

Adult Vaccination Disparities Among Foreign-Born Populations in the U.S., 2012

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Background: Foreign-born persons are considered at higher risk of undervaccination and exposure to many vaccine-preventable diseases. Information on vaccination coverage among foreign-born populations is limited.

Purpose: To assess adult vaccination coverage disparities among foreign-born populations in the U.S.

Methods: Data from the 2012 National Health Interview Survey were analyzed in 2013. For non-influenza vaccines, the weighted proportion vaccinated was calculated. For influenza vaccination, Kaplan–Meier survival analysis was used to assess coverage among individuals interviewed during September 2011–June 2012 and vaccinated in August 2011–May 2012.

Results: Overall, unadjusted vaccination coverage among U.S.-born respondents was significantly higher than that of foreign-born respondents: influenza, age ≥ 18 years (40.4% vs 33.8%); pneumococcal polysaccharide vaccine (PPV), 18–64 years with high-risk conditions (20.8% vs 13.7%); PPV, ≥ 65 years (62.6% vs 40.5%); tetanus vaccination, ≥ 18 years (65.0% vs 50.6%); tetanus, diphtheria, and acellular pertussis (Tdap), ≥ 18 years (15.5% vs 9.3%); hepatitis B, 18–49 years (37.2% vs 28.4%); shingles, ≥ 60 years (21.3% vs 12.0%); and human papilloma virus (HPV), women 18–26 years (38.7% vs 14.7%). Among the foreign born, vaccination coverage was generally lower for non-U.S. citizens, recent immigrants, and those interviewed in a language other than English. Foreign-born individuals were less likely than U.S.-born people to be vaccinated for pneumococcal (≥ 65 years), tetanus, Tdap, and HPV (women) after adjusting for confounders.

Conclusions: Vaccination coverage is lower among foreign-born adults than those born in the U.S. It is important to consider foreign birth and immigration status when assessing vaccination disparities and planning interventions.

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Introduction

Overall, in 2011, an estimated 40 million foreign-born people (13% of the U.S. population) were living in the U.S., an increase compared with 1970 (5%).^{1–3} The foreign born are individuals born outside of the U.S., Puerto Rico, and other U.S.-affiliated areas, such as

Guam and the Marshall Islands who were not U.S. citizens at birth.¹ Although foreign-born populations are distributed throughout the U.S., in 2011, more than 25% lived in California and an additional 30% collectively lived in New York, Texas, and Florida. The foreign born from Latin America was the largest region-of-birth group, accounting for 53% of all foreign-born individuals, followed by 29% from Asia, 12% from Europe, and 7% from other regions. Most (65%) of the foreign born arrived in the U.S. before 2000.¹

Prevalence of most vaccine-preventable diseases (VPDs) in the U.S. are at or near record lows, but VPDs remain endemic in other world regions. Foreign-born persons from endemic countries and their family members in the U.S. are at greater risk of exposure for some VPDs (e.g., hepatitis A and B, congenital rubella) either pre-migration or during return trips to visit friends and family.^{4–6}

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Foreign-born individuals, particularly those from Mexico, have been shown to have lower evidence of protective antibodies for some VPDs, possibly because of lack of vaccination, lower exposure, and waning immunity over time (e.g., tetanus, hepatitis B, varicella).^{5,7-10} The Advisory Committee on Immunization Practices (ACIP) recommends vaccinations for adults in the U.S. to prevent VPDs and their sequelae.¹¹ Influenza vaccination is recommended for adults of all ages each year; other vaccines target different populations based on age, high-risk medical conditions, behavioral risk factors (e.g., injection drug use), occupation, travel, and other indications.^{12,13} Most foreign-born individuals originate from countries with different vaccination schedules and practices than the U.S. Despite significant improvements in global vaccination coverage in recent years, coverage remains low in many regions.¹⁴ Even in the U.S., adult vaccination coverage remains low for most routinely recommended vaccines and well below Healthy People 2020 targets.^{12,13,15}

Analysis of two U.S. national surveys comparing vaccination coverage between foreign-born children and children of foreign-born mothers versus U.S.-born children and children of U.S.-born mothers, respectively, found disparities in vaccination levels of the foreign born for some vaccines (e.g., hepatitis B and *Haemophilus influenzae* type b) and advantages for others (e.g., pneumococcal conjugate vaccine and meningococcal conjugate vaccine).^{6-9,16} Vaccination coverage disparities for foreign-born compared to native populations have been reported from Canada and several countries in Europe, Africa, and Asia.¹⁷⁻²³ A few studies in the U.S. have reported disparities in some vaccinations among foreign-born adults at national, state, or local levels.^{8,24-27} However, comprehensive information on vaccination coverage on this population is limited. The purpose of this study is to examine coverage for certain routinely recommended adult vaccinations among the foreign born compared with U.S.-born individuals, by selected demographic characteristics, to help guide development of strategies for improving vaccination coverage among foreign-born populations. Coverage for influenza; pneumococcal polysaccharide vaccine [PPV]; tetanus toxoid-containing vaccines, including tetanus and diphtheria toxoid [Td] and tetanus, diphtheria, and acellular pertussis [Tdap]; hepatitis A [HepA]; hepatitis B [HepB]; herpes zoster [shingles]; and human papillomavirus [HPV] vaccines were assessed.

Methods

Data from the 2012 National Health Interview Survey (NHIS) were analyzed in 2013. The NHIS is an annual household survey conducted by the National Center for Health Statistics, CDC, which collects health information on the U.S. civilian, non-

institutionalized population.²⁸ Detailed methods for the NHIS are described in other publications.^{14,28} In 2012, the final response rate for the sample adult core was 61.2%.²⁸ The NHIS has routinely collected influenza and PPV vaccination information since 1989. Starting in 2000, HepB vaccination information was collected. Starting in 2008, other vaccination information such as HepA, HPV, shingles, and Td/Tdap was collected.

Vaccination coverage by foreign-born status for influenza, PPV, tetanus toxoid-containing vaccines (Td, Tdap, or unknown type) in the past 10 years, HepA, HepB, shingles, and HPV vaccines were assessed from coded survey questions on receipt of these vaccines.

Covariates from coded survey questions to measure associations among vaccination coverage were selected: U.S.-born status, time in the U.S., language spoken during interview, world region of birth, racial/ethnic status, nativity, and citizenship status. HepA vaccination was assessed among those traveling to countries of high or intermediate endemicity. Persons with high-risk conditions for pneumococcal vaccination were determined by questions in the NHIS and defined as persons with asthma, diabetes, cardiovascular disease, liver diseases, kidney diseases, chronic obstructive pulmonary disease, emphysema, chronic bronchitis, cancer, and current smokers. Poverty status was defined using 2012 poverty thresholds published by the U.S. Census Bureau, with below poverty defined as a total family income of <\$23,492 for a family of four.²⁹

Multivariable logistic regression and predictive marginals were conducted to assess vaccination coverage among U.S.- and foreign-born individuals adjusted for age, gender, race/ethnicity, marital status, education, employment status, poverty level, health insurance, number of doctor visits in the past year, whether the respondent had a usual place of health care, self-reported health status, and region of residence. Adjusted prevalence ratios were calculated comparing the U.S. and foreign born.

SUDAAN statistical software was used to calculate point estimates and 95% CIs of vaccination coverage.³⁰ SUDAAN generated asymmetric CIs based on a logit transformation were used. For the non-influenza adult vaccination coverage estimates, weighted percentages were used. To better assess unadjusted influenza vaccination coverage for the 2011–2012 influenza season, the Kaplan–Meier survival analysis procedure was used to assess coverage among individuals interviewed from September 2011 through June 2012 and vaccinated during August 2011 through May 2012.³¹ Kaplan–Meier analysis has advantages for season-specific influenza estimates over other approaches, such as using a full calendar year of data, or restricting estimates based on interviews conducted in the postvaccination period (e.g., March–June), which does not use all relevant data.³¹ The Kaplan–Meier approach uses all relevant data to maximize precision and use data collected during the vaccination period that likely has more accurate recall of vaccinations.³¹ To assess adjusted vaccination coverage and adjusted prevalence ratios, this study used logistic regression and predicted marginal modeling comparing the U.S. and foreign born for each selected vaccination. The NHIS was approved by the Research Ethics Review Board ([ERB] No. 2009-16) of the National Center for Health Statistics, CDC.

Results

Demographic characteristics of the study population are given in [Table 1](#). Of adults aged ≥ 18 years, 82.6% were born in the U.S. and 17.4% were foreign born. Among the

Table 1. Characteristics of the study population by birth status, U.S., National Health Interview Survey 2012, n (%)

	All adults	U.S. born	Foreign born
Characteristics			
Total	34,525 (100.0)	27,956 (82.6)	6,559 (17.4)
Age (years)			
18–49	18,165 (56.4)	14,057 (54.7)	4,102 (64.6)
50–64	8,978 (25.8)	7,557 (26.5)	1,420 (22.7)
≥ 65	7,382 (17.8)	6,342 (18.9)	1,037 (12.7)
Sex			
Male	15,273 (48.1)	12,277 (48.0)	2,992 (48.8)
Female	19,252 (51.9)	15,679 (52.0)	3,567 (51.2)
Race/ethnicity			
Non-Hispanic white	20,619 (66.5)	19,705 (76.5)	913 (18.9)
Non-Hispanic black	5,119 (11.5)	4,621 (12.4)	494 (7.3)
Hispanic	5,859 (14.9)	2,324 (7.4)	3,532 (50.5)
Non-Hispanic other	2,928 (7.2)	1,306 (3.8)	1,620 (23.3)
Marital status			
Married	14,930 (52.9)	11,497 (51.1)	3,432 (61.5)
Widowed/divorced/separated	9,124 (17.3)	7,713 (17.9)	1,406 (14.4)
Never married	10,393 (29.8)	8,680 (31.0)	1,709 (24.0)
Education			
Less than high school	5,487 (14.0)	3,433 (10.9)	2,053 (28.6)
High school graduate	8,938 (26.3)	7,528 (27.1)	1,409 (22.5)
College	19,947 (59.7)	16,912 (61.9)	3,032 (48.9)
Employment status			
Employed	20,038 (60.8)	15,962 (60.0)	4,070 (64.5)
Unemployed	2,077 (6.3)	1,642 (6.2)	435 (6.7)
Not in work force	12,385 (32.9)	10,332 (33.8)	2,049 (28.8)
Poverty level			
At or above poverty	24,725 (85.3)	20,481 (87.0)	4,242 (77.6)
Below poverty	6,008 (14.7)	4,370 (13.0)	1,637 (22.4)
Health insurance			
Yes, private	19,944 (62.6)	17,137 (66.0)	2,802 (46.6)
Yes, public	8,325 (20.3)	6,711 (20.2)	1,613 (21.2)
Not insured	6,144 (17.0)	4,010 (13.8)	2,131 (32.2)
Number of doctor visits in past year			
0	6,724 (19.7)	4,734 (17.3)	1,986 (30.8)
1	5,860 (18.0)	4,717 (17.9)	1,142 (18.2)

(continued on next page)

foreign born, 49.3% were from Mexico, Central America, or the Caribbean Islands; 22.7% from Asia; 12.3% from Europe; and 6.0% from South America (Table 1).

Overall, vaccination coverage among U.S.-born respondents was significantly higher than that of foreign-born respondents (Table 2): influenza, age ≥ 18 years (40.4% vs 33.8%); PPV, age 18–64 years with high-risk conditions (20.8% vs 13.7%); PPV, age ≥ 65 years (62.6% vs 40.5%); tetanus vaccination, age ≥ 18 years (65.0% vs 50.6%); Tdap, age ≥ 18 years (15.5% vs 9.3%); hepatitis B, age 18–49 years (three or more doses) (37.2% vs 28.4%); shingles, age ≥ 60 years (21.3% vs 12.0%); and HPV, women age 18–26 years (one or more doses) (38.7% vs 14.7%) (Table 2). Exceptions were noted for hepatitis A vaccination among travelers and hepatitis B vaccination of persons ≥ 18 years with diabetes.

Vaccination coverage was significantly higher for foreign-born individuals living in the U.S. < 10 years compared with those in the U.S. ≥ 10 years for Tdap vaccination (11.8% vs 8.7%, respectively), HepB vaccination (18–49 years; 33.7% vs 26.3%), and HepB vaccination (age ≥ 18 years with diabetes; 49.8% vs 20.6%) (Table 2). Vaccination coverage was significantly lower for foreign-born adults with < 10 years of residence in the U.S. compared with those with longer residence (≥ 10 years) for influenza vaccination (23.8% vs 36.4%, respectively) and PPV (age 18–64 years with high-risk conditions; 7.4% vs 14.7%)

Table 1. Characteristics of the study population by birth status, U.S., National Health Interview Survey 2012, n (%) (continued)

	All adults	U.S. born	Foreign born
2-3	8,492 (25.8)	7,013 (26.2)	1,475 (23.7)
4-9	8,105 (23.1)	6,862 (24.1)	1,242 (18.4)
≥ 10	4,669 (13.4)	4,076 (14.4)	593 (8.9)
Usual source of care			
Yes	28,531 (83.9)	23,789 (86.1)	4,735 (73.2)
No	5,642 (16.1)	3,876 (13.9)	1,763 (26.8)
Self-reported health status			
Excellent/very good	19,602 (60.3)	15,903 (60.6)	3,691 (59.3)
Good	9,636 (26.7)	7,741 (26.4)	1,893 (28.2)
Fair	3,999 (9.8)	3,236 (9.8)	763 (9.5)
Poor	1,270 (3.2)	1,062 (3.2)	208 (3.0)
Duration of residence			
U.S. born	27,956 (82.7)	27,956 (100.0)	NA (NA)
In U.S. < 10 years	1,339 (3.6)	NA (NA)	1,339 (20.8)
In U.S. ≥ 10 years	5,167 (13.7)	NA (NA)	5,167 (79.2)
Citizenship			
U.S citizen	31,269 (91.8)	27,956 (100.0)	3,313 (52.5)
Not U.S. citizen	3,214 (8.2)	NA (NA)	3,214 (47.5)
Language of the interview			
English	31,982 (93.7)	27,690 (99.0)	4,284 (68.6)
Not English	2,543 (6.3)	266 (1.0)	2,275 (31.4)
Birthplace			
U.S.	27,956 (82.6)	27,956 (100.0)	NA (NA)
Mexico/Central America/Caribbean Islands	3,443 (8.6)	NA (NA)	3,443 (49.3)
South America	391 (1.0)	NA (NA)	391 (6.0)
Europe	604 (2.1)	NA (NA)	604 (12.3)
Asia	1,569 (4.0)	NA (NA)	1,569 (22.7)
Others	543 (1.7)	NA (NA)	543 (9.7)
Region of U.S. residence			
Northeast	5,774 (18.2)	4,461 (17.5)	1,311 (21.3)
Midwest	7,193 (22.7)	6,466 (25.0)	725 (12.0)
South	12,536 (36.4)	10,496 (37.4)	2,038 (31.9)
West	9,022 (22.6)	6,533 (20.1)	2,485 (34.8)

Note: Values are unweighted sample size and weighted percentage in parentheses. Boldface indicates significance ($p < 0.05$ by χ^2 test comparing U.S.-born and foreign-born). NA, Not applicable.

(Table 2). Except for PPV vaccination of adults aged ≥ 65 years, vaccination coverage among foreign-born adults who were U.S. citizens was significantly higher than that for foreign-born respondents who were not U.S. citizens ($p < 0.05$).

Among U.S.-born respondents who preferred to be interviewed in a non-English language, vaccination coverage was significantly lower for influenza, tetanus, and HPV vaccination for women aged 18–26 years, compared with coverage among those who preferred to be interviewed in English (Table 3). Among the foreign born, coverage was significantly lower for all vaccinations among those who preferred to be interviewed in a language other than English compared with those who preferred English for the interview.

Among the U.S. born, coverage for most vaccinations was significantly lower for non-Hispanic blacks and Hispanics compared with non-Hispanic whites (Table 4). Among the foreign born, Hispanics had significantly lower coverage for most vaccinations compared with non-Hispanic whites, whereas non-Hispanic blacks had significantly lower vaccination coverage only for Td (Table 4). Among all race/ethnic-nativity groups, Hispanic foreign born had the lowest coverage for several vaccines, including influenza, Tdap, HepA, HepB (age 18–49 years), and shingles.

Vaccination coverage by foreign birth region varied

Table 2. Adult vaccination coverage by birth status and years living in the U.S., National Health Interview Survey 2012, % (95% CI)

Vaccination	Overall	U.S. born	Foreign born		Foreign born		Foreign born	
			Living in U.S. < 10 years	Living in U.S. ≥ 10 years	U.S. citizen	Non-U.S. citizen		
Influenza vaccination (2011–2012 season)^a								
≥ 18	39.2 (38.3, 40.2)	40.4 (39.4, 41.5)	33.8 (31.9, 35.8)	23.8 (20.1, 28.1)	36.4 (34.3, 38.7)	42.6 (39.8, 45.6)	24.3 (21.8, 27.0)	
Pneumococcal vaccination (ever received)								
18–64 with high-risk conditions	19.9 (18.8, 21.0)	20.8 (19.6, 22.0)	13.7 (11.6, 16.1)	7.4 (4.4, 12.0)	14.7 (12.2, 17.6)	16.3 (13.1, 20.1)	10.3 (7.7, 13.6)	
≥ 65	59.9 (58.4, 61.4)	62.6 (60.9, 64.2)	40.5 (36.9, 44.2)	48.8 (29.8, 68.1)	40.2 (36.6, 43.9)	40.7 (36.6, 44.9)	39.1 (30.5, 48.4)	
Tetanus vaccination (past 10 years)								
≥ 18	62.5 (61.8, 63.3)	65.0 (64.2, 65.8)	50.6 (49.0, 52.2)	53.1 (49.4, 56.8)	49.9 (48.1, 51.8)	52.4 (50.2, 54.6)	48.8 (46.6, 51.0)	
Tetanus vaccination including pertussis vaccine (past 7 years)								
≥ 18	14.3 (13.7, 15.0)	15.5 (14.8, 16.2)	9.3 (8.3, 10.5)	11.8 (9.3, 15.0)	8.7 (7.6, 10.0)	10.5 (9.0, 12.2)	8.1 (6.7, 9.6)	
Hepatitis A vaccination (≥ 2 doses)								
18–49 among travelers	19.1 (17.7, 20.6)	19.9 (18.2, 21.8)	17.1 (14.8, 19.7)	18.7 (14.9, 23.2)	16.3 (13.6, 19.4)	20.4 (16.9, 24.4)	14.1 (11.4, 17.3)	
Hepatitis B vaccination (≥ 3 doses)								
18–49	35.5 (34.5, 36.5)	37.2 (36.1, 38.3)	28.4 (26.4, 30.5)	33.7 (30.0, 37.6)	26.3 (23.9, 28.7)	36.1 (32.5, 39.7)	22.9 (20.7, 25.3)	
≥ 18 with diabetes	21.2 (19.3, 23.1)	20.8 (18.8, 22.9)	23.1 (18.8, 28.1)	49.8 (32.9, 66.8)	20.6 (16.2, 25.9)	26.9 (21.1, 33.7)	15.7 (10.5, 22.7)	
Shingles vaccination (ever received)								
≥ 60	20.1 (19.1, 21.2)	21.3 (20.2, 22.5)	12.0 (9.9, 14.6)	— ^b	12.1 (9.9, 14.8)	13.2 (10.6, 16.2)	7.3 (4.2, 12.3)	
Human papillomavirus vaccination (≥ 1 dose)								
18–26, male	3.7 (2.7, 5.1)	4.2 (3.0, 5.8)	— ^b	— ^b	— ^b	— ^b	— ^b	
18–26, female	35.6 (33.0, 38.3)	38.7 (35.9, 41.6)	14.7 (10.9, 19.6)	10.7 (6.7, 16.7)	19.1 (12.8, 27.6)	21.2 (13.6, 31.5)	10.4 (6.7, 15.8)	

Note: Boldface indicates significance ($p < 0.05$ by t test [U.S. born versus foreign born; living in U.S. < 10 years versus living in U.S. ≥ 10 years; U.S. citizen versus non-U.S. citizen]).

^aInfluenza vaccination coverage estimates are based on interviews conducted during September 2011 through June 2012, and vaccination received during August 2011 through May 2012.

^bEstimates are not reliable because of sample size < 30 or relative standard error > 30%.

Table 3. Adult vaccination coverage by birth status and language, U.S., National Health Interview Survey 2012, % (95% CI)

Vaccination	U.S. born		Foreign born	
	English-speaking	Non-English-speaking	English-speaking	Non-English-speaking
Influenza vaccination (2011–2012 season)^a				
≥ 18	40.5 (39.5, 41.6)	25.6 (17.6, 36.5)	37.4 (35.0, 39.8)	26.0 (22.8, 29.7)
Pneumococcal vaccination (ever received)				
18–64 with high-risk conditions	20.8 (19.6, 22.0)	21.0 (11.2, 35.9)	15.5 (12.9, 18.5)	9.9 (6.6, 14.5)
≥ 65	62.7 (61.0, 64.3)	— ^b	44.6 (40.0, 49.1)	30.5 (24.4, 37.4)
Tetanus vaccination (past 10 years)				
≥ 18	65.1 (64.3, 66.0)	53.2 (45.4, 60.9)	52.7 (50.8, 54.6)	46.2 (43.1, 49.2)
Tetanus vaccination including pertussis vaccine (past 7 years)				
≥ 18	15.5 (14.8, 16.3)	11.8 (6.6, 20.2)	11.5 (10.2, 13.0)	4.6 (3.3, 6.5)
Hepatitis A vaccination (≥ 2 doses)				
18–49 among travelers	19.8 (18.1, 21.7)	25.2 (14.7, 39.6)	19.3 (16.5, 22.4)	10.9 (7.7, 15.0)
Hepatitis B vaccination (≥ 3 doses)				
18–49	37.2 (36.1, 38.3)	38.9 (30.6, 47.9)	34.6 (31.7, 37.6)	16.0 (13.7, 18.7)
≥ 18 with diabetes	20.8 (18.8, 22.9)	— ^b	29.2 (23.0, 36.3)	13.6 (9.0, 20.2)
Shingles vaccination (ever received)				
≥ 60	21.3 (20.2, 22.5)	— ^b	15.0 (12.1, 18.4)	4.9 (2.8, 8.5)
Human papillomavirus vaccination (≥ 1 dose)				
18–26, male	4.0 (2.8, 5.6)	— ^b	— ^b	— ^b
18–26, female	39.1 (36.2, 42.0)	24.0 (14.1, 37.7)	17.3 (12.1, 24.0)	— ^b

Note: Boldface indicates significance ($p < 0.05$ by *t* test [English-speaking versus non-English-speaking]).

^aInfluenza vaccination coverage estimates are based on interviews conducted during September 2011 through June 2012, and vaccination received during August 2011 through May 2012.

^bEstimates are not reliable because of sample size < 30 or relative standard error $> 30\%$.

across vaccines compared with those born in the U.S. (Table 5). Except for HepB vaccination (age ≥ 18 years with diabetes), adult vaccination coverage was significantly lower among those who were born in Mexico, Central America, or the Caribbean Islands, compared with those who were born in the U.S. Coverage was lower for those born in Europe compared with coverage among those born in the U.S. for PPV and overall tetanus vaccination, but was higher for HepB vaccination for adults aged ≥ 18 years with diabetes (40.4% vs 20.8%, respectively) and similar for other vaccines. Among those who were born in Asia, coverage was lower for PPV (age ≥ 65 years), overall tetanus and Tdap vaccinations, and shingles vaccination, but was higher for HepB vaccination (age ≥ 18 years with diabetes; 34.5% vs 20.8%, respectively).

After adjusting for confounders, foreign-born adults aged ≥ 65 years were less likely to receive pneumococcal

vaccination than the U.S. born, and foreign-born adults aged ≥ 18 years were less likely to receive tetanus or Tdap vaccination than the U.S. born (Table 6). Foreign-born women aged 18–26 years were less likely to receive HPV vaccination than U.S.-born women (Table 6).

Discussion

This is the first comprehensive assessment of vaccination coverage among foreign-born adults in the U.S. Overall, vaccination coverage is generally lower among the foreign-born compared with U.S.-born individuals, even after adjusting for confounders for pneumococcal, tetanus, Tdap, and HPV vaccines. Vaccination coverage for the foreign born differs by time lived in the U.S., citizenship status, language used for interview, race/ethnicity, and birth country/region. Among the foreign

Table 4. Adult vaccination coverage by birth status and race/ethnicity, U.S., National Health Interview Survey 2012, % (95% CI)

Vaccination	U.S. born				Foreign born			
	NH White	NH Black	Hispanic	Other	NH White	NH Black	Hispanic	Other
Influenza vaccination (2011-12 season)^a								
≥ 18	42.6 (41.4, 43.8)	33.5 (31.2, 35.9)	29.9 (26.2, 33.9)	37.7 (33.1, 42.8)	39.1 (33.5, 45.1)	39.2 (32.0, 47.4)	27.2 (24.7, 30.0)	42.0 (38.2, 46.1)
Pneumococcal vaccination (ever received)								
18-64 with high-risk conditions	21.7 (20.3, 23.1)	19.8 (17.4, 22.3)	15.2 (11.9, 19.4)	17.1 (13.0, 22.2)	14.5 (9.6, 21.3)	17.8 (10.0, 29.8)	12.4 (9.5, 16.0)	14.9 (10.3, 21.1)
≥ 65	64.9 (63.1, 66.6)	47.7 (43.3, 52.2)	52.0 (44.0, 59.9)	48.4 (38.5, 58.5)	47.3 (39.7, 55.0)	— ^b	38.3 (33.2, 43.7)	38.3 (31.5, 45.6)
Tetanus vaccination (past 10 years)								
≥ 18	67.3 (66.3, 68.2)	54.2 (52.1, 56.3)	58.3 (55.7, 60.9)	67.3 (63.7, 70.7)	57.1 (52.5, 61.5)	49.4 (43.7, 55.1)*	49.2 (46.8, 51.5)	48.9 (45.9, 51.9)
Tetanus vaccination including pertussis vaccine (past 7 years)								
≥ 18	16.4 (15.5, 17.3)	9.7 (8.1, 11.4)	12.9 (11.0, 15.1)	22.1 (18.6, 26.0)	12.2 (9.4, 15.8)	11.5 (7.3, 17.6)	6.4 (5.1, 7.8)	12.8 (10.4, 15.5)
Hepatitis A vaccination (≥ 2 doses)								
18-49 among travelers	19.3 (17.3, 21.4)	17.2 (12.5, 23.3)	22.3 (18.3, 26.9)	26.6 (20.9, 33.3)	25.8 (19.0, 34.1)	16.6 (10.8, 24.5)	11.9 (9.3, 15.2)	21.4 (17.6, 25.9)
Hepatitis B vaccination (≥ 3 doses)								
18-49	37.6 (36.3, 39.0)	33.7 (30.9, 36.5)	36.6 (33.4, 39.9)	43.1 (38.1, 48.3)	40.1 (33.5, 47.0)	34.4 (27.7, 41.8)	20.9 (18.8, 23.2)	36.7 (32.3, 41.4)
≥ 18 with diabetes	20.4 (18.1, 23.0)	21.3 (17.3, 25.9)	19.5 (13.9, 26.8)	27.0 (18.8, 37.2)	29.2 (15.9, 47.4)	25.4 (13.6, 42.2)	16.7 (12.0, 22.7)	34.1 (24.9, 44.8)
Shingles vaccination (ever received)								
≥ 60	22.9 (21.6, 24.2)	8.8 (6.8, 11.2)	16.0 (11.7, 21.7)	22.5 (16.3, 30.3)	20.1 (14.6, 27.0)	— ^b	4.6 (2.9, 7.2)	14.6 (10.7, 19.8)
Human papillomavirus vaccination (≥ 1 dose)								
18-26, male	3.7 (2.4, 5.6)	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b	— ^b
18-26, female	44.1 (40.5, 47.8)	29.0 (23.1, 35.7)	25.6 (20.6, 31.3)	38.6 (28.3, 50.1)	25.7 (14.3, 41.8)	— ^b	11.5 (7.1, 18.1)	— ^b

Note: Boldface indicates significance ($p < 0.05$ by t test [comparing race/ethnicity where non-Hispanic white is the reference group]).

^aInfluenza vaccination coverage estimates are based on interviews conducted during September 2011 through June 2012, and vaccination received during August 2011 through May 2012.

^bEstimates are not reliable because of sample size < 30 or relative standard error $> 30\%$.

NH, non-Hispanic.

Table 5. Adult vaccination coverage by birth country/region, U.S., National Health Interview Survey 2012, % (95% CI)

Vaccination	Birth country/region					
	U.S.	Mexico/Central America/Caribbean Islands	South America	Europe	Asia	Others
Influenza vaccination (2011–12 season)^a						
≥ 18	40.4 (39.4, 41.5)	28.3 (25.6, 31.2)	26.1 (20.2, 33.4)	36.4 (30.3, 43.3)	42.0 (38.2, 46.0)	43.6 (35.7, 52.4)
Pneumococcal vaccination (ever received)						
18–64 with high-risk conditions	20.8 (19.6, 22.0)	13.0 (9.9, 16.9)	— ^b	13.1 (8.0, 20.7)	15.3 (10.6, 21.5)	18.4 (10.4, 30.3)
≥ 65	62.6 (60.9, 64.2)	35.4 (30.5, 40.7)	53.8 (37.0, 69.8)	47.7 (38.2, 57.4)	35.4 (28.8, 42.7)	47.9 (34.3, 61.7)
Tetanus vaccination (past 10 years)						
≥ 18	65.0 (64.2, 65.8)	48.1 (45.7, 50.6)	53.2 (47.4, 58.8)	58.0 (53.0, 62.8)	48.9 (45.8, 52.0)	56.8 (50.4, 62.9)
Tetanus vaccination including pertussis vaccine (past 7 years)						
≥ 18	15.5 (14.8, 16.2)	6.1 (4.9, 7.5)	9.3 (5.8, 14.6)	12.7 (9.2, 17.4)	12.1 (9.8, 14.7)	15.1 (10.7, 20.7)
Hepatitis A vaccination (≥ 2 doses)						
18–49 among travelers	19.9 (18.2, 21.8)	11.6 (9.1, 14.6)	— ^b	22.8 (14.5, 34.0)	20.5 (16.6, 25.0)	27.3 (19.1, 37.4)
Hepatitis B vaccination (≥ 3 doses)						
18–49	37.2 (36.1, 38.3)	20.1 (18.0, 22.5)	32.7 (25.4, 40.9)	41.8 (33.6, 50.4)	36.1 (31.5, 40.9)	41.3 (34.7, 48.1)
≥ 18 with diabetes	20.8 (18.8, 22.9)	15.9 (11.5, 21.5)	— ^b	40.4 (23.5, 59.9)	34.5 (24.6, 45.9)	— ^b
Shingles vaccination (ever received)						
≥ 60	21.3 (20.2, 22.5)	5.1 (3.2, 8.1)	— ^b	21.4 (14.3, 30.7)	14.6 (10.5, 20.0)	15.3 (9.0, 24.7)
Human papillomavirus vaccination (≥ 1 dose)						
18–26, male	4.2 (3.0, 5.8)	— ^b	— ^b	— ^b	— ^b	— ^b
18–26, female	38.7 (35.9, 41.6)	8.8 (5.2, 14.4)	— ^b	27.9 (15.0, 46.0)	— ^b	— ^b

Note: Boldface indicates significance ($p < 0.05$ by t test [comparing birth country/region where U.S. is the reference group]).

^aInfluenza vaccination coverage estimates are based on interviews conducted during September 2011 through June 2012, and vaccination received during August 2011 through May 2012.

^bEstimates are not reliable because of sample size < 30 or relative standard error $> 30\%$.

Table 6. Adjusted adult vaccination coverage by country of birth, U.S., National Health Interview Survey 2012

Vaccination	U.S. born		Foreign born	
	Adjusted ^a vaccination coverage (95% CI)	Adjusted prevalence ratio (95% CI)	Adjusted vaccination coverage (95% CI)	Adjusted prevalence ratio (95% CI)
Influenza vaccination (2011–2012 season)^b				
≥ 18	37.8 (36.8, 38.7)	ref	36.6 (34.3, 38.9)	1.0 (0.9, 1.0)
Pneumococcal vaccination (ever received)				
18–64 (high-risk)	20.5 (19.3, 21.7)	ref	17.3 (14.2, 21.0)	0.8 (0.7, 1.0)
≥ 65	61.8 (59.9, 63.6)	ref	48.2 (42.6, 53.9)	0.8 (0.7, 0.9)
Tetanus vaccination (past 10 years)				
≥ 18	64.5 (63.6, 65.4)	ref	58.1 (55.7, 60.4)	0.9 (0.9, 0.9)
Tetanus vaccination including pertussis vaccine (past 7 years)				
≥ 18	15.6 (14.8, 16.4)	ref	11.9 (10.3, 13.8)	0.8 (0.7, 0.9)
Hepatitis A vaccination (≥ 2 doses)				
18–49 among travelers	19.3 (17.6, 21.2)	ref	19.1 (15.8, 23.0)	1.0 (0.8, 1.2)
Hepatitis B vaccination (≥ 3 doses)				
18–49	36.6 (35.5, 37.8)	ref	33.6 (30.6, 36.7)	0.9 (0.8, 1.0)
≥ 18 with diabetes	21.4 (19.3, 23.7)	ref	23.7 (17.6, 31.1)	1.1 (0.8, 1.5)
Shingles vaccination (ever received)				
≥ 60	20.6 (19.4, 21.9)	ref	15.9 (12.0, 20.8)	0.8 (0.6, 1.0)
Human papillomavirus vaccination (≥ 1 dose)				
18–26, male	— ^c	ref	— ^c	— ^c
18–26, female	37.4 (34.5, 40.4)	ref	23.0 (16.2, 31.5)	0.6 (0.4, 0.9)

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

^aModel adjusted for age, gender, race/ethnicity, marital status, education, employment status, poverty level, health insurance, number of doctor visits in the past year, usual source of care, self-reported health status, region of residence.

^bInfluenza vaccination coverage estimates are based on interviews conducted during September 2011 through June 2012, and vaccination received during August 2011 through May 2012.

^cNot enough sample size to run adjusted models.

born, vaccination coverage is generally lower among non-U.S. citizens, those interviewed in a language other than English, and non-Hispanic blacks or Hispanics compared with U.S. citizens, those interviewed in English, and non-Hispanic whites. The Hispanic foreign born have the lowest coverage for several vaccines. This finding is particularly relevant because the foreign born from Latin America account for more than half of all foreign-born adults in the U.S.^{1–3}

Vaccination coverage among the foreign born in the U.S. depends on the vaccinations received as children or adults pre-migration, during migration, post-migration, or during return visits to their country of origin. Vaccination coverage and immunization schedules vary

by country and even by regions within countries.^{11,14,32}

For example, the adult vaccination schedules in Mexico are different compared with the U.S. (e.g., influenza: people aged ≥ 60 years, pregnant women, and people with risk factors [Mexico] versus universal vaccination [U.S.]; PPV: people aged ≥ 60 years with high-risk conditions and those aged ≥ 65 years versus people aged 18–64 years with high-risk conditions and those aged ≥ 65 years; Tdap: pregnant women versus people aged ≥ 18 years; HepA: no adult recommendation versus people with high-risk behaviors and those traveling to a country of high or intermediate endemicity; HepB: no adult recommendation versus people with high-risk behaviors, those with diabetes, and healthcare personnel;

HPV: no adult recommendation versus people aged 18–26 years; and shingles: no adult recommendation versus people aged ≥ 60 years).^{11,33} The differences between the U.S. and other countries in the schedules of routine vaccinations among adults may contribute to differences in the coverage levels of the studied vaccines. In most countries, immunization programs have historically focused on children.^{34–36} Depending on their origin, age at arrival, and year of arrival, foreign-born adults may be likely to have differences in vaccination coverage compared with U.S.-born populations when they arrive in the U.S.^{10,24}

After arrival in the U.S., many foreign-born adults experience socioeconomic, cultural, linguistic, and other barriers to accessing health care and preventive services, including immunizations.^{1,2,37} The percentage of uninsured is higher among non-U.S. citizens, recent immigrants, and those with poor/fair English proficiency.^{3,38} The study findings of lower vaccination coverage for non-citizens, recent immigrants, and those interviewed in a language other than English are not unexpected. These characteristics are closely associated with lower access to care.³ These populations may also be less aware of U.S. adult immunization recommendations.³⁹

The finding of disparities in vaccination coverage for non-English speakers also has been reported previously.^{40–46} Limited English proficiency has been reported to be an impediment to accessing health services and health promotion programs.^{40,44} Disparities in influenza and pneumococcal immunizations among older adults have been reported for those speaking Spanish at home,⁴⁰ those with limited English fluency, Hispanic Spanish speakers versus Hispanic English speakers,^{41–45} and those not having English as their primary language,^{40–45} independent of many demographic, access-to-care, and other factors.⁴³

The findings in this report are subject to one limitation. Adult vaccination coverage was self-reported and therefore might be subject to recall bias. However, self-reported influenza, PPV, tetanus, HepA, HepB, shingles, and HPV vaccination status among adults have been shown to be sensitive and specific for all except tetanus.^{47–51}

This study confirms the low adult vaccination coverage in the U.S. and documents significant disparities for foreign-born populations. These disparities are even more relevant because immigration is projected to become the principal driver of U.S. population growth and racial/ethnic diversity.^{1,3,52} Even when no disparities are identified (e.g., HepB), the low overall vaccination coverage is more worrisome for some foreign-born populations because of their higher risk of exposure to certain VPDs.²⁴

Any comprehensive adult vaccination strategy, particularly among the foreign born, needs to be tailored to the needs of the target populations and the capacity of public health and healthcare institutions to address their

vaccination needs.^{53,54} Access-to-care factors play an important role in vaccination uptake.^{55–58} Routine assessment of patient vaccination histories, recommendations, and offers of needed vaccinations should be incorporated into routine clinical care of adults.^{53,54,59} Ensuring standing orders are in place to reduce the number of missed opportunities of individuals who have already accessed healthcare system and enhancing reminder and recall systems for patients and providers are proven strategies to improve adult vaccination coverage.⁵⁴ Increasing healthcare providers' awareness about foreign-born vaccination disparities and best practices for addressing them is particularly important.⁵⁴

Given the high proportion of the foreign born with limited access to health care in the U.S., alternative, targeted outreach strategies have been recommended,⁶⁰ including offering vaccinations at non-traditional settings (e.g., ethnic fairs, migrant camps, workplaces). Community leaders, organizations, and community health workers serving foreign-born adults may be empowered to disseminate linguistic and culturally sensitive vaccination information. Access to low-cost or free vaccinations may be especially important for this population because of its limited economic resources⁶⁰ and high rate of uninsurance. All foreign-born individuals, irrespective of their immigration status, are eligible for public health programs providing vaccinations.^{37,61–63} However, other factors, such as limited local health department funding for vaccinations or immigrants' lack of awareness of their eligibility for those programs, may in practice restrict their use.

The Immigration and Nationality Act⁶⁴ and guidelines from CDC promote vaccinations among certain foreign-born populations. All foreign citizens applying for a permanent resident visa while overseas (482,000 in 2011) or adjusting status when already in the U.S. (580,000 in 2011) are required to show proof of having received all required vaccinations or otherwise must receive the first dose for each vaccine series.⁶⁵ Immigration-required vaccination, however, does not apply to unauthorized immigrants (11 million in 2011), those admitted with temporary worker visas (3.8 million in 2011), and international students and exchange visitors (2.3 million in 2011).⁶⁶ Several provisions of the Affordable Care Act (ACA) might improve access to healthcare services and ACIP-recommended vaccinations for some immigrants who were previously without health insurance.⁶⁷ However, unauthorized immigrants are excluded from the ACA and several large categories of foreign-born legal residents have restrictions in their eligibility for the federal Medicaid program.⁶⁸ Collaboration with immunization programs in countries of origin for targeted outreach and monitoring of migrants would also improve vaccination coverage among the foreign born.

Currently, some national surveys used in vaccination coverage monitoring collect little or no data related to foreign-born persons, limiting assessment disparities in this population. Strategies to increase inclusion of the foreign born in surveys include adding or expanding migration-related variables on surveys, ensuring data collection instruments are available for the main foreign languages spoken in the U.S., making translators available, and collaborating with leaders and organizations trusted by foreign-born communities.^{42,53,54,60,69,70}

As the size and race/ethnic diversity of the foreign-born population in the U.S. continues to increase, the findings of this study indicate that this population will be increasingly important to elimination of national adult vaccination disparities.⁶ Public policy makers, immunization programs, and healthcare providers should consider foreign-born populations in their public health assessment, evaluation, and outreach programs that target disadvantaged groups.⁶

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