccination services, varying recommendations by government and national organizations, patients not disclosing high-risk behaviors, patient non-adherence to multiple office visits, and patient refusal are commonly reported by physicians as barriers to vaccinating adult patients with HepA and HepB vaccines [16–18, 20]. Lack of knowledge among physicians regarding indications for HepA and HepB vaccination has also been reported to be a barrier to vaccination [20]. Studies have shown that a provider recommendation and offer for vaccination is strongly associated with patient vaccination [21]. To increase opportunities for assessment and offering of HepA and HepB vaccines to patients with indications for vaccination, evidence-based interventions aimed at providers, such as provider reminders and standing orders for vaccination are recommended [21, 22].

We found that age, education level, geographic region, and travel history were independently associated with HepA vaccination among persons with CLD. These factors were similar to those associated with HepA vaccination among persons without CLD, and most are related to other indications for vaccination. Higher coverage among younger adults compared with those aged ≥65 years might reflect the aging of cohorts who were recommended to be vaccinated as children [23, 24]. Similarly, differences in coverage by region are likely a result of earlier HepA vaccine recommendations that included routine vaccination of children living in states and communities with high rates of HAV infection, which were concentrated in the western United States [24]. Travelers to countries with high or intermediate endemicity of hepatitis A have been recommended to be vaccinated with HepA vaccine since 1996 [23]. The association between coverage and educational level might be indicative of increased information-seeking behavior and a better understanding of the need of vaccination among more educated persons [25].

Age, education, and receipt of influenza vaccination have previously been identified as factors associated with HepB vaccination among those with CLD [13] and other populations recommended for HepB vaccination [26, 27]. Similar to HepA vaccination, we also found significantly lower HepB vaccination coverage among adults with CLD aged ≥50 years compared with those aged 18–49 years, likely due to universal HepB vaccine recommendations for children and “catch-up” recommendations for adolescents introduced in 1995 and 1999 [28–30]. Adults with CLD who had some college or above education had significantly higher coverage compared with those who had less than a high school education. Higher vaccination coverage among adults with higher education levels might be associated with increasing numbers of colleges and universities that require HepB vaccination for college entrance, as well as a better understanding of the need of vaccination [25, 31]. Higher HepB vaccination coverage among those who had influenza vaccination in

past twelve months could reflect patients' or providers' awareness of the need for vaccinations in general [26, 32].

Despite the ACIP recommendation that persons with diabetes should be vaccinated with HepB vaccine [19], adults with CLD and comorbid diabetes did not have higher coverage compared with those with CLD but without diabetes. Among adults without CLD in our bivariate analysis, persons with diabetes had lower coverage compared with those who did not have diabetes. This finding is consistent with a previous study [33], and might be due to the diabetic population being older, and older age being associated with decreased coverage.

The findings in this study are subject to several limitations. First, all data were self-reported and not verified by medical records, therefore might be subject to recall bias. While self-reported HepA and HepB vaccination status among adults has been shown to be moderately sensitive and specific [34], recall bias might differ between patients with and without CLD if patients with CLD are more frequently asked about vaccination by their medical providers and thus more likely to recall vaccination. Second, the NHIS does not identify all persons who might be at increased risk for HAV and HBV infection, so important confounding factors might have been excluded from the multivariable model. Third, the NHIS does not include institutionalized persons such as those in the military or who are incarcerated. Indications for HepA and HepB vaccination might be different among those persons. Fourth, we do not have information on the vaccine type received by respondents. Respondents were considered to be fully vaccinated for HepA if they reported receipt of ≥2 doses of HepA vaccine; however, if HepA vaccine was received as part of the combination HepA and HepB vaccine (Twinrix) [35], 3 doses would be needed for full coverage. Fifth, nonresponse bias might remain after weighting adjustments. Finally, we have no information about immunity to HAV or HBV. Antibody screening prior to immunization is recommended in some populations with CLD and vaccination is not indicated for those with evidence of prior immunity [36]. The vaccination coverage estimates reported here might be underestimates of the total proportion of persons with CLD with immunity to HAV and HBV.

Conclusions

HepA and HepB vaccination coverage among adults with CLD is low, despite this population having numerous encounters with health care providers. Providers should adhere to recommendations to vaccinate persons with CLD and to the National Vaccine Advisory Committee's standards for adult immunization practices, which include assessing the vaccination status of patients at every visit, strongly recommending needed vaccines, and either administering vaccine or referring patient to providers who can immunize [37]. Employing evidence-based interventions such as standing orders and provider reminders could also increase opportunities to vaccinate this population [21].

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Table 1

Distribution of demographic and access to care characteristics among adults with and without chronic liver disease, National Health Interview Survey, United States, 2014–2015

Characteristic		With chronic liver disease		Without chronic liver disease	
		Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)
Total		927	100	68,068	100
Age	18–49	250	30.4 (26.6, 34.1)	34,265	55.5 (54.8, 56.2) *
	50–64	411	45.0 (40.9, 49.1)	17,343	25.6 (25.0, 26.1)
	≥65	266	24.6 (22.0, 27.2)	16,460	18.9 (18.4, 19.4)
Gender	Male	443	48.6 (44.5, 52.7)	30,407	48.2 (47.7, 48.7)
	Female	484	51.4 (47.3, 55.5)	37,661	51.8 (51.3, 52.3)
Education	< High school	212	21.2 (18.6, 23.9)	9,725	12.9 (12.5, 13.3) *
	High school graduate	244	25.1 (22.0, 28.3)	17,243	25.3 (24.8, 25.8)
	Some college	270	30.6 (27.3, 33.9)	20,959	31.0 (30.4, 31.5)
	College degree or higher	198	23.0 (19.2, 26.8)	19,850	30.8 (30.1, 31.6)
EmploymentStatus	Employed	322	38.9 (35.5, 42.2)	39,729	61.5 (60.9, 62.1) *
	Unemployed	32	3.9 (2.2, 5.7)	2,793	4.4 (4.2, 4.7)
	Not in work force	573	57.2 (53.9, 60.5)	25,518	34.0 (33.4, 34.7)
Poverty	Poverty or above	650	78.1 (75.0, 81.1)	53,927	87.2 (86.7, 87.6) *
	Below poverty	241	21.9 (18.9, 25.0)	20,713	12.8 (12.4, 13.3)
Insurance	Private	398	48.3 (44.5, 52.1)	41,357	64.9 (64.3, 65.6) *
	Public	442	42.9 (39.0, 46.7)	18,284	23.2 (22.6, 23.8)
	None	86	8.9 (7.1, 10.6)	8,150	11.9 (11.5, 12.3)
Race/Ethnicity †	Non-Hispanic white	592	67.7 (64.4, 71.0)	42,249	65.3 (64.5, 66.1)
	Non-Hispanic black	92	8.5 (6.8, 10.1)	9,018	11.6 (11.1, 12.1)
	Hispanic	166	15.5 (12.9, 18.1)	11,266	15.5 (14.9, 16.1)
	Non-Hispanic other	77	8.3 (6.0, 10.7)	5,535	7.6 (7.3, 7.9)
Region	Northeast	156	18.3 (16.2, 20.3)	11,092	17.3 (16.7, 18.0)
	Midwest	175	19.2 (17.3, 21.0)	14,420	22.7 (21.9, 23.5)
	South	291	36.3 (33.7, 39.0)	23,745	37.2 (36.2, 38.1)

Characteristic		With chronic liver disease		Without chronic liver disease	
		Unweighted N	Weighted % (95% CI)	Unweighted N	Weighted % (95% CI)
	West	305	26.2 (23.4, 29.0)	18,811	22.8 (22.0, 23.5)
Marital status	Married	355	51.2 (47.5, 55.0)	29,965	53.2 (52.2, 53.8) *
	Widowed	116	9.5 (7.4, 11.6)	6,514	6.0 (5.7, 6.2)
	Divorced/Separated	235	19.3 (16.8, 21.8)	11,518	11.2 (10.9, 11.6)
	Never Married	216	19.9 (17.2, 22.7)	19,930	29.6 (29.0, 30.3)
Influenza vaccination in past 12 months	Yes	517	55.2 (51.7, 58.6)	30,044	42.4 (41.8, 43.1) *
	No	410	44.8 (41.4, 48.3)	38,024	57.6 (56.9, 58.2)
Has primary doctor	Yes	855	91.8 (89.7, 93.9)	58,707	86.2 (85.8, 86.7) *
	No	71	8.2 (6.1, 10.3)	9,342	13.8 (13.3, 14.2)
Number of office visits	0	68	9.1 (6.8, 11.4)	12,030	18.2 (17.8, 18.7) *
	1–3	268	29.8 (26.6, 32.9)	30,183	45.5 (45.0, 46.1)
	4–9	263	28.3 (25.0, 31.7)	16,399	23.4 (23.0, 23.9)
	≥10	322	32.8 (29.8, 35.8)	9,253	12.8 (12.4, 13.2)
Travel‡	Yes	246	30.2 (26.5, 33.9)	22,652	35.4 (34.8, 36.0) *
	No	680	69.8 (66.1, 73.5)	45,345	64.6 (64.0, 65.2)
Diabetes	Yes	224	21.2 (18.7, 23.8)	7,099	9.2 (8.9, 9.5) *
	No	703	78.8 (76.2, 81.3)	60,941	90.8 (90.5, 91.1)

* $p < 0.05$ comparing distribution among those with and without chronic liver disease.

† Persons identified as Hispanic could be of any race. “Other” includes American Indian/Alaska Native, Asian, and multiracial persons.

‡ Travel to regions with intermediate or high prevalence of hepatitis A virus or hepatitis B virus infection, defined as reported travel outside of the USA since 1995 to location other than Europe, Japan, Australia, New Zealand, or Canada.

Table 2

Hepatitis A vaccination coverage by demographic and access to care characteristics among adults with and without chronic liver disease (CLD), National Health Interview Survey, United States, 2014–2015

Characteristic	With CLD			Without CLD		
	Unweighted N	Weighted % vaccinated (≥2 doses)	Adjusted prevalence difference* (95% CI))	Unweighted N	Weighted % vaccinated (≥2 doses)	Adjusted prevalence difference* (95% CI)
Total	795†	11.5 (9.1, 13.8)		59,758†	9.1 (8.7, 9.5)	
Age						
18–49	204	13.9 (8.4, 19.5)	Referent	28,663	12.4 (11.8, 13.0)	Referent
50–64	359	13.3 (9.7, 17.0)	−0.2 (−7.7, 7.3)	15,873	6.5 (5.9, 7.1)‡	−5.3 (−6.1, −4.5)‡
≥65	232	5.3 (2.0, 8.6)‡	−7.9 (−15.3, −0.4)‡	15,222	4.0 (3.5, 4.5)‡	−7.9 (−8.9, −7.0)‡
Gender						
Male	390	11.2 (7.6, 14.8)	Referent	26,614	8.9 (8.3, 9.4)	Referent
Female	405	11.7 (8.7, 14.8)	2.5 (−3.5, 8.4)	33,144	9.3 (8.9, 9.8)	0.1 (−0.6, 0.9)
Education						
< High school	189	5.0 (1.3, 8.7)	Referent	8,710	4.4 (3.6, 5.1)	Referent
High school graduate	209	13.8 (8.7, 19.0)‡	12.4 (4.2, 20.5)‡	15,491	5.6 (5.1, 6.0)‡§	1.4 (0.2, 2.5)‡
Some college	225	10.8 (7.5, 14.0)	4.7 (−1.2, 10.7)	18,317	10.3 (9.6, 11.0)‡	4.7 (3.5, 5.9)‡
College degree or higher	170	16.4 (9.9, 22.8)‡	7.6 (0.3, 14.8)‡	17,008	13.0 (12.2, 13.8)‡	5.6 (4.3, 6.9)‡
EmploymentStatus						
Employed	282	15.2 (10.5, 20.0)	Referent	34,438	10.4 (9.8, 10.9)	Referent
Unemployed	24	11.0 (3.9, 18.1)	−4.8 (−21.5, 11.9)	2,391	10.0 (8.5, 11.6)	0.3 (−1.3, 2.0)
Not in work force	489	8.9 (6.1, 11.7)	−3.9 (−10.7, 2.8)	22,908	6.8 (6.3, 7.3)‡	0.5 (−0.5, 1.4)
Poverty						
Poverty or above	550	11.9 (9.1, 14.6)	−1.5 (−9.1, 6.1)	47,567	9.4 (9.0, 9.8)	−0.2 (−1.3, 0.9)
Below poverty	214	11.6 (6.4, 16.9)	Referent	9,246	8.4 (7.4, 9.3)	Referent
Insurance						
Private	339	13.2 (9.4, 17.0)	Referent	36,231	10.0 (9.6, 10.5)	Referent
Public	384	10.3 (7.5, 13.1)	1.2 (−6.0, 8.4)	16,148	7.6 (7.0, 8.2)‡	1.4 (0.4, 2.5)‡

Characteristic	With CLD			Without CLD		
	Unweighted N	Weighted % vaccinated (≥2 doses)	Adjusted prevalence difference* (95% CI))	Unweighted N	Weighted % vaccinated (≥2 doses)	Adjusted prevalence difference* (95% CI)
None	71	8.3 (0.3, 16.2)	−1.7 (−11.7, 8.3)	7,166	7.3 (6.4, 8.1)≠	−0.4 (−1.6, 0.7)
Race/Ethnicity//						
Non-Hispanic white	509	11.5 (8.4, 14.5)	Referent	37,587	8.9 (8.5, 9.4)	Referent
Non-Hispanic black	84	12.5 (3.2, 21.8)	−0.5 (−10.4, 9.3)	7,972	8.2 (7.2, 9.1)	−0.1 (−1.3, 1.2)
Hispanic	139	8.1 (2.9, 13.3)	−6.1 (−13.2, 0.9)	9,630	8.6 (7.7, 9.5)	−1.4 (−2.4, −0.3)≠
Non-Hispanic other	63	16.7 (5.2, 28.2)	1.9 (−10.3, 14.1)	4,569	13.3 (11.8, 14.8)≠	−0.2 (−1.4, 1.0)
Region						
Northeast	138	5.8 (3.0, 8.5)	Referent	9,590	7.1 (6.4, 7.8)	Referent
Midwest	145	12.2 (7.9, 16.6)	6.4 (−1.8, 14.6)	12,924	8.3 (7.5, 9.0)≠	1.6 (0.5, 2.6)≠
South	248	9.8 (6.3, 13.3)	4.2 (−2.5, 10.9)	21,018	8.3 (7.7, 8.9)≠	1.8 (0.9, 2.7)≠
West	264	17.4 (11.0, 23.9)≠	12.1 (3.1, 21.2)≠	16,226	12.9 (12.0, 13.8)≠	4.9 (3.8, 5.9)≠
Marital status						
Married	306	11.0 (7.9, 14.2)	Referent	26,497	8.7 (8.3, 9.2)	Referent
Widowed	99	6.4 (4.9, 7.8)	2.5 (−10.4, 15.4)	6,023	2.8 (2.2, 3.4)≠	−2.5 (−3.8, −1.1)≠
Divorced/Separated	203	11.1 (6.3, 15.9)	0.4 (−6.3, 7.2)	10,359	6.7 (6.1, 7.4)≠	−0.2 (−1.1, −0.6)
Never Married	183	15.6 (9.4, 21.8)	6.9 (−1.3, 15.1)	16,760	12.2 (11.5, 12.9)≠	3.3 (2.4, 4.1)≠
Influenza vaccination in past 12 months						
Yes	444	12.3 (9.5, 15.2)	2.5 (−2.8, 7.8)	26,434	10.4 (9.8, 10.9)≠	3.5 (2.7, 4.2)≠
No	351	10.5 (7.0, 14.0)	Referent	33,324	8.2 (7.7, 8.6)	Referent
Has primary doctor						
Yes	735	11.4 (9.0, 13.7)	1.0 (−8.5, 10.6)	51,804	9.1 (8.7, 9.4)	−0.6 (−1.8, 0.6)
No	60	12.6 (2.5, 22.7)	Referent	7,941	9.5 (8.6, 10.4)	Referent
Number of office visits, past 12 months						
0	54	6.0 (0, 12.4)	Referent	10,537	7.3 (6.6., 8.0)	Referent
1–3	228	11.3 (6.5, 16.0)	2.5 (−7.5, 12.5)	26,530	9.6 (9.1, 10.1)≠	1.7 (0.7, 2.6)≠
4–9	234	10.6 (5.9, 15.3)	2.4 (−8.4, 13.3)	14,475	9.2 (8.5, 9.8)≠	2.5 (1.4, 3.7)≠

Characteristic	With CLD			Without CLD		
	Unweighted N	Weighted % vaccinated (≥2 doses)	Adjusted prevalence difference* (95% CI))	Unweighted N	Weighted % vaccinated (≥2 doses)	Adjusted prevalence difference* (95% CI)
≥10	275	13.8 (10.4, 17.2)	6.5 (−4.4, 17.3)	8,070	10.1 (9.1, 11.1)‡	3.4 (1.9, 4.8)‡
Travel¶						
Yes	194	19.8 (13.3, 26.4)‡	11.8 (3.5, 20.2)‡	18,819	16.1 (15.3, 16.8)‡	8.5 (7.7, 9.3)‡
No	601	8.2 (6.3, 10.0)	Referent	40,899	5.6 (5.2, 5.9)	Referent

*Adjusted for all other variables in Table 2.

†132 respondents with CLD and 8,310 respondents without CLD were excluded from the analysis due to missing data for HepA vaccination status.

‡$p < 0.05$ compared with referent category.

§$p < 0.05$ by t-test comparing coverage among those with CLD and without CLD.

‖Persons identified as Hispanic could be of any race. “Other” includes American Indian/Alaska Native, Asian, and multiracial persons.

¶Travel to regions with intermediate or high prevalence of hepatitis A virus infection, defined as reported travel outside of the USA since 1995 to location other than Europe, Japan, Australia, New Zealand, or Canada.

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Table 3

Hepatitis B vaccination coverage by demographic and access to care characteristics among adults with and without chronic liver disease (CLD), National Health Interview Survey, United States, 2014–2015

Characteristic	With CLD			Without CLD		
	Unweighted N	Weighted % vaccinated (3+ doses)	Adjusted prevalence difference* (95% CI))	Unweighted N	Weighted % vaccinated (3+ doses)	Adjusted prevalence difference* (95% CI))
Total	830†	29.1 (25.3, 33.0)		62,015†	24.7 (24.2, 25.3)	
Age						
18–49	227	37.1 (29.2, 45.0)	Referent	30,418	32.2 (31.4, 33.6)	Referent
50–64	366	33.4 (27.8, 39.0)	−4.5 (−14.7, 5.6)	16,243	19.8 (18.9, 20.6)‡§	−12.4 (−13.6, −11.2)‡
≥65	237	12.1 (7.4, 16.8)‡	−24.9 (−35.7, −14.1)‡	15,354	10.7 (9.9, 11.4)‡	−20.8 (−22.3, −19.4)‡
Gender						
Male	394	24.9 (19.6, 30.2)	Referent	27,591	20.8 (20.0, 21.6)	Referent
Female	436	33.1 (27.7, 38.5)	8.1 (−0.5, 16.7)	34,424	28.3 (27.6, 29.1)‡	7.0 (5.9, 8.0)‡
Education						
< High school	186	18.2 (11.6, 24.8)	Referent	8,869	12.7 (11.6, 13.7)	Referent
High school graduate	227	26.8 (19.7, 33.9)	7.7 (−3.5, 18.8)	15,844	17.4 (16.4, 18.3)‡§	3.5 (1.8, 5.1)‡
Some college	240	36.1 (28.8, 43.4)‡	14.4 (2.5, 26.3)‡	19,156	29.3 (28.3, 30.3)‡	11.7 (10.0, 13.5)‡
College degree or higher	175	32.7 (24.6, 40.8)‡	16.9 (2.6, 31.2)‡	17,899	31.4 (30.5, 32.4)‡	12.0 (10.2, 13.9)‡
EmploymentStatus						
Employed	290	31.2 (24.4, 38.0)	Referent	36,057	28.5 (27.8, 29.2)	Referent
Unemployed	30	45.9 (23.9, 67.9)	15.4 (−6.1, 36.9)	2,484	25.9 (23.2, 28.5)	−0.5 (−3.1, 2.1)
Not in work force	510	26.5 (21.6, 31.3)	2.7 (−8.2, 13.5)	23,452	17.9 (17.1, 18.7)‡§	−2.8 (−3.9, −1.6)‡
Poverty						
Poverty or above	579	29.0 (24.3, 33.7)	2.9 (−7.8, 13.6)	49,373	25.4 (24.8, 25.9)‡	−0.2 (−1.8, −1.4)
Below Poverty	220	31.7 (22.9, 40.6)	Referent	9,645	22.9 (21.4, 24.5)	Referent
Insurance						
Private	350	28.7 (22.9, 34.5)	Referent	37,767	27.4 (26.7, 28.1)	Referent
Public	398	28.0 (22.6, 33.4)	0 (−9.9,10.0)	16,601	19.9 (18.9, 20.9)‡§	1.4 (−0.1, 2.8)

Characteristic	With CLD			Without CLD		
	Unweighted N	Weighted % vaccinated (3+ doses)	Adjusted prevalence difference* (95% CI))	Unweighted N	Weighted % vaccinated (3+ doses)	Adjusted prevalence difference* (95% CI))
None	81	36.9 (27.1, 46.7)	0.7 (−12.6, 14.0)	7,419	20.0 (18.6, 21.3)ǂ§	−1.5 (−3.2, −0.2)
Race/Ethnicity‖						
Non-Hispanic white	535	28.6 (23.6, 33.7)	Referent	38,862	25.6 (24.8, 26.3)	Referent
Non-Hispanic black	81	23.5 (13.0, 34.1)	−2.2 (−17.0, 12.5)	8,284	23.9 (22.6, 25.2)ǂ	−1.6 (−3.1, 0)
Non-Hispanic	146	29.4 (19.9, 39.0)	6.0 (−7.5, 19.4)	10,019	19.0 (17.8, 20.2)ǂ	−6.2 (−7.6, −4.7)ǂ
other	68	37.4 (23.0, 51.9)	8.0 (−6.5, 22.4)	4,850	30.5 (28.7, 32.2)ǂ	0.2 (−1.4, 1.9)
Region						
Northeast	139	22.3 (11.6, 33.1)	Referent	10,016	23.0 (21.5, 24.5)	Referent
Midwest	152	39.6 (31.3, 47.8)ǂ	13.0 (−2.2, 28.2)	13,365	27.3 (26.0, 28.6)ǂ§	3.6 (1.7, 5.4)ǂ
South	265	25.7 (20.2, 31.3)	2.4 (−11.1, 15.8)	21,854	22.9 (22.1, 23.7)	0.7 (−1.0, 2.4)
West	274	31.2 (23.1, 39.3)	0.7 (−14.0, 15.4)	16,780	26.5 (25.4, 27.6)ǂ	3.0 (1.1, 4.8)ǂ
Marital status						
Married	317	25.7 (20.1, 31.3)	Referent	27,403	23.6 (22.9, 24.3)	Referent
Widowed	101	20.2 (8.4, 32.1)	3.0 (−11.6, 17.5)	6,040	9.6 (8.6, 10.6)ǂ	−5.4 (−7.3, −3.4)ǂ
Divorced/Separated	217	39.4 (31.9, 46.9)ǂ	10.1 (−1.3, 21.5)	10,593	21.6 (20.5, 22.7)ǂ§	0.6 (−0.7, 2.0)
Never Married	191	32.3 (23.1, 41.3)	3.5 (−7.4, 14.5)	17,855	31.2 (30.0, 32.4)ǂ	5.6 (4.3, 6.9)ǂ
Influenza vaccination in past 12 months						
Yes	457	30.5 (25.8, 35.2)	8.0 (0.1, 15.8)ǂ	27,491	27.9 (27.1, 28.8)ǂ	8.7 (7.5, 9.8)ǂ
No	373	27.4 (21.3, 33.4)	Referent	34,524	22.3 (21.6, 23.1)	Referent
Has primary doctor						
Yes	766	28.4 (24.3, 32.4)	−6.6 (−23.6, 10.5)	53,713	24.9 (24.3, 25.5)ǂ	−0.7 (−2.3, 0.8)
No	64	37.4 (23.9, 50.8)	Referent	8,286	23.4 (22.1, 24.7)	Referent
Number of office visits, past 12 months						
0	61	25.5 (10.8, 40.2)	Referent	10,907	19.7 (18.6, 20.8)	Referent
1–3	247	26.8 (20.0, 33.7)	−0.5 (−17.0, 16.1)	27,586	25.8 (25.0, 26.6)ǂ	3.9 (2.5, 5.3)ǂ
4–9	236	26.0 (19.5, 32.6)	0 (−17.4, 17.3)	14,981	25.4 (24.2, 26.5)ǂ	5.6 (3.9, 7.3)ǂ

Characteristic	With CLD			Without CLD		
	Unweighted N	Weighted % vaccinated (3+ doses)	Adjusted prevalence difference* (95% CI))	Unweighted N	Weighted % vaccinated (3+ doses)	Adjusted prevalence difference* (95% CI))
≥10	281	35.3 (28.8, 41.8)	10.3 (−8.3, 28.8)	8,386	26.8 (25.4, 28.3)‡§	6.9 (5.0, 8.7)‡
Travel¶						
Yes	215	30.9 (23.1, 38.7)	0.9 (−8.8, 10.5)	20,116	31.2 (30.3, 32.1)‡	6.2 (5.1, 7.2)‡
No	615	28.4 (24.4, 32.4)	Referent	41,857	21.3 (20.7, 22.0)§	Referent
Diabetes						
Yes	203	27.1 (19.9, 34.4)	1.2 (−8.5, 10.9)	6,525	17.4 (16.1, 18.6)‡§	−0.5, (−2.2, 1.3)
No	627	29.7 (25.3, 34.1)	Referent	55,469	25.5 (24.9, 26.1)	Referent

*Adjusted for all other variables in Table 3.

†97 respondents with CLD and 6,053 respondents without CLD were excluded from the analysis due to missing data for HepB vaccination status.

‡p < 0.05 compared with referent category.

§p < 0.05 by t-test comparing coverage among those with CLD and without CLD.

‖Persons identified as Hispanic could be of any race. “Other” includes American Indian/Alaska Native, Asian, and multiracial persons.

¶Travel to regions with intermediate or high prevalence of hepatitis B virus infection, defined as reported travel outside of the USA since 1995 to location other than Europe, Japan, Australia, New Zealand, or Canada.