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Self-reported hepatitis A vaccination as a predictor of hepatitis A virus antibody protection in U.S. adults: National Health and Nutrition Examination Survey 2007–2012

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Abstract

Objectives—To estimate the predictive value of self-reported hepatitis A vaccine (HepA) receipt for the presence of hepatitis A virus (HAV) antibody (anti-HAV) from either past infection or vaccination, as an indicator of HAV protection.

Methods—Using 2007–2012 National Health and Nutrition Examination Survey data, we assigned participants to 4 groups based on self-reported HepA receipt and anti-HAV results. We compared characteristics across groups and calculated three measures of agreement between self-report and serologic status (anti- HAV): percentage concordance, and positive (PPV) and negative (NPV) predictive values. Using logistic regression we investigated factors associated with agreement between self-reported vaccination status and serological results.

Results—Demographic and other characteristics varied significantly across the 4 groups. Overall agreement between self-reported HepA receipt and serological results was 63.6% (95% confidence interval [CI] 61.9–65.2); PPV and NPV of self-reported vaccination status for serological result were 47.0% (95% CI 44.2–49.8) and 69.4% (95% CI 67.0–71.8), respectively. Mexican American and foreign-born adults had the highest PPVs (71.5% [95% CI 65.9–76.5], and 75.8% [95% CI 71.4–79.7]) and the lowest NPVs (21.8% [95% CI 18.5–25.4], and 20.0% [95% CI 17.2–23.1]), respectively. Young (ages 20–29 years), US-born, and non-Hispanic White adults had the lowest

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The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Contributors

MMD contributed to conception of the study, design of the analytic plan, analysis and interpretation of the data, and writing and reviewing the manuscript. RMK and RBJ contributed to design of the analytic plan, interpretation of results, and writing and reviewing the manuscript. TVM generated the research questions, and contributed to design of the analytic plan, interpretation of results, and writing and reviewing the manuscript. All authors gave final approval for the version of the manuscript to be submitted.

Conflict of interest

None to report.

PPVs (37.9% [95% CI 34.5–41.5], 39.1% [95% CI, 36.0–42.3], and 39.8% [36.1–43.7]), and the highest NPVs (76.9% [95% CI 72.2–81.0, 78.5% [95% CI 76.5–80.4)], and 80.6% [95% CI 78.2–82.8), respectively. Multivariate logistic analyses found age, race/ethnicity, education, place of birth and income to be significantly associated with agreement between self-reported vaccination status and serological results.

Conclusions—When assessing hepatitis A protection, self-report of not having received HepA was most likely to identify persons at risk for hepatitis A infection (no anti-HAV) among young, US-born and non-Hispanic White adults, and self-report of HepA receipt was least likely to be reliable among adults with the same characteristics.

Keywords

Hepatitis A vaccine (HepA); Self-report; Vaccination status; Serological testing; Predictive value; Concordance

1. Introduction

In the 1980s and 1990s, large areas of the United States experienced cyclic outbreaks of hepatitis A virus (HAV) disease [1]. To reduce the burden of HAV disease, from 1996 to 2007 the Advisory Committee on Immunization Practices (ACIP) made recommendations for use of hepatitis A vaccines (HepA), which were first approved in 1995–1996 [2–5]. Initial recommendations were for adults at increased risk for HAV infection, including persons planning international travel to HAV endemic areas (1996) and for children aged ≥2 years residing in areas where incidence was at least twice the U.S. average (1999). Subsequent HepA recommendations added all children starting at age 12–23 months (2006), persons wishing HAV protection, and post-exposure prophylaxis for healthy persons aged 1 to <40 years [2–5].

As vaccination coverage increased in the United States, rates of acute HAV disease declined. In 2011, rates had decreased by more than 95% and were the lowest recorded [6]. Declines were greatest among children recommended to receive routine hepatitis A vaccination. In 2012, although rates continued to decline among children aged 0–9 years, the rates and proportion of hepatitis A cases among adults increased [7]. Complications and severe HAV disease are most likely to occur among adults [8].

Early evidence suggests a growing proportion of the adult population has no evidence of hepatitis A protection, which usually would have been acquired at a young age when HAV was endemic in the United States [9]. Providers and public health personnel evaluating adults for hepatitis A vaccination must rely on self-reported HepA receipt or disease history when records are not available [10]. In 2013, a domestic outbreak of HAV infection associated with imported HAV-contaminated pomegranate arils resulted in 165 cases in 10 states. Ninety-three percent of cases were among adults aged ≥18 years, and 45% of adults were hospitalized. One retailer alone evaluated more than 10,000 people for post-exposure prophylaxis with HepA [11].

The predictive value of self-reported vaccination history for HAV protection among adults has received limited evaluation [10,12]. Antibody to HAV (anti-HAV) results from either

vaccination or infection and is considered a marker of protection from HAV infection [13,14]. The National Health and Nutrition Examination Survey (NHANES) provides a unique opportunity to examine the correlation between self-reported HepA receipt and serological test results in the general U.S. population. We used 2007–2012 NHANES data from participants aged ≥20 years to calculate measures of agreement and identify factors associated with agreement between self-report and protection against HAV infection.

2. Methods and materials

2.1. Survey design

The NHANES, conducted by the U.S. Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS), collects nationally representative data on health and nutritional status from the non-institutionalized civilian U.S. population. NHANES uses a complex probability sampling design and collects information from approximately 5000 persons per year using standardized household interviews, physical examinations, and tests of biologic samples. Participants are interviewed in their homes to ascertain demographic characteristics and self-reported vaccination against hepatitis A. More information on survey design, including Institutional Review Board approval for data collection and analysis, and informed consent procedure, is available from survey documentation at http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm

2.2. Laboratory testing

Serum specimens from participants aged ≥2 years were tested for total anti-HAV using a competitive immunoassay technique (HAV T–Anti-HAV Total, VITROS Immunodiagnostic System (Ortho-Clinical Diagnostics, Inc., Rochester, NY)). Presence of total anti-HAV indicates immunity against HAV infection acquired from past infection or vaccination. Tests considered reactive initially were repeated in duplicate. Further details of laboratory testing are available from the survey documentation at http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm

2.3. Definitions and measures

Self-reported HepA receipt was accessed from responses to the question "Hepatitis A vaccine is given as a two dose series to some children older than 2 years and also to some adults, especially people who travel outside the United States. It has only been available since 1995. Have you ever received hepatitis A vaccine?" Because seroconversion rates are high (~95%) after the first dose of HepA [15], we classified persons as "in agreement" with self-report when they reported receiving any doses of HepA and were anti-HAV positive, or if they reported no doses and were anti-HAV negative. We classified persons as "not in agreement" when they reported receiving any doses of HepA and were anti-HAV negative, or if they reported no doses and were anti-HAV positive.

Race and ethnicity were obtained by self-report from all NHANES participants. Prior to release in NHANES public use data files, NCHS combines responses on ethnicity and race into a limited number of categories. For 2007–2010 the categories were Mexican-American, Other Hispanic, Non-Hispanic Black, Non-Hispanic White and Other Race – Including

Multi-Racial; for 2011–2012, 6 categories were used: those used for 2007–2010 plus Asian. In our analysis we used the 2007–2010 categories, with Asian recoded into Other Race for 2011–2012. Due to insufficient sample sizes resulting from changes in oversampling over time, NCHS does not recommend producing estimates for any Hispanic subgroup other than Mexican-American or for the Other Race subgroup. Therefore, estimates for these groups are not provided although participants belonging to these groups were included in the analyses.

2.4. Statistical analysis

We used SUDAAN (version 10.0), a statistical package designed to analyze complex survey data, for analysis [16]. Estimates were weighted to represent the total civilian, non-institutionalized U.S. population and to account for oversampling and non-response to the household interview and physical examination. Weights were further adjusted to account for analyzing multiple years of data. We included only those aged ≥20 years in our analyses. A *p*-value <.05 was considered significant.

We estimated demographic (age at interview, sex, race/ethnicity, poverty index, birth place and education) and other (health insurance coverage) characteristics for groups obtained by combining vaccination report and anti-HAV test results: Group 1 reported receiving any doses of HepA and were anti-HAV negative, Group 2 reported any doses and were anti-HAV positive, Group 3 reported no doses and were anti-HAV negative, and Group 4 reported no doses and were anti-HAV positive. For each group and characteristic we calculated three measures of agreement: percent with agreement between self-reported vaccination status and serological result, positive predictive value (PPV) and negative predictive value (NPV). We used predictive values to refer to the predictive value of self-reported vaccination for serological status. Chi-square tests were used for statistical comparisons between subgroups as an overall test for difference across levels of a factor. To avoid multiple testing, pairwise differences across levels of a factor with >2 levels and differences in PPV and NPV were determined by observing whether each estimate was contained within the 95% confidence interval of the other.

We conducted two separate logistic regression analyses to assess factors associated with agreement using the aforementioned characteristics. One analysis included only those who reported receiving any doses of HepA (Groups 1 and 2) and the other including only those who reported receiving no doses (Groups 3 and 4). In each regression analysis, crude prevalence ratios were obtained using a separate logistic regression model for each of the independent variables. Variables that were statistically significant in simple logistic models were included in initial multivariate modeling. Variables not found to be significant in simple logistic models or at earlier stages of model building were added to the final multivariate model one at a time to test for confounding and significance. Final models included all variables found to be significant and any potential confounders (e.g., sex).

3. Results

Of 24,731 persons aged ≥20 years sampled in the NHANES 2007–2012, 17,713 (71.6%) were interviewed and 17,085 (96.4% of those interviewed) were examined. Serum samples

were available for anti-HAV testing for 15,747 (92.2% of those examined). Of the 17,713 interviewed, 15,375 (86.8%) provided a valid response to the hepatitis A vaccination question, 12 (0.07%) responded “don’t know” and 2326 (13.13%) refused to answer. Because not every participant with an anti-HAV result responded to the vaccination question, the sample size for our analysis was 13,651 (79.9% of those examined had data for both).

Overall, an estimated 26.2% (95% CI 24.7–27.8) self-reported HepA receipt and 34.8% (32.7–37.1) were anti-HAV positive. By group, 13.9% (13.0–14.9, n = 1622) reported receiving any HepA doses but were anti-HAV negative (Group 1), 12.3% (11.2–13.5, n = 1901) reported any doses and were antibody positive (Group 2), 51.3% (49.0–53.5, n = 5606) reported no doses and were antibody negative (Group 3) and 22.5% (20.9–24.3, n = 4522) reported no doses but were anti-HAV positive (Group 4).

Except for sex, demographic and other characteristics varied significantly across the 4 groups (Table 1). Group 1 (those who reported vaccination but were anti-HAV negative) were the youngest. Group 3 (those who reported no vaccination and were anti-HAV negative) were most likely to be non-Hispanic White and least likely to be Mexican-American, and most likely to have income at or above poverty level or to have health insurance coverage. Group 4 (those who reported no vaccination but were anti-HAV positive) were the oldest, least likely to be non-Hispanic White, and most likely to have education less than high school. Regardless of vaccination history, Groups 2 and 4 (those who were anti-HAV positive) were most likely to be foreign-born, and Groups 1 and 3 (those who were anti-HAV negative) were most likely to be US-born.

Overall agreement between self-reported hepatitis A vaccination and serological results was 63.6% (61.9–65.2) (Table 2). Overall PPV of self-report was 47.0% (44.2–49.8) and NPV was 69.4% (67.0–71.8). NPV was highest for those aged <60 years at interview, non-Hispanic Whites, and those with income at or above poverty level, education above high school, US birth, and health insurance coverage. PPV was highest for those aged ≥60 years, Mexican-Americans and those who were foreign born. Sex was not predictive of agreement.

Simple logistic regression analysis involving those who reported receiving HepA (Groups 1 and 2) found significant positive associations between agreement with serologic results and Mexican-American race/ethnicity and foreign birth and significant negative associations between agreement and age <60 years at interview and education greater than or equal to high school; sex, poverty level and health insurance coverage were not significantly associated with agreement in simple logistic models (Table 3) Simple logistic regression analysis involving those who reported no doses (Groups 3 and 4) found significant positive associations between agreement with serologic results and age <60 years at interview and education greater than or equal to high school and significant negative associations between agreement and Mexican-American and Black non-Hispanic race/ethnicity, income below poverty level, non-US birth, and no health insurance coverage; only sex was not significantly associated with agreement in simple logistic models (Table 4). In the final multivariate logistic models, all factors significant in the simple logistic analyses except

health insurance coverage retained their significant associations with agreement with serologic results (Tables 3 and 4).

4. Discussion

NHANES data provide a unique opportunity to assess agreement between self-reported HepA receipt and serological evidence of anti-HAV protection in a nationally representative sample of the U.S. adult population. We found overall agreement was 63.6%, similar to [10,18] or a little lower [17,19] than findings for other vaccines. PPVs >70% were found among Mexican American and foreign born adults, and NPVs >76% were found among young, US-born, and non-Hispanic White adults. Of concern, PPVs of self-reported HepA receipt were <40% among young, US-born, and non-Hispanic White adults, suggesting a large proportion of adults in these groups might believe they are protected against HAV infection when they are not.

Lack of easily accessible adult vaccination records and lack of health-care provider and patient knowledge about the need for vaccination have been identified as barriers to adult vaccination [20]. Adult self-reported hepatitis A vaccination coverage among persons recommended for vaccination was estimated at <20% in the 2012 National Health Interview Survey [21]. When vaccination records are not available, determining which patients will benefit from hepatitis A vaccination presents a challenge for providers assessing adults who might be at risk for HAV infection or for severe HAV disease, e.g., injecting and non-injecting drug users, men who have sex with men, persons working with HAV-infected primates or who have chronic liver disease [4]. Lack of records also is a barrier to making rapid vaccination decisions needed for impending international travel and for known HAV exposure [5,13]. A false impression of protection might leave the patient unprotected; unnecessary vaccination adds cost and inconvenience. Current recommendations for obtaining pre-vaccination serologic testing to determine HAV protection suggest considering the expected prevalence of anti-HAV, the cost of vaccination compared with the cost of serologic testing and an additional visit, and the likelihood that testing will not interfere with needed vaccination [4,22]. These recommendations were based on the results of NHANES surveys conducted in 1988–1994, which found that the prevalence of anti-HAV was >33% among adults aged >40 years [4,23]. In contrast, NHANES data from 2009 to 2010 found the prevalence of anti-HAV among U.S.-born adults did not reach >33% until persons were aged ≥60 years, highlighting the increasing proportion of U.S. adults who are hepatitis A susceptible. (Public Health Grand Rounds, April 2013. Available at: http://www.cdc.gov/cdcgrandrounds/archives/2013/april2013.htm).

Most current national systems for assessing adult vaccination coverage rely on self-report of vaccination [18,24]. Reliable data assessing vaccine coverage among adults is important for public health to assess programmatic success and to identify gaps in coverage. In conjunction with surveillance for determining disease incidence, vaccine coverage data provide information for planning targeted vaccination among persons who will benefit [24,25]. Greater focus on adult immunization has stimulated efforts to include adult vaccination as a standard of care in electronic medical records and in Immunization

Information Systems (IIS) registries for adults [20,26,27]. Registries will likely improve assessment of adult vaccination status.

A major advantage of NHANES data for assessing the validity of self-reported HepA receipt is its relatively large sample size, which allows for assessing groups of adults with relatively low vaccination coverage. NHANES data also reflect HAV protection from infection as well as from vaccination, which may be more relevant in the context of changing disease and susceptibility patterns in the population. NHANES data have previously been used to assess the validity of self-reported hepatitis B vaccination. A limitation of these analyses was waning of hepatitis B vaccine-induced antibody to levels no-longer defined as protective [28]. In contrast, after hepatitis A vaccination, anti-HAV has persisted in the majority of responders since vaccines were approved for use in 1995–1996; mathematical modeling suggests persistence of vaccine-induced anti-HAV might be ≥25 years in as many as 95% of the population [29–32].

Our findings are generally in accord with those of others [10,12,33]. Rolnick et al. examined self-reported HepA receipt with confirmation in electronic medical records or on vaccination cards [10]. In their study non-Hispanic Whites comprised 85% of subjects, none were Hispanic, and 79% had some college or higher education. HepA coverage in electronic records was 15.7% in the source population; in contrast, anti-HAV was found in 34.8% of subjects in our analysis of NHANES data. Self-reported HepA coverage in Rolnick et al. was 23.3% among interviewed subjects, similar to selfreported coverage in NHANES (26.2%). The NPV of self-reported vaccination in Rolnick et al. was 94.0%, substantially higher than the 69.4% in NHANES. Overall, PPVs were similar in Rolnick et al. and NHANES (42.1% and 47.0%, respectively). Among older adults, Rolnick et al. reported lower PPV than found in NHANES (39.9% for ages ≥65, and 64.7% for ages ≥60 years, respectively). Mongillo et al. examined NPV and PPV of agreement between self-reported HepA receipt and presence of anti-HAV among Italian college students aged <30 years [12]. NPV (96.1%) and PPV (52.7%) of self-reported vaccination were slightly higher than found in NHANES among persons ages 20–29 years (76.9% and 37.9%, respectively), but the pattern was similar. Discrepancies between our results and those of Rolnick et al. and Mongillo et al., likely reflect the outcomes evaluated (confirmed vaccination or anti-HAV), and the characteristics of the populations surveyed [10,12].

Our results have unavoidable limitations. The classification for agreement between self-reported HepA receipt and serological status had potential for misclassification of persons who were previously HAV infected but reported no vaccination, or the small proportion of vaccinated persons who do not respond with anti- HAV. However, our objective was to determine whether self-report of vaccination reflected protection measured as anti-HAV, regardless of the source of protection (vaccination or infection). We assumed the presence of anti-HAV indicated protection against HAV disease primarily through vaccination, but misclassification could have occurred if anti-HAV was acquired through past infection. NHANES does not ask for hepatitis A disease history and laboratory assays do not distinguish between anti-HAV acquired through infection and anti-HAV induced by vaccination. We assumed that adults who received either one or two doses of the recommended two-dose HepA series had measurable anti- HAV. Although seroconversion

rates after the first dose are high (~95%), some vaccinated adults would not have seroconverted, and these adults would have been misclassified as lacking agreement [12,34]. The NHANES question about hepatitis A vaccination indicates the vaccine is given to children ages ≥2 years; this might have caused confusion by some participants since HepA has been recommended at age 12–23 months since 2006 and also for some adults [4]. NHANES data are representative of the civilian, non-institutionalized U.S. population but do not include persons who are homeless, in the military, or living in group quarters (e.g., college students). Thus, the results might not apply to the entire U.S. population. Lastly, measures of agreement between self-report and anti-HAV are at population level and do not directly address results for an individual whose hepatitis A protection is being evaluated.

In conclusion, findings from NHANES 2007–2012 document the limitations of self-reported HepA receipt. They illustrate that providers caring for adults (especially non-Hispanic Whites) in the United States should be aware that self-reported HepA receipt has a relatively low PPV for hepatitis A protection; this is particularly relevant given that a substantial proportion of the U.S. adult population is susceptible to HAV infection. Findings from this analysis might alert providers to avoid missed opportunities to vaccinate susceptible individuals and to avoid vaccinating persons who are already protected. These findings also provide information to public health vaccination programs and providers regarding the characteristics of persons whose self-reported hepatitis A vaccination status most reliably predicts HAV protection, and the need for additional education about the risks of HAV disease and the benefits of hepatitis A vaccination.

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Table 1

Estimated demographic characteristics by self-reported vaccination status and serological results: NHANES 2007–2012 participants aged ≥20 years (*n* = 13,651).

Characteristic	Report+/serology neg (Group 1)		Report+/serology+ (Group 2)		Report neg/serology neg (Group 3)		Report neg/serology+ (Group 4)	
	n = 1622[a]	Weighted % (95% CI)	*n* = 1901[a]	Weighted % (95% CI)	*n* = 5606[a]	Weighted % (95% CI)	*n* = 4522[a]	Weighted % (95% CI)
Age at interview (years)***								
20–29	602	36.1 (31.8–40.6)	421	24.9 (21.3–28.8)	796	14.5 (12.9–16.1)	335	9.9 (8.3–11.7)
30–39	393	22.1 (19.3–25.2)	965	21.3 (19.0–23.9)	1016	16.8 (15.6–18.2)	461	12.9 (11.2–14.8)
40–49	291	19.1 (17.0–21.5)	318	18.0 (15.2–21.1)	1109	22.5 (20.8–24.3)	609	15.4 (14.1–16.9)
50–59	154	12.8 (10.8–15.1)	296	15.5 (13.5–17.7)	960	21.9 (20.2–23.7)	792	19.3 (17.4–21.3)
60+	182	9.9 (7.8–12.5)	501	20.3 (17.7–23.3)	1725	24.3 (22.7–26.1)	2325	42.5 (39.3–45.8)
Sex								
Male	738	45.6 (42.8–48.4)	912	48.6 (46.8–51.5)	2765	48.1 (47.0–49.2)	2220	47.3 (45.2–49.5)
Female	884	54.4 (51.6–57.2)	989	51.4 (48.8–54.2)	2841	51.9 (50.8–53.0)	2302	52.7 (50.5–54.8)
Race/ethnicity***								
Mexican American	119	4.6 (3.4–6.3)	414	13.2 (10.4–16.6)	274	2.3 (1.6–3.2)	1209	18.8 (14.6–24.0)
Non-Hispanic White	792	70.5 (65.7–75.0)	323	52.7 (46.9–58.4)	3685	83.3 (80.1–86.0)	1217	45.7 (39.1–52.4)
Non-Hispanic Black	437	14.0 (11.0–17.5)	360	11.7 (9.8–13.8)	1185	9.3 (7.4–11.6)	895	12.4 (10.0–15.2)
Poverty index***								
Below poverty	386	17.8 (15.1–20.9)	421	18.2 (15.1–21.7)	895	10.7 (9.3–12.2)	1049	20.6 (18.4–22.9)
At or above poverty	1116	82.2 (79.1–84.9)	1310	81.8 (78.3–84.9)	4380	89.3 (87.8–90.7)	2954	79.4 (77.1–81.6)
Education***								
<High school	254	12.0 (9.8–14.6)	516	18.0 (15.4–21.0)	888	11.8 (10.4–13.4)	2002	35.0 (32.5–37.6)
High school/GED	343	19.7 (16.8–23.0)	307	14.4 (12.2–16.8)	1495	25.4 (23.4–27.4)	1025	24.0 (22.4–25.6)
>High school	1022	68.3 (64.1–72.2)	1075	67.6 (63.5–71.5)	3221	62.8 (59.8–65.8)	1488	41.0 (38.3–43.8)
Place of birth***								
United States	1427	90.2 (87.4–92.5)	964	65.4 (59.9–70.6)	5272	95.6 (94.6–96.4)	2319	59.5 (54.0–64.8)
Elsewhere	195	9.8 (7.5–12.6)	936	34.6 (29.4–40.1)	334	4.4 (3.6–5.4)	2197	40.5 (35.2–46.0)
Health insurance***								
Any	1205	78.4 (75.1–81.3)	1400	78.8 (74.4–82.5)	4503	84.0 (82.5–85.4)	3269	75.0 (72.0–77.8)

Characteristic	Report+/serology neg (Group 1)		Report+/serology+ (Group 2)		Report neg/serology neg (Group 3)		Report neg/serology+ (Group 4)	
	***n* = 1622[a]**	**Weighted % (95% CI)**	***n* = 1901[a]**	**Weighted % (95% CI)**	***n* = 5606[a]**	**Weighted % (95% CI)**	***n* = 4522[a]**	**Weighted % (95% CI)**
None	417	21.6 (18.7–24.9)	499	21.2 (17.5–25.6)	1100	16.0 (14.6–17.5)	1248	25.0 (22.2–28.0)

Report+ = reported receipt of any doses of vaccine; report neg = reported receipt of no doses of vaccine.

*** $p < .001$ for overall chi-square test for difference in characteristic across the 4 categories of self-reported vaccination status and serological results.

[a] Some rows may not sum to the column total due to missing data. For race/ethnicity, column percentages do not sum to 100% since estimates for other Hispanics and for those of other/multiple race groups are not presented.

Table 2

Agreement[a] between self-reported hepatitis A vaccination status and HAV serological test result by selected characteristics medical examination participants: NHANES 2007–2012 Aged ≥20 years (n = 13,651).

Characteristic	n^b	Number in agreement	Weighted % in agreement (95% CI)	χ^2 p-value	PPV (%) (95% CI)	NPV (%) (95% CI)
Total	13,651	7507	63.6 (61.9–65.2)		47.0 (44.2–49.8)	69.4 (67.0–71.8)
Age at interview (years)						
20–29	2154	1217	59.1 (55.9–62.2)	<.001	37.9 (34.5–41.5)	76.9 (72.2–81.0)
30–39	2235	1381	65.3 (62.5–68.0)		46.1 (41.2–51.1)	74.8 (71.3–78.0)
40–49	2327	1427	69.1 (66.4–71.7)		45.4 (39.8–51.1)	76.8 (73.6–79.8)
50–59	2202	1256	68.2 (64.7–71.4)		51.7 (46.4–57.1)	72.1 (67.8–76.0)
60+	4733	2226	57.8 (55.0–60.6)		64.7 (58.2–70.6)	56.6 (53.2–59.9)
Sex						
Male	6635	3677	64.3 (62.3–66.2)	.168	48.6 (45.1–52.1)	69.8 (67.0–72.4)
Female	7016	3830	62.9 (60.9–64.8)		45.6 (42.3–48.8)	69.1 (66.6–71.6)
Race/ethnicity						
Mexican-American	2016	688	36.4 (33.7–39.2)	<.001	71.5 (65.9–76.5)	21.8 (18.5–25.4)
White non-Hispanic	6217	4208	71.0 (69.0–72.9)		39.8 (36.1–43.7)	80.6 (78.2–82.8)
Black non-Hispanic	2877	1545	56.7 (53.7–59.7)		42.5 (38.4–46.8)	63.1 (59.5–66.6)
Poverty index						
Below poverty	2751	1316	52.7 (49.3–56.1)	<.001	47.2 (41.8–52.7)	55.3 (50.1–60.4)
At or above poverty	9760	5690	66.2 (64.5–67.9)		46.6 (43.2–50.0)	72.9 (70.7–75.0)
Education						
<High school	3660	1404	46.4 (43.5–49.3)	<.001	57.2 (51.3–62.8)	43.4 (39.2–47.7)
High school/GED	3170	1802	64.5 (61.6–67.3)		39.3 (34.4–44.4)	70.6 (67.3–73.8)
>High school	6806	4296	68.4 (66.6–70.1)		46.8 (43.7–49.8)	77.7 (75.6–79.7)
Place of birth						
United States	9982	6236	68.8 (67.2–70.3)	<.001	39.1 (36.0–42.3)	78.5 (76.5–80.4)
Elsewhere	3662	1270	38.4 (36.1–40.7)		75.8 (71.4–79.7)	20.0 (17.2–23.1)
Health insurance						
Any	10,377	5903	65.5 (63.8–67.2)	<.001	47.1 (43.8–50.4)	71.8 (69.6–74.0)
None	3264	1599	55.6 (51.8–59.4)		46.5 (41.3–51.7)	59.3 (53.9–64.5)

[a] Agreement means either the participant reported receipt of any doses of HAV vaccine and was anti-HAV positive or the participant reported receipt of no doses of HAV vaccine and was anti-HAV negative.

[b] For race/ethnicity, rows do not sum to the column total since estimates for other Hispanics and for those of other/multiple race groups are not presented.

Table 3

Crude (CPR) and adjusted prevalence ratios (APR) for factors associated with agreement between self-report of hepatitis A vaccination and HAV serological testing (Groups 1 and 2) medical examination participants: NHANES 2007–2012 aged ≥20 years.

Factor	Simple logistic model		Final multivariate logistic model	
	CPR (95% CI)	*p*-value*	APR (95% CI)	*p*-value†
Age at interview (years)				
20–29	0.59 (0.51–0.67)	<.001	0.56 (0.49–0.64)	<.001
30–39	0.71 (0.62–0.82)	<.001	0.65 (0.57–0.74)	<.001
40–49	0.70 (0.61–0.80)	<.001	0.66 (0.58–0.76)	<.001
50–59	0.80 (0.72–0.89)	<.001	0.78 (0.70–0.87)	<.001
60+ (ref)	–	–	–	–
Sex				
Male	1.07 (0.98–1.15)	.113	1.05 (0.97–1.13)	.242
Female (ref)	–	–	–	–
Race/ethnicity				
Mexican-American	1.80 (1.60–2.02)	<.001	1.58 (1.40–1.78)	<.001
White non-Hispanic (ref)	–	–	–	–
Black non-Hispanic	1.07 (0.94–1.22)	.318	1.13 (1.02–1.25)	.019
Poverty index				
Below poverty	1.01 (0.89–1.16)	.838	NS	–
At or above poverty (ref)	–	–		
Education				
<High school (ref)	–	–	–	–
High school/GED	0.69 (0.59–0.79)	<.001	0.84 (0.73–0.96)	.013
>High school	0.82 (0.73–0.91)	.001	1.03 (0.92–1.15)	.574
Place of birth				
United States (ref)	–	–	–	–
Elsewhere	1.94 (1.76–2.14)	<.001	1.72 (1.54–1.92)	<.001
Health insurance				
Any (ref)	–	–		
None	0.99 (0.86–1.13)	.844	NS	–

NS = variable not significant in simple logistic model or when added to final multivariate logistic model and therefore not included in the final multivariate model. Final model includes all variables found to be significant and potential confounds such as sex, even if not significant.

*p-value for significance of beta coefficients from simple logistic models.

†p-value for significance of beta coefficients from the final multivariate logistic model.

Table 4

Crude (CPR) and adjusted prevalence ratios (APR) for factors associated with agreement between self-report of no hepatitis A vaccination and HAV serological testing (Groups 3 and 4) medical examination participants: NHANES 2007–2012 aged ≥20 years.

Factor	Simple logistic model		Final multivariate logistic model	
	CPR (95% CI)	*p*-value*	APR (95% CI)	*p*-value†
Age at interview (years)				
20–29	1.36 (1.25–1.48)	<.001	1.51 (1.41–1.61)	<.001
30–39	1.32 (1.23–1.42)	<.001	1.49 (1.40–1.58)	<.001
40–49	1.36 (1.28–1.45)	<.001	1.47 (1.39–1.55)	<.001
50–59	1.27 (1.20–1.35)	<.001	1.32 (1.25–1.39)	<.001
60+ (ref)	–	–	–	–
Sex				
Male	1.01 (0.98–1.04)	.563	1.02 (0.99–1.05)	.154
Female (ref)	–	–	–	–
Race/ethnicity				
Mexican-American	0.27 (0.23–0.32)	<.001	0.49 (0.43–0.57)	<.001
White non-Hispanic (ref)	–	–	–	–
Black non-Hispanic	0.78 (0.73–0.83)	<.001	0.79 (0.75–0.85)	<.001
Poverty index				
Below poverty	0.76 (0.70–0.83)	<.001	0.95 (0.92–0.98)	.001
At or above poverty (ref)	–	–	–	–
Education				
<High school (ref)	–	–	–	
High school/GED	1.63 (1.50–1.76)	<.001	1.16 (1.11–1.21)	<.001
>High school	1.79 (1.63–1.97)	<.001	1.24 (1.19–1.30)	<.001
Place of birth				
United States (ref)	–	–	–	–
Elsewhere	0.25 (0.22–0.30)	<.001	0.47 (0.42–0.53)	<.001
Health insurance				
Any (ref)	–	–		
None	0.83 (0.76–0.90)	<.001	NS	–

NS = variable not significant in earlier stages of multivariate modeling and not included in the final multivariate logistic model. Final model includes all variables found to be significant and potential confounds such as sex, even if not significant.

*p-value for significance of beta coefficients from simple logistic models.

†p-value for significance of beta coefficients from the final multivariate logistic model.