HHS Public Access

Author manuscript

Am J Prev Med. Author manuscript; available in PMC 2022 May 07.

Published in final edited form as:

Am J Prev Med. 2021 November ; 61(5): 652–664. doi:10.1016/j.amepre.2021.04.029.

Hepatitis B vaccination among adults with diabetes mellitus, United States, 2018

Peng-jun Lu, MD, PhD[1], **Mei-Chuan Hung, PhD, MPH**[1,2], **Anup Srivastav, PhD, MPVM**[1,2], **Walter W. Williams, MD, MPH**[1], **Aaron M. Harris, MD, MPH**[3]

[1]Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road, NE, Atlanta, GA 30329

[2]Leidos Inc, Atlanta, GA 30345

[3]Division of Viral Hepatitis, National Center for HIV/AIDS, Viral Hepatitis, STD, & TB Prevention, Centers for Disease Control and Prevention, 1600 Clifton Road, NE, Atlanta, GA 30333

Abstract

Background: Hepatitis B vaccination is routinely recommended for adults with diabetes mellitus (DM) aged <60 years and for those aged ≥60 years at the discretion of their healthcare provider.

Purpose: To assess hepatitis B vaccination coverage among adults with and without DM.

Methods: Data from the 2014–2018 National Health Interview Survey were analyzed in 2020 to determine hepatitis B vaccination series completion (≥3 doses) among adults aged 18–59 and ≥60 years with DM. Multivariable logistic regression analysis was conducted to identify factors independently associated with hepatitis B vaccination among adults aged 18–59 and ≥60 years with DM.

Results: Among adults aged 18–59 years with DM in 2018, 33.2% had received hepatitis B vaccination (≥3 doses), an increase of 9.7 percentage points from 2014 (p<0.05). Among adults aged ≥60 years with DM, coverage was 15.3% in 2018 and did not increase during 2014–2018. Coverage was not significantly different among adults with DM compared with those without DM, even after controlling for factors assessed. Among adults with DM aged 18–59 and ≥60 years, younger age, having some college or college education, having been tested for human immunodeficiency virus, being healthcare personnel, or having traveled to hepatitis B virus–endemic areas were independently associated with increased likelihood of vaccination.

Conclusions: Self-reported hepatitis B vaccination coverage among adults with DM remains suboptimal. Healthcare providers should assess patients' diabetes status, recommend and offer needed vaccinations to patients or refer them to alternate sites for vaccination.

Correspondence and requests for reprints should be sent to: Peng-jun Lu, Immunization Services Division, National Center for Immunization and Respiratory Diseases, Centers for Disease Control and Prevention, 1600 Clifton Road, NE, Mail Stop H24-4, Atlanta, GA 30329, plu@cdc.gov.

Conflict of Interest Statement:
All authors have no conflicts of interest to be stated.

Keywords

Hepatitis B vaccine; diabetes mellitus; vaccination; coverage; trends; adult; National Health Interview Survey (NHIS)

Introduction

Hepatitis B virus (HBV) causes acute and chronic liver infection, resulting in substantial morbidity and mortality.[1, 2] Compared with adults without diabetes mellitus (DM), adults with DM have a 60% higher prevalence of HBV infection and twice the odds of experiencing acute HBV infection.[1, 2] Data also suggested the possibility of a higher case-fatality proportion among persons with diabetes acutely infected with HBV compared with those without diabetes.[1, 2] Repeated outbreaks of HBV infection among adults with DM associated with receiving assisted blood glucose monitoring underscore this population's continued risk and outbreaks were still being reported recently.[3, 4]

In 2011, the Advisory Committee on Immunization Practices (ACIP) released new guidelines recommending hepatitis B vaccination for all unvaccinated adults with DM aged <60 years.[1] For unvaccinated adults with DM aged ≥60 years, the ACIP recommends hepatitis B vaccination at the discretion of their healthcare provider.[1, 2] As with other vaccines, the immunogenic response to hepatitis B vaccine decreases with age. Decisions to vaccinate persons ≥60 years with DM should include the patient's overall health status and likelihood of acquiring HBV, including the need for assisted blood-glucose monitoring which is performed for a patient with diabetes by a health care provider with potential multiple users (shared use of blood-contaminated equipment increases the risk for exposure to HBV).[1] However, it might be difficult to implement a risk condition–based provider vaccination recommendation.

There are limited data regarding factors associated with hepatitis B vaccination among adults aged 18–59 and ≥60 years with DM and those without DM.[5, 6] This study assessed hepatitis B vaccination coverage among adults aged 18–59 and ≥60 years with and without DM, factors associated with vaccination among adults with or without DM, and national trends in hepatitis B vaccination among adults with DM using data from the National Health Interview Survey (NHIS). The information can help improve planning and implementing strategies for increasing hepatitis B vaccination coverage among adults with DM.

Methods

Data from the 2014–2018 NHIS were analyzed in 2020 to determine hepatitis B vaccination coverage (≥3 doses) among adults aged 18–59 years and ≥60 years by DM status. NHIS is a national cross-sectional household survey conducted by the U.S. Census Bureau for the Centers for Disease Control and Prevention's National Center for Health Statistics.[7] NHIS provides estimates on health indicators, healthcare utilization and access, and health-related behaviors for the U.S. non-institutionalized, civilian population. The NHIS sample is selected using complex sampling design involving stratification, clustering, and multistage sampling with a nonzero probability of selection for each person. Estimates were weighted

to the adult non-institutionalized, civilian population of the United States. Face-to-face interviews were conducted each week throughout the year in a probability sample of households. In the sample adult core, one adult per sampled family was randomly selected and asked to complete the sample adult questionnaire. Final response rates for the core survey sample of adults ranged from 53.0% in 2017 to 58.9% in 2014.[7] In 2018, the final response rate for the sample adult core was 53.1%.[7] The total adult sample for estimating the prevalence of DM was 25,397 persons aged ≥18 years.

Hepatitis B vaccination coverage was determined using the following sample adult core survey question: "*Have you ever received hepatitis B vaccine?*" An affirmative answer to this question prompted a second question concerning how many doses respondents received: "*Did you receive three doses of the hepatitis B vaccine or less than three doses?*" Individuals who reported that a doctor or other health professional ever told them that they had diabetes (excluding gestational diabetes) were categorized as adults with DM.

Hepatitis B vaccination coverage was stratified by age group (18–59 years and ≥60 years) for the following demographic, access-to-care, and other characteristics: age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic Asian, and non-Hispanic others [including American Indian/Alaska Native persons, and persons of multiple races]), marital status, educational level, employment status, poverty level, region of residence, U.S.–born status, number of physician contacts in the past 12 months, hospitalization in the past 12 months, usual place for healthcare, health insurance status, ever being tested for human immunodeficiency virus (HIV), healthcare personnel (HCP) status, ever being lived with someone who had hepatitis diseases, traveler status (travelers: persons who traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada since 1995 were considered having traveled to countries with high or intermediate hepatitis B virus endemicity; non-travelers: persons who did not travel outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada since 1995), status of receiving influenza vaccination in the past 12 months, and ever having chronic liver disease.

Weighted proportions, 95% confidence intervals (CI), and adjusted prevalence ratios (adjusted prevalence of vaccination among observation group over reference group) were calculated using SAS and SAS-callable SUDAAN software.[8] All analyses were weighted to the adult non-institutionalized, civilian population of the United States. Sample demographic characteristics stratified by age and DM status were reported, and differences/similarities in the distribution of the demographic, access-to-care, and other characteristics between adults with and without DM were tested using the chi-square test. Differences in hepatitis B vaccination coverage between the two age groups (18–59 years and ≥60 years), DM status, and by demographic, access-to-care, and other characteristics were tested using two-tailed *t*-tests with a significance level set at $p<0.05$. Factors associated with hepatitis B vaccination were assessed using multivariable logistic models. Separate logistic regression models were conducted among adults aged 18–59 and ≥60 years including DM status as an independent variable to determine if DM status was an independent predictor of vaccination. Tests for linear trend of hepatitis B vaccination coverage among adults aged 18–59 and ≥60 years with DM from 2014–2018 were conducted.

Results

Among individuals aged ≥18 years, 6.0% reported having DM among those aged 18–59 years, and 20.1% reported having DM among those aged ≥60 years. Demographic characteristics of the study population are presented in Table 1. The distribution of adults aged 18–59 years with DM and those without DM significantly differed by all sociodemographic and access-to-care characteristics except sex, U.S. born status, health insurance status, ever tested for HIV, and healthcare personnel status (Table 1). The distribution of adults aged ≥60 years with DM and those without DM significantly differed by all sociodemographic and access-to-care characteristics except marital status, region, ever tested for HIV, and ever lived with a hepatitis patient (Table 1).

Table 2 presents the results of the bivariate analysis of hepatitis B vaccination coverage (≥3 doses). Overall, 33.2% of adults aged 18–59 years with DM reported receipt of ≥3 doses of hepatitis B vaccine compared with 37.0% among those aged 18–59 years without DM (p>0.05) (Table 2), and 41.4% (95% CI:37.5%–45.5%) of adults aged 18–59 years with DM reported receipt of ≥1 dose of hepatitis B vaccine compared with 44.4% among those aged 18–59 years without DM (p>0.05) (Data not shown). Overall, 15.3% of adults aged ≥60 years with DM reported receipt of ≥3 doses compared with 15.9% among those aged ≥60 years without DM (p>0.05) (Table 2), and 20.9% of adults aged ≥60 years with DM reported receipt of ≥1 dose compared with 19.7% among those aged ≥60 years without DM (p>0.05) (Data not shown).

Overall, hepatitis B vaccination coverage (≥3 doses) among adults aged 18–59 years with DM was not significantly higher compared with those without DM across all socio-demographic and access-to-care characteristics except those with chronic liver diseases. Hepatitis B vaccination coverage (≥3 doses) among adults aged ≥60 years with DM was not significantly higher compared with those without DM across all socio-demographic and access-to-care characteristics (Table 2).

Overall, hepatitis B vaccination coverage (≥3 doses) among adults aged 18–59 years with DM (33.2%) was significantly higher compared with those aged ≥60 years with DM (15.3%) and also higher across all socio-demographic and access-to-care characteristics except among non-Hispanic black persons (Table 2). Hepatitis B vaccination coverage (≥3 doses) among adults aged 18–59 years without DM (37.0%) was significantly higher compared with those aged ≥60 years without DM (15.9%) and also higher across all socio-demographic and access-to-care characteristics except among those with chronic liver diseases (Table 2).

Among adults with DM overall, the common factors that were significantly associated with increased hepatitis B vaccination compared with the reference level across age groups (18–59 and ≥60 years) were being younger, having above a high school education, having ever been tested for HIV, being a HCP, and being a traveler (Table 2). Hispanic ethnicity was significantly associated with lower likelihood of hepatitis B vaccination across age groups (18–59 and ≥60 years) (Table 2). Among adults without DM, the common factors that were significantly associated with increased hepatitis B vaccination compared with the reference

level across age groups (18–59 and ≥60 years) were being younger, having above a high school education, being employed, being at or above poverty, having ever been tested for HIV, being a HCP, having ever lived with a hepatitis patient, being a traveler, and having received influenza vaccination in the past 12 months (Table 2).

In multivariable analysis, among all adults with DM status as an independent variable, DM status was not significantly associated with hepatitis B vaccination among both adults aged 18–59 years and ≥60 years (prevalence ratios 1.07 and 1.09, respectively, $p>0.05$) (data not shown). In multivariable analysis among adults aged 18–59 years with DM, younger age (18–29 and 30–49 years), having some college education or being a college graduate, having ever been tested for HIV, being a HCP, having ever lived with a hepatitis patient, and being a traveler were independently associated with increased likelihood of vaccination. Being non-Hispanic black or Hispanic persons was independently associated with decreased likelihood of vaccination (Table 3). Among adults aged ≥60 years with DM, younger age (60–64 years), having some college or being a college graduate, having ever been tested for HIV, being a HCP, and being a traveler were independently associated with increased likelihood of vaccination (Table 3). Other factors independently associated with hepatitis B vaccination are presented in Table 3.

Hepatitis B vaccination coverage (≥3 doses) increased 9.7 percentage points among adults aged 18–59 years with DM between 2014 and 2018 (test for linear trend, $p<0.05$) and coverage increased substantially in 2018 (Figure 1); hepatitis B vaccination coverage (≥3 doses) did not increase among adults aged ≥60 years with DM during this period (test for linear trend, $p>0.05$).

Discussion

Findings from this study indicated that persons with DM were not more likely to have received hepatitis B vaccination compared with persons without DM; moreover, in 2018, hepatitis B vaccination coverage (≥3 doses) among adults aged 18–59 and ≥60 years was suboptimal (33.2% and 15.3%, respectively). Hepatitis B vaccination is the cornerstone of the national hepatitis B elimination strategy.[9] However, seven years after the ACIP recommended hepatitis B vaccination (≥3 doses) for adults with DM,[1] about two out of three adults aged 18–59 years had not been vaccinated, leaving most DM patients unprotected and putting them at higher risk from HBV infection. Healthcare providers should ensure they routinely assess patients' need for hepatitis B vaccination, including among persons with DM.[2]

Factors associated with lower hepatitis B vaccination coverage among adults with DM might include more difficulty in implementing a risk condition–based vaccination recommendation compared with implementing age group–based vaccination recommendation; DM patients with limited awareness about their high risk for HBV infection, limiting the motivation of seeking vaccine to protect themself; lack of awareness among the public about adult vaccination; failure of providers to routinely assess vaccine needs of adult patients; financial risks providers incur to stock vaccines and provide vaccination services to adults; acute

medical care taking precedence over providing vaccination services: and some providers not perceiving responsibility to be the vaccinator.[10-18]

Trend analysis from this study showed that hepatitis B vaccination coverage among adults aged 18–59 years with DM increased from 2014 to 2018. The reason for coverage increases among adults aged 18–59 years with DM in 2018 is not fully understood and continued monitoring of coverage among this group is necessary. Theoretically, hepatitis B vaccination coverage should increase, since the proportion of unvaccinated adults with DM should decline over time due to the aging cohort of persons vaccinated as infants. Universal infant vaccination and immunization of previously unvaccinated children aged 11–12 years were first recommended in 1991 and 1995, respectively.[19, 20] Hepatitis B vaccination coverage for early childhood and adolescents now exceeds 90%.[21, 22] Thus, most younger adults with DM would be expected to have been vaccinated in childhood or adolescent vaccination programs.

Higher vaccination coverage is expected among the younger adults, so it is not surprising that age was strongly associated with reported hepatitis B vaccination among adults with DM in this study. Findings from this study indicated that adults aged 18–29 years were approximately two times more likely to report receiving hepatitis B vaccination than those aged 50–59 years after controlling for other factors. Higher vaccination coverage among younger adults likely reflects the aging of the cohort of children who were vaccinated under the childhood and adolescent vaccination recommendations.[21-24] Additionally, coverage was significantly higher among adults aged 30–49 years compared with those aged 50–59 years and among adults aged 60–64 years compared with those aged ≥65 years. The incidence of HBV infection is higher among younger adults compared with older adults, and higher vaccination coverage among younger adults may reflect a targeted effort by healthcare providers to immunize persons perceived to be at greater risk.[25-26]

Hepatitis B vaccination coverage among adults with DM was not significantly higher compared with those without DM across most socio-demographic and access-to-care characteristics. DM status was not significantly associated with hepatitis B vaccination, and this result remained after controlling for other factors. One study based on the 2009 NHIS (pre-2011 ACIP recommendation) showed that the baseline hepatitis B vaccination coverage among US adults with DM was even lower than adults without DM.[27] This finding indicates vaccination coverage did not rise in accordance with ACIP recommendations for use of hepatitis vaccine among adults with DM.[1, 2]

Several other characteristics including higher education, having been tested for HIV, being a healthcare provider, having ever lived with a hepatitis patient, or having traveled to HBV-endemic areas were independently associated with increased likelihood of vaccination among adults with DM. These findings were similar with those reported from a previous study.[27] Being healthcare personnel, having ever lived with a hepatitis patient, and travelers are risk groups that are also recommended to receive hepatitis B vaccination.[2, 28, 29] Although vaccination was not optimal in these groups, these results indicated vaccination coverage was higher among these risk groups in accordance with the ACIP recommendations for use of hepatitis B vaccine.[2]

The findings in this study are subject to some limitations. First, the determination of vaccination status in the NHIS was not validated by medical records; self-report of vaccination might be subject to recall bias. Adults particularly might not be able to recall accurately vaccines received as infants or adolescents, so hepatitis B vaccination coverage levels might be greatly underestimated. The self-report accuracy of hepatitis B vaccination has been poorly studied. One study using serological data found self-report to be unreliable.[30] However, another study found patient recall nearly as sensitive and specific (hepatitis B: sensitivity 80%, specificity 100%) as the medical record.[31] Another study indicated that adult self-reported hepatitis B vaccination status was about 73% sensitive and 67% specific.[32] The findings for hepatitis B vaccination among younger adults should be viewed with caution, NHIS likely underestimates coverage in this group based on comparison with estimates derived from provider-reported vaccinations from the National Immunization Survey-Teen.[22] Second, the NHIS sample excludes persons in the military and those residing in institutions, for whom both the risk for hepatitis B infection and vaccination coverage might differ from the rest of the population; thus, generalizations may not be made beyond this population. Third, response rates for the surveys used in the analysis ranged from 53.0% to 58.9%. Nonresponse bias can result if respondents and non-respondents differ in their vaccination rates. Finally, demographic and other characteristics (e.g., DM status, HCP status, access-to-care characteristics) were self-reported and were not validated.

Self-reported hepatitis B vaccination coverage among adults with DM remains suboptimal. An estimated 23.8 million adults aged ≥18 years had DM in 2018.[33] But only 33% (18–59 years) and 15% (≥60 years) had received the vaccine even though vaccination has been recommended since 2011. The caveat was that not all adults aged ≥60 years are recommended to get the vaccine and thus we did not know what proportion of this group should be vaccinated.[1]ACIP continues to emphasize that persons with DM should be a focus of vaccination efforts.[2] Substantial improvement in hepatitis B vaccination of adults with DM is needed to maximally reduce the health impact of HBV infection in this population. Ongoing programs or disease-related professional organizations have supported intensive efforts to improve vaccination among persons with high-risk conditions.[34-35] For example, the Diabetes Quality Improvement Project, a collaborative effort between public and private organizations, is focused on improving preventive care for persons with DM, including increased vaccination coverage.[34, 35] Additionally, according to the 2017 National Practice Survey from the American Association of Diabetes Educators, only 31% of DM educators offer information or discuss vaccination with patients.[36] To improve vaccination coverage, DM educators could routinely discuss needed vaccinations with persons who have DM and recommend vaccination. Primary care providers, subspecialists, and pharmacists should routinely assess patient vaccination status and recommend and offer vaccinations when patients access the medical system even though it might be difficult to implement a risk condition–based provider vaccination recommendation.[37] Expanded access through greater use of complementary settings and vaccine providers, and better use of evidence-based practices at medical sites (e.g., standing orders, and reminder/recall notification) may help to improve hepatitis B vaccination coverage.[37-38] Additionally, vaccination coverage among adults with DM was not significantly higher than those without DM, indicating that

additional strategies are needed to improve coverage among adults with DM in accordance with ACIP recommendations.

Acknowledgments:

Authors thank Mary Ann Hall, James A. Singleton, and Kimberly Nguyen for their important review of this manuscript.

Disclaimer:

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

References

1. Centers for Disease Control and Prevention. Use of hepatitis B vaccination for adults with diabetes mellitus: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Morb Mortal Wkly Rep 2011;60(50):1709–1711. [PubMed: 22189894]
2. Centers for Disease Control and Prevention. Prevention of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices. MMWR Morb Mortal Wkly Rep 2018;67(1):1–31. [PubMed: 29324727]
3. Reilly ML, Schillie SF, Smith E, et al. Increased risk of acute hepatitis B among adults with diagnosed diabetes mellitus. J Diabetes Sci Technol 2012;6:858–866. [PubMed: 22920812]
4. Centers for Disease Control and Prevention. Healthcare-Associated Hepatitis B and C Outbreaks (≥ 2 cases) Reported to the CDC 2008–2019. Available at: https://www.cdc.gov/hepatitis/outbreaks/healthcarehepoutbreaktable.htm. Accessed March 24, 2021.
5. Villarroel MA, Vahratian A. Vaccination coverage among adults with diagnosed diabetes: United States, 2015. NCHS Data Brief. 2016 Dec;(265):1–8.
6. Byrd KK, Lu PJ, Murphy TV. Baseline hepatitis B vaccination coverage among persons with diabetes before implementing a U.S. recommendation for vaccination. Vaccine. 2012 May;30(23):3376–3382. [PubMed: 22472793]
7. Centers for Disease Control and Prevention. National Health Interview Survey. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Dept of Health and Human Services; 2019. Available at: ftp://ftp.cdc.gov/pub/Health_Statistics/NCHS/Dataset_Documentation/NHIS/2018/srvydesc.pdf. Accessed January 13, 2021.
8. Shah B, Barnwell B, Bieier G. SUDAAN user's manual, Release 11.1. Research Triangle Park, NC: Research Triangle Institute; 2010.
9. National Academies of Sciences, Engineering, and Medicine (NASEM). A national strategy for the elimination of hepatitis b and c: Phase two report. Washington, DC: the National Academies Press; 2017. Available at: http://nationalacademies.org/hmd/Reports/2017/national-strategy-for-the-elimination-of-hepatitis-b-and-c.aspx. Accessed February 2, 2021.
10. Egede LE, Zheng D. Racial/ethnic differences in influenza vaccination coverage in high-risk adults. Am J Public Health 2003;93:2074–2078. [PubMed: 14652337]
11. Singleton JA, Wortley PM, Lu PJ. Influenza vaccination of persons with cardiovascular disease in the United States. Texas Heart Inst J 2004;31:1–6.
12. Nichol KL, Zimmerman R. Generalist and subspecialist physicians' knowledge, attitudes, and practices regarding influenza and pneumococcal vaccinations for elderly and other high-risk patients: a nationwide survey. Arch Intern Med 2001;161:2702–2708. [PubMed: 11732935]
13. Bridges CB, Hurley LP, Williams WW, Ramakrishnan A, Dean AK, Groom AV. Meeting the challenges of immunizing adults. Am J Prev Med 2015;49(Suppl 4):S455–464. [PubMed: 26382294]
14. Joon Lee T, Hayes S, Cummings DM, et al. Herpes zoster knowledge, prevalence, and vaccination rate by race. J Am Board Fam Med 2013;26:45–51. [PubMed: 23288280]

15. Johnson DR, Nichol KL, Lipczynski K. Barriers to adult immunization. Am J Med 2008;121(Suppl 2):S28–35.
16. Winston CA, Wortley PM, Lees KA. Factors associated with vaccination of Medicare beneficiaries in five U.S. communities: results from the Racial and Ethnic Adult Disparities in Immunization Initiative survey, 2003. J Am Geriatr Soc 2006;54:303–310. [PubMed: 16460383]
17. Hurley LP, Bridges CB, Harpaz R, et al. U.S. physicians' perspective of adult vaccine delivery. Ann Intern Med 2014;160:161–170. [PubMed: 24658693]
18. The power to protect: vaccination guidelines for adults with chronic diseases. Available at: https://www.medscape.com/viewarticle/886087?src=par_cdc_stm_mscpedt&faf=1 Accessed January 27, 2021.
19. Centers for Disease Control and Prevention. Hepatitis B virus: a comprehensive strategy for eliminating transmission in the United States through universal childhood vaccination. MMWR Morb Mortal Wkly Rep 1991;40(RR-13):1–19. [PubMed: 1898620]
20. Centers for Disease Control and Prevention. Update: recommendations to prevent hepatitis B virus transmission—United States. MMWR Morb Mortal Wkly Rep 1995;44:574–575. [PubMed: 7616955]
21. Centers for Disease Control and Prevention. Vaccination coverage by age 24 months among children born in 2015 and 2016—National Immunization Survey-Child, United States, 2016–2018. Morb Mortal Wkly Rep MMWR 2019;68(41):913–918. [PubMed: 31622284]
22. Centers for Disease Control and Prevention. National, regional, state, and selected local area vaccination coverage among adolescents aged 13–17 years — United States, 2018. MMWR Morb Mortal Wkly Rep 2019;68(33):713–728. [PubMed: 31437141]
23. Centers for Disease Control and Prevention (CDC). National and state vaccination coverage among adolescents aged 13–17 years – United States, 2019. MMWR Morb Mortal Wkly Rep 2020;69(33):1109–1116. [PubMed: 32817598]
24. Lu PJ, Byrd KK, Murphy TV. Hepatitis A vaccination coverage among adults 18–49 years traveling to a country of high or intermediate endemicity, United States. Vaccine. 2013;31(19):2348–2357. [PubMed: 23523408]
25. Centers for Disease Control and Prevention. Surveillance for acute viral hepatitis—United States, 2007. MMWR Morb Mortal Wkly Rep 2009;58 (SS-3):1–27. [PubMed: 19145219]
26. Centers for Disease Control and Prevention. Surveillance for viral hepatitis—United States, 2017. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Dept of Health and Human Services; 2019. Available at: https://www.cdc.gov/hepatitis/statistics/2017surveillance/index.htm. Accessed January 27, 2021.
27. Lu PJ, Byrd KK, Murphy TV, Weinbaum C. Hepatitis B vaccination coverage among high-risk adults 18-49 years, U.S., 2009. Vaccine. 2011;29(40):7049–7057. [PubMed: 21782873]
28. Centers for Disease Control and Prevention. Update: recommendations to prevent hepatitis B virus transmission—United States. MMWR Morb Mortal Wkly Rep 1999;48(2):33–34. [PubMed: 9933127]
29. Centers for Disease Control and Prevention. A comprehensive immunization strategy to eliminate transmission of hepatitis B virus infection in the United States: recommendations of the Advisory Committee on Immunization Practices (ACIP). MMWR Morb Mortal Wkly Rep 2006;55(RR-16):1–25. [PubMed: 16410759]
30. Trevisan A, Frasson C, Morandin M, et al. Immunity against infectious diseases: predictive value of self-reported history of vaccination and disease. Infect Control Hosp Epidemiol 2007;28:564–569. [PubMed: 17464916]
31. Stange KC, Zyzanski SJ, Smith TF, et al. How valid are medical records and patient questionnaires for physician profiling and health services research? A comparison with direct observation of patients visits. Med Care 1998;36:851–867. [PubMed: 9630127]
32. Rolnick SJ, Parker ED, Nordin JD, et al. Self-report compared to electronic medical record across eight adult vaccines: do results vary by demographic factors? Vaccine 2013;31(37):3928–3935. [PubMed: 23806243]
33. Centers for Disease Control and Prevention. National diabetes statistics report, 2020. Atlanta, GA: Centers for Disease Control and Prevention, U.S. Dept of Health and Human Services; 2020.

https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf. Accessed January 26, 2021.

34. Silver A, Figge J, Haskin DL, et al. An asthma and diabetes quality improvement project: enhancing care in clinics and community health centers. J Community Health. 2011 Apr;36(2):180–190. [PubMed: 20668924]
35. McLaughlin S The Diabetes Quality Improvement Project. Diabetes Spectr 2000 Jan 1;13(1):5–10.
36. American Association of Diabetes Educators (AADE): Vaccination practice for people with diabetes. Chicago, IL: American Association of Diabetes Educators; 2019. Available at: https://www.diabeteseducator.org/docs/default-source/practice/educator-tools/vaccination-practices-for-adults-with-diabetesv2.pdf?sfvrsn=2. Accessed January 27, 2021.
37. National Vaccine Advisory Committee. Recommendations from the National Vaccine Advisory committee: standards for adult immunization practice. Public Health Rep 2014;129(2):115–123. [PubMed: 24587544]
38. Community Preventive Services Task Force. Increasing appropriate vaccination: health care system-based interventions implemented in combination (2010 Archived Review). Atlanta, GA: Centers for Disease Control and Prevention; 2010. Available at: http://www.thecommunityguide.org/vaccines/healthsysteminterventions.html Accessed January 27, 2021.

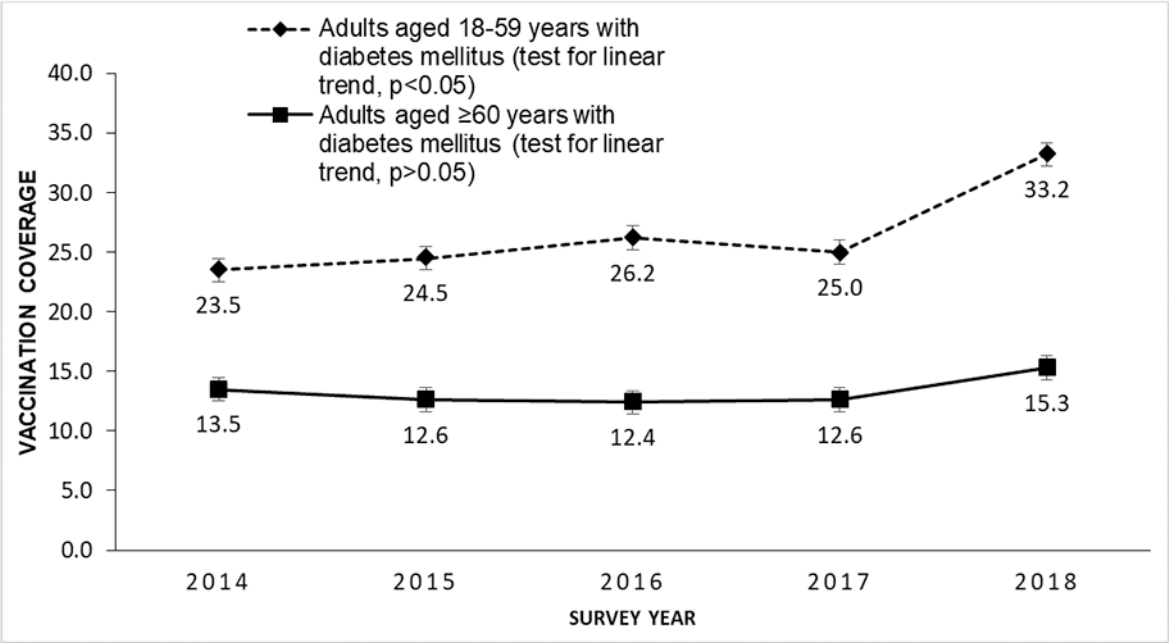

Figure 1.

Hepatitis B vaccination coverage (≥3 doses) among adults aged ≥18 years with diabetes mellitus, United States, 2014–2018 National Health Interview Survey

Table 1.

Sample characteristics of adults, by age groups, diabetes status, demographic and access-to-care characteristics, 2018 NHIS

		18–59 years			≥60 years		
			With diabetes	Without diabetes		With diabetes	Without diabetes
Characteristic		**Sample**	**Weighted %**	**Weighted %**	**Sample**	**Weighted %**	**Weighted %**
Total		15,736	6.0	94.0	9,661	20.1	79.9
Age							
	18–29	3,724	7.8	**30.7** [a]	NA	NA	NA
	30–49	7,797	42.7	47.4	NA	NA	NA
	50–59	4,215	49.5	21.9	NA	NA	NA
	60–64	NA	NA	NA	2,372	24.3	**30.6** [b]
	≥65	NA	NA	NA	7,289	75.7	69.4
Sex							
	Male	7,382	48.2	49.3	4,152	52.5	**44.3** [b]
	Female	8,354	51.8	50.7	5,509	47.5	55.7
Race/ethnicity							
	Non-Hispanic White	9,951	51.8	**58.6** [a]	7,395	63.6	**77.8** [b]
	Non-Hispanic Black	1,850	14.7	12.5	985	14.0	8.2
	Hispanic	2,459	21.2	19.1	718	14.1	8.2
	Non-Hispanic Asian	934	6.3	6.7	353	5.5	4.3
	Non-Hispanic Other	542	5.9	3.2	210	2.7	1.6
Marital Status							
	Married	7,044	52.3	**49.4** [a]	4,404	57.8	59.5
	Widowed/divorced/separated	2,544	17.7	9.7	4,277	33.7	31.9
	Never married	6,116	30.0	40.9	960	8.5	8.5
Education							
	High school or less	5,053	43.5	**33.5** [a]	3,938	49.5	**38.3** [b]
	Some college or college graduate	8,579	48.3	54.3	4,479	41.7	48.0
	Above college graduate	2,054	8.2	12.2	1,192	8.8	13.6
Employment status							
	Employed	12,279	64.8	**78.4** [a]	2,629	19.7	**31.5** [b]
	Not employed	3,449	35.2	21.6	7,030	80.3	68.5
Poverty level							
	At or above federal poverty line	13,208	82.1	**89.4** [a]	8,145	88.4	**93.1** [b]
	Below federal poverty line	1,995	17.9	10.6	874	11.6	6.9
Region							

Characteristic		18–59 years			≥60 years		
		Sample	With diabetes Weighted %	Without diabetes Weighted %	Sample	With diabetes Weighted %	Without diabetes Weighted %
	Northeast	2,413	12.9	**16.8** [a]	1,726	18.0	19.7
	Midwest	3,693	22.0	22.2	2,251	21.2	21.6
	South	5,747	42.1	36.6	3,561	40.3	36.1
	West	3,883	23.0	24.5	2,123	20.5	22.7
US born status							
	U.S. born	12,886	78.3	79.1	8,456	81.1	**85.4** [b]
	Not U.S. born	2,833	21.7	20.9	1,199	18.9	14.6
Physician contacts in the past 12 months							
	None	3,132	7.1	**22.1** [a]	728	3.2	**8.7** [b]
	1	3,126	8.4	21.5	1,195	6.6	14.1
	2–3	4,094	23.9	27.1	2,647	23.4	29.4
	4–9	3,127	35.6	18.4	3,096	38.7	30.9
	≥10	2,049	25.0	10.9	1,863	28.1	16.9
Hospitalization in the past 12 months							
	Yes	1,111	15.3	**5.8** [a]	1,515	21.2	**13.2** [b]
	No	14,618	84.7	94.2	8,138	78.8	86.8
Usual place for healthcare							
	Yes	12,952	92.7	**82.0** [a]	9,172	98.2	**94.7** [b]
	No	2,682	7.3	18.0	445	1.8	5.3
Health insurance							
	Yes	13,623	88.5	86.4	9,429	98.4	**97.2** [b]
	No	2,043	11.5	13.6	222	1.6	2.8
Ever tested for HIV							
	Yes	7,837	51.2	49.6	2,382	27.9	25.4
	No	7,224	48.8	50.4	6,802	72.1	74.6
Healthcare personnel							
	Yes	1,738	10.0	11.0	443	2.9	**5.5** [b]
	No	13,771	90.0	89.0	9,104	97.1	94.5
Ever lived with a hepatitis patient							
	Yes	613	5.9	**3.6** [a]	397	4.8	4.7
	No	14,528	94.1	96.4	8,711	95.2	95.3
Travelers [c]							
	Yes	6,743	31.8	**44.9** [a]	2,896	29.4	**34.0** [b]
	No	8,761	68.2	55.1	6,632	70.6	66.0

Characteristic		Sample	18–59 years With diabetes Weighted %	18–59 years Without diabetes Weighted %	Sample	≥60 years With diabetes Weighted %	≥60 years Without diabetes Weighted %
Received influenza vaccination in past 12 months							
	Yes	5,760	50.3	**35.4** [a]	6,155	72.3	**62.8** [b]
	No	9,726	49.7	64.6	3,389	27.7	37.2
Persons with chronic liver diseases							
	Yes	213	3.9	**1.1** [a]	211	4.2	**1.8** [b]
	No	15,294	96.1	98.9	9,330	95.8	98.2

Note: Boldface indicates statistical significance (p<0.05).

[a] Significant difference between adults aged 18–59 years with diabetes and without diabetes (by chi-square test, $p<0.05$).

[b] Significant difference between adults aged ≥60 years with diabetes and without diabetes (by chi-square test, $p<0.05$).

[c] Persons traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada since 1995 were considered having traveled to countries with high or intermediate hepatitis B virus endemicity.

NA: Not applicable.

Table 2.

Hepatitis B vaccination coverage among adults, by age groups, diabetes status, demographic and access-to-care characteristics, 2018 NHIS

		18–59 years		≥60 years	
		Vaccination coverage with ≥3 dose among adults with diabetes	Vaccination coverage with ≥3 dose among adults without diabetes	Vaccination coverage with ≥3 dose among adults with diabetes	Vaccination coverage with ≥3 dose among adults without diabetes
Characteristic		**% (95% CI)**	**% (95% CI)**	**% (95% CI)**	**% (95% CI)**
Total		33.2 (29.5-37.2)	37.0 (35.7-38.3)	**15.3 (13.3-17.4)** [a]	**15.9 (14.8-17.0)** [a]
Age					
	18–29	**54.8 (37.4-71.1)** [b]	**47.6 (45.1-50.2)** [b]	NA	NA
	30–49	**36.4 (30.4-42.8)** [b]	**36.1 (34.5-37.8)** [b]	NA	NA
	50–59[c]	27.7 (23.1-32.9)	24.8 (22.9-26.8)	NA	NA
	60–64	NA	NA	**22.0 (17.2-27.7)** [b]	**21.9 (19.7-24.4)** [b]
	≥65[c]	NA	NA	13.1 (11.1-15.4)	**13.2 (12.1-14.4)**
Sex					
	Male	29.8 (24.6-35.6)	**32.8 (31.0-34.6)** [b]	**14.7 (12.1-17.7)** [a]	**13.6 (12.2-15.1)** [a,b]
	Female[c]	36.2 (31.0-41.8)	41.1 (39.5-42.7)	**15.9 (13.1-19.3)** [a]	**17.7 (16.1-19.3)** [a]
Race/ethnicity					
	Non-Hispanic White[c]	38.0 (33.2-43.1)	39.2 (37.7-40.8)	**15.5 (13.1-18.1)** [a]	**15.9 (14.7-17.2)** [a]
	Non-Hispanic Black	**25.0 (15.8-37.2)** [b]	**31.9 (28.4-35.6)** [b]	17.3 (12.2-23.9)	**13.5 (10.5-17.2)** [a]
	Hispanic	**24.9 (16.8-35.3)** [b]	**32.0 (29.3-34.9)** [b]	**9.2 (4.9-16.7)** [a,b,d]	**16.0 (12.0-21.0)** [a]
	Non-Hispanic Asian	49.0 (32.8-65.5)	41.7 (37.5-46.1)	**15.7 (8.1-28.2)** [a,d]	**18.4 (13.4-24.8)** [a]
	Non-Hispanic Other	**20.5 (10.3-36.7)** [b,d]	**35.8 (30.0-42.1)** [e]	**31.8 (14.7-55.8)** [d]	**17.2 (10.6-26.7)** [a]
Marital Status					
	Married[c]	32.0 (26.9-37.5)	35.8 (34.3-37.4)	**15.3 (12.7-18.4)** [a]	**17.5 (16.0-19.1)** [a]
	Widowed/ divorced/ separated	34.2 (27.1-42.2)	**31.3 (28.7-34.0)** [b]	**14.5 (11.5-18.1)** [a]	**13.3 (11.8-15.1)** [a,b]
	Never married	34.3 (27.1-42.2)	**39.7 (37.6-41.8)** [b]	**18.5 (12.5-26.3)** [a]	**13.8 (10.6-17.9)** [a]
Education					
	High school or less[c]	22.1 (17.2-27.8)	24.7 (22.8-26.7)	**10.9 (8.4-14.0)** [a]	**9.8 (8.4-11.3)** [a]
	Some college or college graduate	**42.3 (36.6-48.2)** [b]	**42.1 (40.4-43.7)** [b]	**19.3 (16.1-22.9)** [a,b]	**18.4 (16.7-20.1)** [a,b]
	Above college graduate	**40.5 (28.6-53.6)** [b]	**49.8 (47.0-52.6)** [b]	**19.2 (13.1-27.4)** [a,b]	**24.3 (21.1-27.9)** [a,b]
Employment status					

Characteristic		18–59 years		≥60 years	
		Vaccination coverage with ≥3 dose among adults with diabetes	Vaccination coverage with ≥3 dose among adults without diabetes	Vaccination coverage with ≥3 dose among adults with diabetes	Vaccination coverage with ≥3 dose among adults without diabetes
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
	Employed	35.7 (30.9-40.7)	**37.6 (36.3-39.1)** [b]	**20.6 (15.9-26.3)** [a,b]	**20.5 (18.4-22.7)** [a,b]
	Not employed[c]	28.7 (23.1-35.0)	34.7 (32.2-37.3)	**14.0 (11.9-16.4)** [a]	**13.7 (12.5-15.0)** [a]
Poverty level					
	At or above federal poverty line	34.4 (30.1-39.0)	**38.4 (37.0-39.8)** [b]	**15.5 (13.3-18.0)** [a]	**16.4 (15.2-17.6)** [a,b]
	Below federal poverty line[c]	28.8 (21.1-38.0)	29.6 (26.6-32.8)	**17.2 (11.7-24.5)** [a]	**12.4 (9.4-16.3)** [a]
Region					
	Northeast[c]	38.7 (28.6-50.0)	37.4 (34.5-40.4)	**15.8 (11.3-21.8)** [a]	**15.8 (13.2-18.8)** [a]
	Midwest	35.1 (27.3-43.7)	38.6 (36.0-41.2)	**18.4 (14.5-23.1)** [a]	**15.7 (13.6-18.0)** [a]
	South	29.0 (23.7-34.9)	**33.5 (31.3-35.8)** [b]	**11.5 (9.0-14.6)** [a]	**13.5 (12.0-15.3)** [a]
	West	36.1 (28.1-44.8)	40.7 (37.9-43.5)	**19.0 (14.1-25.2)** [a]	**19.8 (17.2-22.8)** [a,b]
US born status					
	U.S. born[c]	33.4 (29.2-37.8)	**38.6 (37.2-40.1)** [e]	**15.9 (13.8-18.3)** [a]	**15.6 (14.5-16.8)** [a]
	Not U.S born	32.4 (24.0-42.2)	**30.7 (28.2-33.4)** [b]	**12.4 (8.5-17.8)** [a]	**17.5 (14.3-21.4)** [a]
Physician contacts in the past 12 months					
	None[c]	30.3 (17.8-46.5)	28.5 (26.2-31.1)	**12.8 (5.5-27.1)** [§]	**13.9 (10.5-18.1)** [a]
	1	30.3 (19.3-44.2)	**34.7 (32.4-37.2)** [b]	**12.5 (7.3-20.7)** [a]	**15.5 (12.9-18.5)** [a]
	2-3	35.4 (27.7-43.9)	**39.7 (37.7-41.9)** [b]	**16.0 (12.1-21.0)** [a]	**15.9 (13.9-18.1)** [a]
	4-9	30.6 (24.2-37.7)	**40.6 (38.0-43.2)** [b,e]	**16.0 (12.9-19.7)** [a]	**15.8 (14.0-17.7)** [a]
	≥10	36.2 (29.4-43.7)	**45.7 (42.4-49.0)** [b,e]	**14.3 (11.0-18.3)** [a]	**17.5 (15.0-20.3)** [a]
Hospitalization in the past 12 months					
	Yes	35.6 (27.1-45.2)	39.0 (34.7-43.4)	**14.7 (10.9-19.5)** [a]	**16.1 (13.2-19.5)** [a]
	No[c]	32.7 (28.7-37.1)	36.9 (35.6-38.2)	**15.4 (13.2-17.9)** [a]	**15.8 (14.7-17.1)** [a]
Usual place for healthcare					
	Yes	33.6 (29.7-37.8)	**38.1 (36.7-39.5)** [b,e]	**15.4 (13.4-17.6)** [a]	**16.1 (14.9-17.3)** [a]
	No[c]	27.7 (16.0-43.4)	32.0 (29.4-34.8)	**8.1 (2.7-22.3)** [a,§]	**11.8 (8.2-16.6)** [a]
Health insurance					
	Yes	34.4 (30.3-38.6)	**39.2 (37.8-40.6)** [b,e]	**15.4 (13.4-17.6)** [a]	**16.0 (14.9-17.2)** [a]
	No[c]	25.9 (17.6-36.5)	23.5 (20.9-26.3)	**9.0 (2.1-32.0)** [a,§]	**11.7 (6.7-19.6)** [a]

Characteristic		18–59 years		≥60 years	
		Vaccination coverage with ≥3 dose among adults with diabetes	Vaccination coverage with ≥3 dose among adults without diabetes	Vaccination coverage with ≥3 dose among adults with diabetes	Vaccination coverage with ≥3 dose among adults without diabetes
		% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Ever tested for HIV					
	Yes	**39.7 (34.6-45.1)** [b]	**42.8 (41.1-44.5)** [b]	**25.6 (20.9-30.9)** [a,b]	**27.4 (24.6-30.4)** [a,b]
	No[c]	27.0 (21.9-32.7)	31.9 (30.1-33.7)	**11.3 (9.4-13.5)** [a]	**12.1 (11.0-13.3)** [a]
Healthcare personnel					
	Yes	**65.4 (53.8-75.4)** [b]	**71.5 (68.5-74.3)** [b]	**40.3 (25.6-57.0)** [a,b]	**47.6 (41.5-53.7)** [a,b]
	No[c]	29.4 (25.5-33.7)	32.4 (31.0-33.8)	**14.5 (12.6-16.6)** [a]	**14.0 (13.0-15.2)** [a]
Ever lived with a hepatitis patient					
	Yes	**49.2 (33.5-65.0)** [b]	**49.0 (44.0-54.1)** [b]	**25.7 (15.7-38.9)** [a]	**26.7 (20.6-33.8)** [a,b]
	No[c]	31.7 (27.8-35.8)	**36.4 (35.0-37.8)** [e]	**14.1 (12.1-16.3)** [a]	**14.9 (13.8-16.1)** [a]
Travelers[f]					
	Yes	**43.4 (36.5-50.7)** [b]	**44.8 (43.0-46.6)** [b]	**20.4 (16.0-25.7)** [a,b]	**22.2 (20.0-24.6)** [a,b]
	No[c]	28.6 (24.5-33.2)	31.0 (29.4-32.6)	**13.1 (11.1-15.5)** [a]	**12.7 (11.5-14.0)** [a]
Received influenza vaccination in past 12 months					
	Yes	35.0 (29.9-40.4)	**47.2 (45.3-49.2)** [b,e]	**17.1 (14.6-19.8)** [a,b]	**18.5 (17.1-20.0)** [a,b]
	No[c]	31.4 (26.2-37.1)	31.4 (29.9-32.9)	**10.6 (7.7-14.5)** [a]	**11.6 (10.1-13.2)** [a]
Persons with chronic liver diseases					
	Yes	**59.4 (41.3-75.2)** [b]	**34.1 (25.4-44.0)** [e]	**20.4 (10.9-35.0)** [a]	**28.8 (19.3-40.6)** [b]
	No[c]	32.2 (28.4-36.3)	**37.1 (35.7-38.4)** [e]	**15.0 (13.0-17.3)** [a]	**15.6 (14.5-16.8)** [a]

Note: Boldface indicates statistical significance ($p<0.05$).

[a] $p<0.05$ by t test for comparisons between adults aged 18–59 and ≥60 years with diabetes, and between adults aged 18–59 and ≥60 years without diabetes within each level of each characteristic.

[b] $p<0.05$ by t test for comparisons within each variable with the indicated reference level.

[c] Reference level.

[d] Estimate is not reliable due to relative standard error (standard error/estimates) >0.3.

[e] $p<0.05$ by t test for comparisons between adults with diabetes and those without diabetes within each level of each characteristic.

[f] Persons traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada since 1995 were considered having traveled to countries with high or intermediate hepatitis B virus endemicity.

NA: Not applicable.

Table 3.

Adjusted prevalence ratio (APR)[a] for hepatitis B vaccination (≥3 dose) among adults aged ≥18 years, 2018 NHIS

		18–59 years		≥60 years	
		With diabetes	Without diabetes	With diabetes	Without diabetes
Characteristic		APR (95% CI)	APR (95% CI)	APR (95% CI)	APR (95% CI)
Age					
	18–29	**2.03 (1.46, 2.81)** [b]	**2.09 (1.90, 2.29)** [b]	NA	NA
	30–49	1.12 (0.87, 1.45)	**1.42 (1.31, 1.55)** [b]	NA	NA
	50–59‡	Reference	Reference	NA	NA
	60–64	NA	NA	**1.51 (1.10, 2.08)** [b]	**1.42 (1.22, 1.66)** [b]
	≥65	NA	NA	Reference	Reference
Sex					
	Male	0.84 (0.66, 1.06)	0.96 (0.91, 1.02)	1.06 (0.80, 1.39)	**0.74 (0.64, 0.85)** [b]
	Female	Reference	Reference	Reference	Reference
Race/ethnicity					
	Non-Hispanic White	Reference	Reference	Reference	Reference
	Non-Hispanic Black	**0.61 (0.40, 0.93)** [b]	**0.85 (0.76, 0.96)** [b]	1.36 (0.88, 2.10)	0.81 (0.62, 1.07)
	Hispanic	**0.63 (0.40, 0.98)** [b]	0.94 (0.85, 1.04)	0.62 (0.31, 1.27)	0.97 (0.70, 1.36)
	Non-Hispanic Asian	1.00 (0.59, 1.69)	1.00 (0.88, 1.13)	1.01 (0.47, 2.19)	1.03 (0.70, 1.53)
	Non-Hispanic Other	0.66 (0.40, 1.09)	0.92 (0.77, 1.10)	1.23 (0.56, 2.72)	1.20 (0.73, 1.99)
Marital Status					
	Married	Reference	Reference	Reference	Reference
	Widowed/divorced/ separated	1.18 (0.91, 1.53)	0.98 (0.90, 1.06)	1.05 (0.78, 1.40)	**0.82 (0.70, 0.95)** [b]
	Never married	1.14 (0.88, 1.48)	0.98 (0.91, 1.04)	1.08 (0.70, 1.65)	**0.76 (0.59, 0.98)** [b]
Education					
	High school or less	Reference	Reference	Reference	Reference
	Some college or college graduate	**1.62 (1.21, 2.17)** [b]	**1.33 (1.24, 1.44)** [b]	**1.42 (1.03, 1.97)** [b]	**1.53 (1.28, 1.84)** [b]
	Above college graduate	1.31 (0.82, 2.09)	**1.49 (1.35, 1.64)** [b]	1.43 (0.90, 2.28)	**1.84 (1.47, 2.29)** [b]
Employment status					
	Employed	1.00 (0.76, 1.32)	0.93 (0.87, 1.01)	1.11 (0.79, 1.58)	0.98 (0.83, 1.14)
	Not employed	Reference	Reference	Reference	Reference
Poverty level					
	At or above federal poverty line	0.98 (0.73, 1.33)	1.08 (0.98, 1.19)	0.89 (0.57, 1.41)	1.01 (0.74, 1.39)
	Below federal poverty line	Reference	Reference	Reference	Reference
Region					
	Northeast	Reference	Reference	Reference	Reference

Characteristic		18–59 years		≥60 years	
		With diabetes	Without diabetes	With diabetes	Without diabetes
		APR (95% CI)	APR (95% CI)	APR (95% CI)	APR (95% CI)
	Midwest	1.07 (0.75, 1.54)	1.07 (0.96, 1.19)	1.07 (0.70, 1.63)	1.12 (0.90, 1.41)
	South	0.97 (0.71, 1.33)	1.01 (0.91, 1.12)	0.67 (0.43, 1.04)	0.88 (0.70, 1.10)
	West	1.17 (0.80, 1.70)	**1.13 (1.02, 1.26)** [b]	1.24 (0.81, 1.91)	1.24 (0.99, 1.54)
US born status					
	U.S. born	Reference	Reference	Reference	Reference
	no U.S born	1.27 (0.89, 1.80)	**0.87 (0.79, 0.97)** [b]	0.83 (0.47, 1.46)	1.09 (0.85, 1.41)
Physician contacts in the past 12 months					
	None	Reference	Reference	Reference	Reference
	1	0.85 (0.47, 1.54)	1.03 (0.94, 1.13)	1.05 (0.37, 3.03)	0.86 (0.62, 1.18)
	2–3	1.34 (0.83, 2.15)	1.09 (1.00, 1.20)	1.33 (0.51, 3.45)	0.88 (0.66, 1.18)
	4–9	1.01 (0.63, 1.62)	1.09 (0.99, 1.21)	1.27 (0.49, 3.24)	0.86 (0.64, 1.14)
	≥10	1.08 (0.66, 1.78)	**1.22 (1.09, 1.37)** [b]	1.16 (0.45, 2.98)	0.88 (0.64, 1.19)
Hospitalization in the past 12 months					
	Yes	1.06 (0.79, 1.41)	0.93 (0.83, 1.04)	0.96 (0.70, 1.33)	1.11 (0.91, 1.36)
	No	Reference	Reference	Reference	Reference
Usual place for healthcare					
	Yes	1.29 (0.75, 2.22)	1.00 (0.92, 1.09)	1.74 (0.49, 6.23)	1.05 (0.69, 1.61)
	No	Reference	Reference	Reference	Reference
Health insurance					
	Yes	1.14 (0.81, 1.61)	**1.18 (1.06, 1.32)** [b]	1.93 (0.48, 7.68)	1.36 (0.75, 2.47)
	No	Reference	Reference	Reference	Reference
Ever tested for HIV					
	Yes	**1.26 (1.01, 1.57)** [b]	**1.23 (1.16, 1.30)** [b]	**2.15 (1.65, 2.81)** [b]	**1.83 (1.58, 2.12)** [b]
	No	Reference	Reference	Reference	Reference
Healthcare personnel					
	Yes	**1.96 (1.51, 2.55)** [b]	**1.91 (1.80, 2.04)** [b]	**2.33 (1.51, 3.58)** [b]	**2.52 (2.12, 3.00)** [b]
	No	Reference	Reference	Reference	Reference
Ever lived with a hepatitis patient					
	Yes	**1.43 (1.01, 2.02)** [b]	**1.35 (1.21, 1.50)** [b]	1.50 (0.98, 2.30)	**1.52 (1.15, 2.01)** [b]
	No	Reference	Reference	Reference	Reference
Travelers [c]					
	Yes	**1.49 (1.18, 1.87)** [b]	**1.28 (1.21, 1.36)** [b]	**1.45 (1.08, 1.95)** [b]	**1.40 (1.21, 1.63)** [b]
	No	Reference	Reference	Reference	Reference
Received influenza vaccination in past 12 months					

Characteristic		18–59 years		≥60 years	
		With diabetes	Without diabetes	With diabetes	Without diabetes
		APR (95% CI)	APR (95% CI)	APR (95% CI)	APR (95% CI)
	Yes	0.97 (0.79, 1.21)	**1.19 (1.13, 1.26)** [b]	1.36 (0.96, 1.91)	**1.42 (1.21, 1.66)** [b]
	No	Reference	Reference	Reference	Reference
Persons with chronic liver diseases					
	Yes	1.39 (0.89, 2.15)	0.85 (0.61, 1.17)	1.56 (0.81, 3.00)	1.26 (0.71, 2.24)
	No	Reference	Reference	Reference	Reference

Note: Boldface indicates statistical significance ($p<0.05$).

[a] Adjusted estimates control for age, sex, race/ethnicity, marital status, educational level, employment status, poverty level, region of residence, U.S. born status, number of physician contacts in the previous year, hospitalization in the past year, usual place for health care, health insurance status, ever tested for human immunodeficiency virus (HIV), health care personnel status, ever lived with a hepatitis patient, travel status, received influenza vaccination in past 12 months, and persons with chronic liver diseases.

[b] $p<0.05$ by t test for comparisons within each variable with the indicated reference level.

[c] Persons traveled outside the United States to countries other than Europe, Japan, Australia, New Zealand, or Canada since 1995 were considered having traveled to countries with high or intermediate hepatitis B virus endemicity.

NA: Not applicable.